R. T. Cunningham Inc.

General Office—415 South Fifth St., Harrison, N. J.

Sales Divisions

Eastern Division Sales Manager (New York City)
—Meade Brunet

Boston, Mass....................250 Stuart St.
New York, N. Y..................261 Fifth Ave.
Philadelphia, Pa.............1400 So. Penn Square

Central Division Sales Manager (Chicago, Ill.)
—M. F. Burns

Atlanta, Ga................498 Spring St., N. W.
Chicago, Ill.............520 North Michigan Ave.
Cleveland, Ohio..................925 Euclid Ave.

Western Division Sales Manager (Kansas City, Mo.)
—F. H. Larrabee

Dallas, Tex......................2200 Griffin St.
Kansas City, Mo.........2300 Fidelity Bank Bldg.
Minneapolis, Minn...............725 Rand Tower
San Francisco, Calif................325 Ninth St.

Warehouses and Service Stations

Central Warehouse

589 East Illinois St....................Chicago, Ill.
W. J. Flannelly, *Manager*

Eastern Warehouse

401 Bergen St....................Harrison, N. J.
E. M. Greenhalgh, *Manager*

Pacific Warehouse

325 Ninth St..................San Francisco, Calif.
H. G. Cunningham, *Manager*

Southern Warehouse

498 Spring St., N. W..................Atlanta, Ga.
P. M. Jefferys, *Manager*

Southwestern Warehouse

2200 Griffin St........................Dallas, Tex.
J. W. Cocke, *Manager*

Cunningham RADIO TUBE REFERENCE BOOK

1 • 9 • 3 • 3

Price $1.00

E. T. CUNNINGHAM, INC.
HARRISON, NEW JERSEY
A Radio Corporation of America Subsidiary

FORM NO. 1223

PERSONAL

Name ______________________________

Residence ______________________________

____

Business Address ________________________

____

In case of accident, please notify

____

____

Telephone ______________________________

Accident Ins. Policy No. __________________

Automobile Information:

License No. ___________________________

Motor No. _____________________________

Model No. _____________________________

____

____

____

____

THIS BOOK IS VALUABLE
If found, please return to the above.

E. T. Cunningham Inc.

We, of E. T. Cunningham, Inc., are proud to list some of our major accomplishments for 1932:

More Closely Knit Executive Organization—A thorough study of the executives of the home office, research, engineering, manufacturing, and district sales organizations of E. T. Cunningham, Inc. reveals that each man has been selected because of his qualifications for his particular job. Functioning smoothly as a whole, the executives of E. T. Cunningham, Inc. are basing their decisions upon the basic consideration of the interests of the distributor, dealer, and consumer.

New Tube Developments—For a number of years, radio set designers have been handicapped by the necessity of using certain tube types of old design. While the introduction of the '24, '35 and '47 made possible, sets of improved performance, tube and set design have not been coordinated to the proper degree. Sensing this need for an entirely new series of tubes of vastly improved design, the Cunningham Radio Tube Laboratories began, in 1931, an intensive program of research and development.

The first major results of this development program were made public in the Spring of 1932 with the announcement of the sensational Super-phonic Cunningham Radio Tubes. Developed at a cost of over $500,000, these new Cunningham Radio Tubes made possible the design of radio receivers of immeasurably improved performance. Radio set manufacturers were quick to appreciate and capitalize the tremendous advance made possible by these tubes. The result has been sets of vastly improved design, giving the radio distributor and dealer merchandise of demonstrably improved performance and added sales appeal.

Continuing the advance in tube design marked by the Super-phonic Cunningham Radio Tubes, the Cunningham Radio Tube Laboratories brought out in 1932 other new tube types engineered to meet the particular requirements of special applications.

Improved Manufacturing Facilities—Keeping pace with the development laboratories, the factories of E. T. Cunningham, Inc. have instituted new methods and installed new equipment to raise even higher the Cunningham standard of quality. The factory personnel has been carefully selected and trained. New and elaborate testing devices guard Cunningham quality at each step in the manufacture.

Today Cunningham Radio Tubes, manufactured under more rigid inspection limits and subjected to more exhaustive tests, are of even higher quality than those made in the past.

Selected Distributor List—E. T. Cunningham, Inc. feels justly proud of its wholesale distributors. Carefully selected with regard to their ability to render service and merchandising assistance to the retail dealer, they are an integral and important link in the distribution set-up of E. T. Cunningham, Inc.

Tube Checkers—A good tube checker has long been a necessity in every radio store. Although E. T. Cunningham, Inc. is not in the tube checker business, it cooperated with leading checker manufacturers in the design of adequate equipment, in order that radio dealers might obtain a good tube checker with a minimum cash outlay. These checkers were made available to dealers under a plan whereby an instrument of the highest quality could be obtained with a very low expenditure.

Merchandising Activities—Continuing a practice begun in 1931, E. T. Cunningham, Inc. conducted successful merchandising activities to assist those dealers who are showing outstanding ability in promoting the sale of Cunningham Radio Tubes. These dealers have received special cooperation and sales promotional material.

Radio Service Helps—Ever conscious of the importance of the radio service man to the industry, E. T. Cunningham, Inc. has devoted much time to the study of his problems. The result of these investigations has been the introduction of many technical and merchandising helps for the service department. New technical publications have been issued to give the information about Cunningham Radio Tubes needed in servicing modern receivers. Special set testing equipment has been made available under a plan which makes it possible for every radio service man to own the most modern servicing equipment. A complete system of records and files, procurable at a very low cost, enables the radio service department to keep accurate records with a minimum of effort. Sales aids designed particularly for the service department offer effective means of tapping profitably the tremendous radio service market.

Advertising Campaigns—Successful newspaper and magazine advertising campaigns have hammered home to the consumer the message of improved radio reception to be had with Cunningham Radio Tubes.

Test Activities—Each new merchandising idea developed by E. T. Cunningham, Inc. has been thoroughly tested by actual contact with the consumer. Only proved merchandising plans are released to Cunningham dealers.

New Packing—During 1932 a new type of packing for Cunningham Radio Tubes was developed. Representing a considerable monetary saving to distributors and dealers in packing and shipping expense over old packing methods, the new style sleeve packing has added display value and increased sales appeal.

Cunningham RADIO TUBE QUALITY

THE STORY OF A STANDARD

The vacuum tube undoubtedly has the most technical background of any product commonly used by the public. It is in all respects a scientific instrument, and as such must be manufactured with a degree of care and precision unknown in other common articles.

We may take a watch as a standard of comparison. To the layman a fine watch represents the ultimate in precision and accuracy. And yet a stop watch, the most delicately attuned of the timepieces, functions only on tenth-of-a-second intervals. A vacuum tube that responds to more than a million impulses a second is used in every radio set.

The task confronting the tube manufacturer begins to be appreciated. It is his job to turn out a product that measures up to every standard of the laboratory—but in quantities infinitely larger than required by any laboratory; not one or a dozen perfect specimens, but millions of them—all of the same high quality.

Stringent limitations are responsible for the extremely high quality of Cunningham Radio Tubes as they are manufactured today. But Cunningham engineers are not content with merely maintaining today's standard—high as it is. They are constantly and energetically striving to raise that standard, in order that the Cunningham organization's leadership in the vacuum tube field may always be preserved.

We have now progressed to the point where we are able to produce tubes with characteristics which remain practically unchanged throughout the useful life of the tube. Through improvement in strength of construction, we are now able to produce tubes whose characteristics are unaffected by the shocks and jars encountered in shipping. We are today testing *all tubes* for characteristics which more closely define the multiplicity of applications demanded by the large variety of radio receivers, and we have lowered the gas content limit of most tubes by from 50 to 75 per cent.

Paradoxically, such significant advances in quality have been achieved in spite of a product that grows ever more complicated. The reason for this increasing intricacy is the desire to give the set owner sterling performance *coupled with ease of operation.* Similar performance might be accomplished by changes within the set, but this would necessitate additional apparatus and higher costs.

If we go back far enough in the production line, we come to raw materials. The materials that go into Cunningham Radio Tube manufacture come from the four corners of the earth. Fifty-one out of the ninety-one known elements go into the construction of tubes. Every kind of raw material that goes into Cunningham Radio Tubes is tested, checked, or analyzed in the company's own laboratories.

Metal used in making Cunningham Radio Tube parts is first thoroughly cleaned. Parts are stamped out by automatic machinery which has been designed and built in the shops of the Cunningham company and represents the last word in tube-making machinery.

We proceed to the making of the stem and the assembly of the parts thereon, which forms the completed "mount". This is extremely exacting work. In one type of tube there are 40 different parts and 70 welding operations. A glance at a finished tube will show how fine many of these parts are and how closely they are assembled. Yet so carefully selected, trained, and supervised are the workers who assemble Cunningham Radio Tube mounts, and so efficient is the system under which they work, that the percentage of defective workmanship is amazingly small.

Each mount is completely assembled by one worker. By doing the entire unit, he takes greater pride, and therefore greater pains, in his work. Furthermore, each mount bears permanently the number of the employee who assembled it. Thus, if the mount proves defective, responsibility may definitely be fixed. The quality score of each operator is kept permanently on file. Great care is exercised in the selection of Cunningham employees. Only after a period of intensive training, under the supervision of experienced workers, is an operator ready to work on actual production.

After assembly, the mount is placed in its glass bulb, which is then sealed and evacuated. Next, the base is cemented on, and, after packing, the tube is ready for shipment except for testing.

Testing plays an immensely important part in the making of a Cunningham Radio Tube. It is difficult to give an idea of the number of tests, but engineers say, conservatively, that there are at least 35 distinct examinations. A thorough test follows every step of importance along the production line.

After the tube is completed, it is given a "100% check"—for all characteristics, shorts, loose bases, etc.—even for noise in a standard model radio set. Twenty-four hours later, sample tubes, representing 10-20% of the total, are again completely checked. A week or ten days later, every single tube is given another thorough test to make certain that each tube meets the rigid specifications of E. T. Cunningham, Inc.

Another group of tubes, selected at random from each dav's production, goes to the life testing racks. Here, the tubes are operated at normal voltages, just as they would operate in the owner's radio set. From time to time, they are taken from the racks and given a searching cross-examination. Should it be found that their characteristics are not remaining uniform throughout the life of the tube, or that the life is not normal, that production, of which they are representative, never leaves the warehouse.

Thus we see that each Cunningham Radio Tube receives a series of gruelling tests and inspections. Those which pass are worthy of the name they bear, for they are truly instruments of laboratory quality.

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, 1933	Est. % of Families Having Radio Sets
Alabama	2,646,248	592,530	157,996	26.7
Birmingham	259,678	64,443	28,292	43.9
Mobile	68,202	16,909	6,033	35.7
Montgomery	66,079	17,195	6,149	35.8
Arizona	435,573	106,630	37,582	35.2
Douglas	9,828	2,397	836	34.9
Phoenix	48,118	12,666	5,831	46.0
Tucson	32,506	8,266	3,371	40.8
Arkansas	1,854,482	439,408	115,555	26.3
Fort Smith	31,429	8,200	3,551	43.3
Little Rock	81,679	20,123	10,081	50.1
Pine Bluff	20,760	5,549	2,236	40.3
California	5,677,251	1,618,533	1,117,187	69.0
Berkeley	82,109	24,440	19,155	78.4
Fresno	52,513	14,556	8,117	55.8
Glendale	62,736	19,324	16,945	87.7
Long Beach	142,032	47,153	35,286	74.8
Los Angeles	1,238,048	370,462	281,241	75.9
Oakland	284,063	83,350	62,359	74.8
Pasadena	76,086	23,068	17,635	76.4
Sacramento	93,750	24,886	17,459	70.2
San Diego	147,995	45,454	31,008	68.2
San Francisco	634,394	180,346	118,321	65.6
San Jose	57,651	16,872	12,012	71.2
Colorado	1,035,791	268,531	147,403	54.9
Colorado Sps.	33,237	10,048	5,960	59.3
Denver	287,861	79,879	54,196	67.8
Pueblo	50,096	12,360	6,092	49.3
Connecticut	1,606,903	389,596	280,601	72.0
Bridgeport	146,716	35,902	27,127	75.6
Hartford	164,072	40,796	28,599	70.1
New Britain	68,124	15,568	9,444	60.7
New Haven	162,655	39,647	28,282	71.3
Waterbury	99,902	23,125	13,391	57.9
Delaware	238,380	59,295	37,354	63.0
Dover	4,800	1,200	753	62.8
New Castle	4,131	1,033	646	62.5
Wilmington	106,597	25,694	18,124	70.5
District of Columbia				
Washington	486,869	126,014	89,455	71.0
Florida	1,468,211	377,823	123,171	32.6
Jacksonville	129,549	32,555	13,624	41.8
Miami	110,637	30,902	12,894	41.7
St. Petersburg	40,425	12,749	5,262	41.3
Tampa	101,161	25,111	7,967	31.7
Georgia	2,908,506	654,009	176,944	27.1
Atlanta	270,366	68,021	29,343	43.1
Augusta	60,342	15,421	4,754	30.8
Macon	53,829	13,938	4,344	31.2
Savannah	85,024	22,495	7,214	32.1

U. S. POPULATION—RADIO SETS—Con't.

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1933	Est. % of Families Having Radio Sets
Idaho	445,032	108,515	51,465	47.4
Boise	21,544	5,931	3,419	57.6
Idaho Falls	9,429	2,300	1,088	47.3
Pocatello	16,471	4,164	2,217	53.2
Illinois	7,630,654	1,934,445	1,406,567	72.7
Chicago	3,376,438	845,868	679,120	80.3
Cicero	66,602	16,276	13,292	81.7
Decatur	57,510	15,421	10,025	65.0
E. St. Louis	74,347	19,122	11,224	58.7
Evanston	63,338	16,472	15,562	94.5
Oak Park	63,982	17,021	17,019	99.9
Peoria	104,969	26,627	19,178	72.0
Rockford	85,864	22,187	17,199	77.5
Springfield	71,864	18,799	12,298	65.4
Indiana	3,238,503	844,463	496,246	58.8
Evansville	102,249	25,769	13,194	51.2
Ft. Wayne	114,946	29,199	22,934	78.5
Gary	100,426	23,232	14,763	63.5
Hammond	64,560	15,513	12,082	77.9
Indianapolis	364,161	98,841	63,455	64.2
South Bend	104,193	25,682	17,765	69.2
Terre Haute	62,810	17,612	10,187	57.8
Iowa	2,470,939	636,905	418,435	65.7
Cedar Rapids	56,097	15,350	10,624	69.2
Davenport	60,751	16,706	11,831	70.8
Des Moines	142,559	38,190	26,167	68.5
Sioux City	79,183	20,051	13,354	66.6
Waterloo	46,191	11,957	8,457	70.7
Kansas	1,880,999	488,055	273,156	56.0
Kansas City	121,857	31,657	18,657	58.9
Topeka	64,120	17,468	11,498	65.8
Wichita	111,110	30,021	16,493	54.9
Kentucky	2,614,589	610,288	216,039	35.4
Covington	65,252	17,271	10,873	63.0
Lexington	45,736	12,060	5,391	44.7
Louisville	307,745	80,297	40,699	50.7
Louisiana	2,101,593	486,424	137,685	28.3
Baton Rouge	30,720	7,600	2,585	34.0
New Orleans	458,762	112,329	42,897	38.2
Shreveport	76,655	20,087	9,460	47.1
Maine	797,423	198,372	111,809	56.4
Bangor	28,749	6,906	4,193	60.7
Lewiston	34,948	7,998	3,739	46.7
Portland	70,810	17,582	11,346	64.5
Maryland	1,631,526	386,087	231,628	60.0
Baltimore	804,874	194,491	128,454	66.0
Cumberland	37,747	8,909	5,384	60.4
Hagerstown	30,861	7,701	4,224	54.9

U. S. POPULATION—RADIO SETS—Con't.

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1933	Est. % of Families Having Radio Sets
Massachusetts	4,249,614	1,024,527	765,633	74.7
Boston	781,188	180,451	132,166	73.2
Brockton	63,797	16,724	12,543	75.0
Cambridge	113,643	27,524	19,910	72.3
Fall River	115,274	27,077	16,611	61.3
Haverhill	48,710	12,764	8,383	65.7
Holyoke	56,537	14,010	9,503	67.8
Lawrence	85,068	20,097	10,899	54.2
Lowell	100,234	23,805	13,630	57.3
Lynn	102,320	26,001	21,114	81.2
Malden	58,036	14,187	11,869	83.7
Medford	59,714	14,413	12,935	89.7
New Bedford	112,597	27,982	15,129	54.1
Newton	65,276	15,350	14,323	93.3
Pittsfield	49,677	12,093	8,864	73.3
Quincy	71,983	18,343	16,415	89.5
Somerville	103,908	25,552	20,751	81.2
Springfield	149,900	38,188	29,719	77.8
Worcester	195,311	46,020	35,463	77.1
Michigan	4,842,325	1,183,157	801,898	67.8
Bay City	47,355	11,457	7,502	65.5
Dearborn	50,358	11,476	8,952	78.0
Detroit	1,568,662	371,344	279,142	75.2
Flint	156,492	37,757	26,207	69.4
Grand Rapids	168,592	43,567	28,982	66.5
Hamtramck	56,268	11,303	5,013	44.4
Highland Park	52,959	13,038	10,627	81.5
Jackson	55,187	14,335	10,584	73.8
Kalamazoo	54,786	13,867	9,522	68.7
Lansing	78,397	20,182	14,506	71.9
Pontiac	64,928	15,189	10,541	69.4
Minnesota	2,563,953	608,398	392,108	64.4
Duluth	101,463	23,984	16,026	66.8
Minneapolis	464,356	117,777	90,412	76.8
St. Paul	271,606	67,999	52,162	76.7
Mississippi	2,009,821	472,354	106,433	22.5
Jackson	48,282	11,130	4,045	36.3
Meridian	31,954	8,128	2,699	33.2
Vicksburg	22,943	6,861	2,047	29.8
Missouri	3,629,367	941,821	513,602	54.5
Kansas City	399,746	109,242	72,078	66.0
St. Joseph	80,935	21,065	13,219	62.8
St. Louis	821,960	215,680	145,216	67.3
Springfield	57,527	15,667	6,993	44.6
Montana	537,606	137,010	67,285	49.1
Butte	39,532	10,352	4,587	44.3
Great Falls	28,822	7,374	4,053	55.0
Missoula	14,657	3,924	1,675	42.7
Nebraska	1,377,963	343,781	223,244	64.9
Grand Island	18,041	4,555	2,883	63.3
Lincoln	75,933	20,229	13,641	67.4
Omaha	214,006	54,845	38,233	69.7

U. S. POPULATION—RADIO SETS—Con't.

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1933	Est. % of Families Having Radio Sets
Nevada	91,058	25,730	12,287	47.8
Las Vegas	5,165	1,476	706	47.8
Reno	18,529	5,093	3,147	61.8
Sparks	4,508	1,288	615	47.7
New Hampshire	465,293	119,660	73,607	61.5
Concord	25,228	6,181	4,103	66.4
Manchester	76,834	18,832	10,878	57.8
Nashua	31,463	7,612	4,861	63.9
New Jersey	4,041,334	987,616	794,848	80.5
Atlantic City	66,198	16,986	11,910	70.1
Bayonne	88,979	18,564	13,696	73.8
Camden	118,700	27,874	19,620	70.4
East Orange	68,020	19,077	18,223	95.5
Elizabeth	114,589	26,772	20,778	77.6
Hoboken	59,261	13,655	9,340	68.4
Irvington	56,733	15,106	14,421	95.5
Jersey City	316,715	76,436	61,334	80.2
Newark	442,337	105,398	75,415	71.6
Passaic	62,959	14,847	10,381	69.9
Paterson	138,513	35,556	27,506	77.4
Trenton	123,356	27,183	19,765	72.7
Union	58,659	16,127	12,818	79.5
New Mexico	423,317	98,820	28,356	28.7
Albuquerque	26,570	6,821	3,178	46.6
Roswell	11,173	2,860	1,091	38.1
Santa Fe	11,176	2,625	897	34.2
New York	12,588,066	3,162,118	2,370,911	75.0
Albany	127,412	34,186	24,980	73.1
Binghamton	76,662	18,880	12,378	65.6
Buffalo	573,076	140,215	100,984	72.0
Mount Vernon	61,499	15,361	13,488	87.8
New Rochelle	54,000	12,542	11,134	88.8
New York	6,930,446	1,728,695	1,317,846	76.2
Niagara Falls	75,460	17,626	13,506	76.6
Rochester	328,132	82,205	59,900	72.9
Schenectady	95,692	24,281	18,154	74.8
Syracuse	209,326	53,203	38,897	73.1
Troy	72,763	19,034	12,846	67.5
Utica	101,740	24,935	16,383	65.7
Yonkers	134,646	32,582	26,716	82.0
North Carolina	3,170,276	645,245	182,875	28.3
Asheville	50,193	11,762	5,555	47.2
Charlotte	82,675	19,319	9,727	50.3
Durham	52,037	11,508	4,073	35.4
Greensboro	53,569	11,528	5,096	44.2
Winston Salem	75,274	17,210	5,681	33.0
North Dakota	680,845	145,382	84,266	58.0
Fargo	28,619	6,679	4,252	63.7
Grand Forks	17,112	4,032	2,406	59.7
Minot	16,099	3,639	2,482	68.2

U. S. POPULATION—RADIO SETS—Con't.

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1933	Est. % of Families Having Radio Sets
Ohio	6,646,697	1,700,877	1,102,183	64.8
Akron	225,040	62,689	43,584	69.5
Canton	104,906	26,365	17,872	67.8
Cincinnati	451,160	122,832	80,796	65.8
Cleveland	900,429	222,131	144,980	65.3
Cleveland Hts.	50,945	13,271	13,117	98.8
Columbus	290,564	75,806	50,954	67.2
Dayton	200,982	52,839	38,331	72.5
Hamilton	52,176	13,219	8,799	66.6
Lakewood	70,509	19,656	18,373	93.5
Springfield	68,743	18,237	12,660	69.4
Toledo	290,718	74,205	58,092	78.3
Youngstown	170,002	39,101	24,610	62.9
Oklahoma	2,396,040	565,348	218,855	38.7
Muskogee	32,026	8,391	4,122	49.1
Oklahoma City	185,389	47,394	25,416	53.6
Tulsa	141,258	37,156	21,072	56.7
Oregon	953,786	267,690	162,172	60.6
Eugene	18,901	5,358	3,135	58.5
Portland	301,815	87,375	65,193	74.6
Salem	26,266	6,788	4,356	64.2
Pennsylvania	9,631,350	2,239,179	1,460,445	65.2
Allentown	92,563	22,838	18,206	79.7
Altoona	82,054	20,005	12,328	61.6
Bethlehem	57,892	13,570	9,783	72.1
Chester	59,164	13,579	8,636	63.6
Erie	115,967	28,252	19,338	68.4
Harrisburg	80,339	21,652	15,757	72.8
Johnstown	66,993	15,076	8,294	55.0
Lancaster	59,949	15,433	10,219	66.2
McKeesport	54,632	12,484	7,629	61.1
Philadelphia	1,950,961	459,629	337,408	73.4
Pittsburgh	669,817	155,519	107,944	69.4
Reading	111,171	27,706	20,311	73.3
Scranton	143,433	32,988	18,542	56.2
Wilkes-Barre	86,626	18,752	11,247	60.0
Rhode Island	687,497	165,811	123,001	74.2
Pawtucket	77,149	19,121	15,203	79.5
Providence	252,981	61,628	44,386	72.0
Woonsocket	49,376	11,253	7,430	66.0
South Carolina	1,738,765	366,265	90,780	24.8
Charleston	62,265	16,746	5,244	31.3
Columbia	51,581	11,239	4,323	38.5
Greenville	20,154	7,223	2,672	37.0
South Dakota	692,849	161,332	98,998	61.4
Aberdeen	16,465	4,058	2,711	66.8
Pierre	3,659	851	522	61.3
Sioux Falls	33,362	8,248	5,663	68.7

U. S. POPULATION—RADIO SETS—Con't.

City and State	Population U. S. Census 1930	No. of Families U. S. Census 1930	Estimated No. of Radio Sets Jan. 1, 1933	Est. % of Families Having Radio Sets
Tennessee	2,616,556	601,578	189,327	31.5
Chattanooga	119,798	29,252	11,813	40.4
Knoxville	105,802	24,381	10,232	42.0
Memphis	253,143	68,452	29,660	43.3
Nashville	153,866	39,501	17,934	45.4
Texas	5,824,716	1,383,280	494,703	35.8
Austin	53,120	12,815	4,952	38.6
Beaumont	57,732	14,512	5,766	39.7
Dallas	260,475	67,376	38,733	57.5
El Paso	102,421	24,564	8,968	36.5
Ft. Worth	163,447	43,167	22,225	51.5
Galveston	52,938	13,635	6,852	50.3
Houston	292,352	75,681	37,209	49.2
Port Arthur	50,902	12,522	5,236	41.8
San Antonio	231,542	55,898	24,099	43.1
Waco	52,848	13,329	6,288	47.2
Utah	507,847	116,254	67,660	58.2
Ogden	40,272	9,971	6,436	64.5
Provo	14,766	3,204	2,239	69.9
Salt Lake City	140,267	34,548	24,632	71.3
Vermont	359,611	89,439	55,221	61.7
Burlington	24,789	6,028	3,624	60.1
Montpelier	7,837	1,959	1,211	61.8
Rutland	17,315	4,374	3,047	69.7
Virginia	2,421,851	530,092	187,389	35.4
Lynchburg	40,661	9,357	3,607	38.5
Norfolk	129,710	31,991	15,792	49.4
Richmond	182,929	44,929	22,888	50.9
Roanoke	69,206	15,944	7,708	48.3
Washington	1,563,396	426,019	253,224	59.4
Seattle	365,583	101,794	70,553	69.3
Spokane	115,514	32,116	20,844	64.9
Tacoma	106,817	30,686	20,117	65.6
West Virginia	1,729,205	374,646	151,680	40.5
Charleston	60,408	14,128	8,191	58.0
Huntington	75,572	17,975	9,493	52.8
Wheeling	61,659	15,595	10,086	64.7
Wisconsin	2,939,006	713,576	486,683	68.2
Kenosha	50,262	12,088	9,535	78.9
Madison	57,899	15,097	11,963	79.2
Milwaukee	578,249	143,879	114,958	79.9
Racine	67,542	16,845	14,177	84.2
Wyoming	225,565	57,218	29,293	51.2
Casper	16,619	4,663	2,749	59.0
Cheyenne	17,361	4,590	3,072	66.9
Sheridan	8,536	2,189	1,120	51.2
U. S.	122,775,047	29,980,146	17,215,245	57.4

Radio 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 of Frequencies A continuous range of frequencies between two specified frequency limits.

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 Current The current associated with a carrier wave.

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 Amplifiers are generally employed in the operation of well-designed audio-frequency and radio-frequency amplifiers of radio receivers. For this use fidelity of signal reproduction is of prime importance. However, fidelity is obtained at the expense of power output and at relatively low efficiency. A radio tube used as a Class A Amplifier, is operated under such conditions that its dynamic characteristics are essentially linear.

Class B Amplifiers are employed in radio-frequency power amplifiers and in balanced or push-pull modulators of radio telephone transmitters. It is also finding applications for power output stages of some of the more recent designs of radio receivers. For these uses, large power output is obtained without appreciable distortion and with good efficiency. However, to obtain this large power, a larger exciting grid voltage is usually required than for the same tube in Class A Service. A radio tube used as a Class B Amplifier is operated under such conditions that with no exciting grid voltage applied to the tube, the plate current is very small. Under these conditions when excitation voltage is applied, only' the least negative half of this voltage produces power output.

Class C Amplifiers cover those applications where tubes are employed as oscillators or radio-frequency power amplifiers for transmitters. For these uses, very large power output with high efficiency is of primary consideration. However, this high output is obtained at the expense of considerable harmonic distortion. This distortion introduced in the output may be an advantage as for example in the case of frequency doubler circuits. In the case of a transmitting power output stage, the harmonics are removed from the fundamental frequency by means of suitable filters. A radio tube used as a Class C Amplifier is operated under such conditions that the grid is biased well beyond the point at which plate current starts. Under these conditions when excitation voltage of sufficient magnitude is applied, large peaks of plate current are obtained in the output of the tube.

Communication Band The band of frequencies due to modulation (including keying) actually occupied by the emission, for a given type of transmission.

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 Waves the successive oscillations of which are identical under permanent conditions.

Control Electrode An electrode upon which a voltage is impressed to vary the current to one or more other electrodes.

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)

Demodulation The detection of a modulated wave, current, or voltage, in order to obtain the signal imparted to it in the modulation process.

Detection The process of operation on a frequency or combination of frequencies by means of an asymmetrical conducting device to produce certain desired frequencies or changes in current.

Detector A device having an asymmetrical conduction characteristic which is used for operation on a frequency or combination of frequencies to produce certain desired frequencies or changes in current. (See Rectifier, Modulation, Demodulation.)

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 to the voltage between it and the other conductor divided by this voltage, all other conductors in the neighborhood being at the potential of either conductor.

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

Direct Current An 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 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 Superhetrodyne 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 output voltage under consideration is substantially proportional to the carrier voltage 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.

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.

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

Modulation The process whereby the frequency or amplitude of a wave is varied in accordance with a signal wave.

Modulator A device to effect 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, a cathode, and three additional electrodes. (Ordinarily the three additional electrodes are of the nature of grids.)

Percentage Modulation The ratio of half the difference between the maximum and minimum amplitudes of a modulated wave to the average amplitude, expressed 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.

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.")

Relay A device by means of which contacts in one circuit are operated by a change in conditions in the same circuit or in one or more associated circuits.

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 An electrode, usually associated with suitable auxiliary screening, and interposed between certain of the other electrodes to substantially eliminate the capacitance between them.

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

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 Conduction or charging current in an antenna resulting from physical contact between the antenna and charged bodies or masses of gas.

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.

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

RADIO LOG

Call Letters	Location	Dial Setting

Important U. S. Broadcasting Stations

Kilocycles	Call Letters	Location	Chain
980	KDKA	Pittsburgh, Pa.	N
1290	KDYL	Salt Lake City, Utah	N
1430	KECA	Los Angeles, Cal.	N
1180	KEX	Portland, Ore.	N
770	KFAB	Lincoln, Nebr.	C
1050	KFBI	Abilene, Kans.	
680	KFEQ	St. Joseph, Mo.	
1300	KFH	Wichita, Kan.	C
640	KFI	Los Angeles, Cal.	N
1340	KFPY	Spokane, Wash.	C
610	KFRC	S. Francisco, Cal.	C
600	KFSD	San Diego, Cal.	N
550	KFYR	Bismarck, N. D.	N
1470	KGA	Spokane, Wash.	N
1330	KGB	San Diego, Cal.	C
950	KGHL	Billings, Mont.	N
790	KGO	S. Francisco Cal.	N
620	KGW	Portland, Ore.	N
900	KHJ	Los Angeles Cal.	C
590	KHQ	Spokane, Wash.	N
970	KJR	Seattle, Wash.	N
1390	KLRA	Little Rock, Ark.	C
560	KLZ	Denver, Colo.	C
950	KMBC	Kansas City, Mo.	C
1090	KMOX	St. Louis, Mo.	C
1050	KNX	Los Angeles, Cal.	
830	KOA	Denver, Colo.	N
1180	KOB	Albuquerque, N. Mex.	
1380	KOH	Reno, Nevada	C
1260	KOIL	Council Bluffs, Ia.	N
940	KOIN	Portland, Ore.	C
1270	KOL	Seattle, Wash.	C
1480	KOMA	Okla. City, Okla.	C
920	KOMO	Seattle, Wash.	N
680	KPO	S. Francisco, Cal.	N
920	KPRC	Houston, Texas	N
1040	KRLD	Dallas, Texas	C
1330	KSCJ	Sioux City, Ia.	C
550	KSD	St. Louis, Mo.	N
1130	KSL	Salt Lake City, Utah	C
1460	KSTP	St. Paul, Minn.	N
620	KTAR	Phoenix, Ariz.	N
1450	KTBS	Shreveport, La.	N
1040	KTHS	Hot Springs, Ark.	N
1120	KTRH	Houston, Texas	C
1290	KTSA	San Antonio, Tex.	C
570	KVI	Tacoma, Wash.	C
1140	KVOO	Tulsa, Okla.	N
1270	KVOR	Colo. Sprgs, Colo.	C
1420	KWCR	Cedar Rapids, Ia.	N
1350	KWK	St. Louis, Mo.	N
850	KWKH	Shreveport, La.	
1020	KYW	Chicago, Ill.	N
1410	WAAB	Boston, Mass.	C
860	WABC	N.Y. City, N.Y.	C
1240	WACO	Waco, Texas	C
1320	WADC	Tallmadge, Ohio	C
1140	WAPI	Birmingham, Ala.	N
1060	WBAL	Baltimore, Md.	N
800	WBAP	Ft. Worth, Tex.	N
770	WBBM	Chicago, Ill.	C
1410	WBCM	Bay City, Mich.	C
900	WBEN	Buffalo, N. Y.	N
930	WBRC	Birmingham, Ala.	C
1080	WBT	Charlotte, N. C.	C
990	WBZ	Boston, Mass.	N
990	WBZA	Boston, Mass.	N
1220	WCAE	Pittsburgh, Pa.	N
1430	WCAH	Columbus, Ohio	C
600	WCAO	Baltimore, Md.	C
1170	WCAU	Philadelphia, Pa.	C
1080	WCBD	Zion, Ill.	
810	WCCO	Minneapolis, Minn.	C
970	WCFL	Chicago, Ill.	N
1490	WCKY	Covington, Ky.	N
940	WCSH	Portland, Me.	N
1220	WDAE	Tampa, Fla.	C
610	WDAF	Kansas City, Mo.	N
940	WDAY	Fargo, N. D.	N
1120	WDBO	Orlando, Fla.	C
1280	WDOD	Chattanooga, Tenn.	C
1330	WDRC	Hartford, Conn.	C
1250	WDSU	New Orleans, La.	C
660	WEAF	New York, N. Y.	N
780	WEAN	Providence, R. I.	C
1290	WEBC	Superior, Wis.	N
590	WEEI	Boston, Mass.	N
870	WENR	Chicago, Ill.	N
800	WFAA	Dallas, Texas	N
610	WFAN	Philadelphia, Pa.	C
1360	WFBL	Syracuse, N. Y.	C
1230	WFBM	Indianapolis, Ind.	C
1270	WFBR	Baltimore, Md.	N
560	WFI	Philadelphia, Pa.	N
940	WFIW	Hopkinsville, Ky.	

N—Stations associated with National Broadcasting Company.

C—Stations associated with Columbia Broadcasting System.

Important U. S. Broadcasting Stations

Kilo-cycles	Call Letters	Location	Chain	Kilo-cycles	Call Letters	Location	Chain
620	WFLA	Clearwater, Fla.	N	670	WMAQ	Chicago, Ill.	N
1450	WGAR	Cleveland, Ohio	N	1440	WMBD	Peoria, Ill.	C
720	WGN	Chicago, Ill.	C	1080	WMBI	Chicago, Ill.	
550	WGR	Buffalo, N. Y.	C	780	WMC	Memphis, Tenn.	N
890	WGST	Atlanta, Ga.	C	600	WMT	Waterloo, Iowa	C
790	WGY	Schenectady, N. Y.	N	1230	WNAC	Boston, Mass.	C
				570	WNAX	Yankton, S.Dak.	C
1150	WHAM	Rochester, N. Y.	N	560	WNOX	Knoxville, Tenn.	C
820	WHAS	Louisville, Ky.	C	1190	WOAI	San Antonio, Tex.	N
1440	WHEC	Rochester, N.Y.	C	1000	WOC	Davenport, Ia.	N
1390	WHK	Cleveland, Ohio	C	640	WOI	Ames, Iowa	
1000	WHO	Des Moines, Ia.	N	1440	WOKO	Albany, N. Y.	C
1430	WHP	Harrisburg, Pa.	C	710	WOR	Newark, N. J.	
1280	WIBA	Madison, Wis.	N	1200	WORC	Worcester, Mass.	C
560	WIBO	Chicago, Ill.		590	WOW	Omaha, Nebr.	N
580	WIBW	Topeka, Kan.	C	1160	WOWO	Ft. Wayne, Ind.	C
1300	WIOD	Miami, Fla.	N	1100	WPG	Atlantic C'y, N.J.	C
610	WIP	Philadelphia, Pa.	C	680	WPTF	Raleigh, N. C.	N
1010	WIS	Columbia, S. C.	N	560	WQAM	Miami, Fla.	C
1120	WISN	Milwaukee, Wis.	C	950	WRC	Washington, D.C.	N
890	WJAR	Providence, R. I.	N	600	WREC	Memphis, Tenn.	C
1290	WJAS	Pittsburgh, Pa.	C	1220	WREN	Lawrence, Kan.	N
900	WJAX	Jacksonville, Fla.	N	1250	WRHM	Minneapolis, Minn.	
1270	WJDX	Jackson, Miss.	N				
1130	WJJD	Mooseheart, Ill.		1280	WRR	Dallas, Texas	C
750	WJR	Detroit, Mich.	N	830	WRUF	Gainesville, Fla.	
1460	WJSV	Mt. Vernon Highway, Va.	C	1110	WRVA	Richmond, Va.	N
				1330	WSAI	Cincinnati, O.	N
760	WJZ	New York, N. Y.	N	740	WSB	Atlanta, Ga.	N
1380	WKBH	La Crosse, Wis.	C	650	WSM	Nashville, Tenn.	N
570	WKBN	Youngstown, O.	C	1320	WSMB	New Orleans, La.	N
1480	WKBW	Buffalo, N. Y.	C	1340	WSPD	Toledo, Ohio	C
550	WKRC	Cincinnati, O.	C	580	WTAG	Worcester, Mass.	N
900	WKY	Okla. City, Okla.	N	1070	WTAM	Cleveland, O.	N
1470	WLAC	Nashville, Tenn.	C	1330	WTAQ	Eau Claire, Wis.	C
1200	WLAP	Louisville, Ky.		780	WTAR	Norfolk, Va.	C
900	WLBL	Stevens Pt., Wis.		1060	WTIC	Hartford, Conn.	N
1260	WLBW	Erie, Pa.	C	620	WTMJ	Milwaukee, Wis.	N
620	WLBZ	Bangor, Me.	C	1260	WTOC	Savannah, Ga.	C
560	WLIT	Philadelphia, Pa.	N	920	WWJ	Detroit, Mich.	N
870	WLS	Chicago, Ill.	N	570	WWNC	Asheville, N. C.	N
700	WLW	Cincinnati, O.	N	1160	WWVA	Wheeling, W.Va.	C
630	WMAL	Washington, D.C.		1240	WXYZ	Detroit, Mich.	

N—Stations associated with National Broadcasting Company.

C—Stations associated with Columbia Broadcasting System.

Tools the Radio Service Man Should Carry

1 filament-break or neutralizing adaptor, UX. (4 prong)
1 filament-break or neutralizing adaptor, UY. (5 prong)
1 standard set analyzer.
1 portable modulated oscillator.
1 volt-ohmmeter.
1 small hand drill with assorted drills.
several small files.
1 hammer.
1 pair high resistance headphones.
1 electrician's knife.
1 pair diagonal cutting pliers.
1 pair long nose pliers.
1 pair 6" side cutting pliers.
1 complete set of Cunningham Radio Tubes.
1 non-metallic screw driver.
1 large screw driver.
1 small screw driver.
1 set small socket wrenches.
1 electric soldering iron.
rosin core solder.
1 roll friction tape.
assorted nuts, screws and washers.
1 roll solid No. 18 Push Back Wire.
2 non-metallic socket wrenches.
1 set small open end wrenches.

The above are bare necessities. In addition to these the well prepared and efficient service man will also add the following items.

1 small bottle wood alcohol.
1 pocket ammeter.
1 small bottle household ammonia.
1 small piece of cheese cloth.
7 small fixed condensers—.0001—.001—.006—.00025—.01—.5—1.0 m f d.
1 star drill.
1 small flashlight, fountain pen type.
8 grid leaks—.1—.25—.5—1.0—2.0—3.0—5.0—10. megohms.
1 small hydrometer in carrying case.
2 glass insulators.
several "Nail-It" knobs.
1 small bottle furniture polish.
5 carbon resistors—500, 700, 800, 1,000, 2,000 ohms.
6 variable wound resistors—2,000, 5,000, 10,000, 25,000, 50,000, 100,000 ohms.
6 wire wound resistors—1,000, 2,000, 3,000, 5,000, 7,500, 10,000 ohms.
1 small bottle Vaseline.
1 roll antenna wire.
1 roll lead-in wire.
1 6-32 tap and wrench.
1 8-32 tap and wrench.
1 dentist's hand mirror.

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_c = 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.

Receiver Circuit Analysis

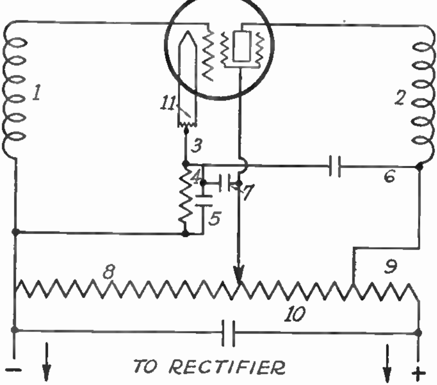


Fig. 1

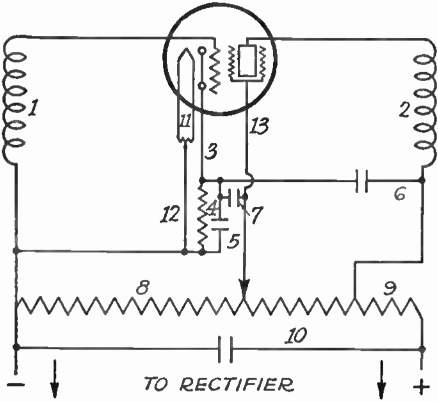


Fig. 2

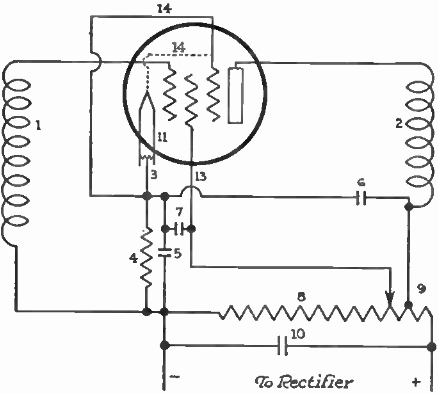

14
14
1
2
11
3
13
6
7
4
5
8
9
10
−
To Rectifier
+

Fig. 3

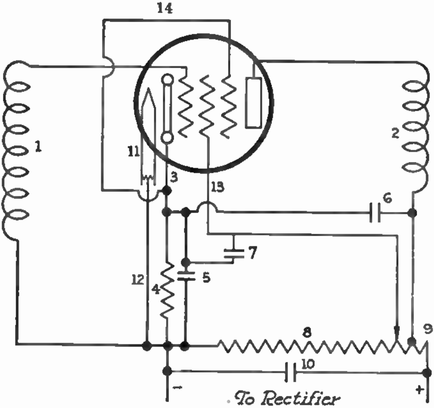

14
1
2
11
3
13
6
7
5
12
4
8
9
10
−
To Rectifier
+

Fig. 4

Receiver Circuit Analysis

Circuit No.	Condition	Ec_1	Ec_2	Ic_2	Ib	Eb	Ek_f	Ec
1	Op	O	Lo	Hi	Hi	Lo	Hi	
* 2	Op	O	Nor	Hi	O	O	O	
† 3	Op	Hi	O	O	O	O	Hi	
4	Op	Hi	O	O	O	O	Hi	
5	S	O	Lo	Hi	Hi	Lo	O	
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	O	O	O	O	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	O	O	O	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	O	O	O	O	O	O	
10	S	O	O	O	O	O	O	
11	Op	Nor	Nor	Nor	Nor	Nor	Nor	Hum
12	Op	Nor	Nor	Nor	Nor	Nor	O	Hum
13	Op	O	O	O	O	Hi	O	
14	Op	Nor	Nor	Hi	Lo	Nor	Nor	Hi

Exceptions:

*Ec_1 = O when Individual Bias Resistor.

Ec_1 = Lo when Common Bias Resistor, or S. G. Tube.

†Ec_1 & Ek_f = Hi when Individual Bias Resistor.

Ec_1 & Ek_f = Lo when Common Bias Resistor.

‡Ec_1 and Ek_f = O when condenser return is to neg. end No. 4 or Neg. Rectifier.

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 D. C. 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, $E_m = R_m I_m$ R_m = resistance of meter = 50 ohms I_m = full scale current = 1 milliampere = .001 ampere E_m = 50x.001 = 0.05 volts.

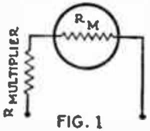


FIG. 1

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 mil meter 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.

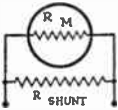


FIG. 2

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

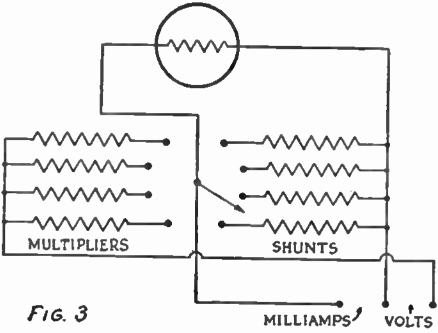


FIG. 3

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	Resistance in Ohms of Multiplier or Shunt		Multiply old scale by
0-10	Voltmeter	10,000	M	10
0-50	"	50,000	M	50
0-100	"	100,000	M	100
0-250	"	250,000	M	250
0-500	"	500,000	M	500
0-1000	"	1,000,000	M	1000
0-10	Milliammeter	3	S	10
0-50	"	0.551	S	50
0-100	"	0.272	S	100
0-500	"	0.0541	S	500
	35 Ohm (0-1.5) Milliammeter			
0-15	Voltmeter	10,000	M	10
0-150	"	100,000	M	100
0-750	"	500,000	M	500
0-15	Milliammeter	3.89	S	10
0-75	"	0.714	S	50
0-150	"	0.354	S	100
0-750	"	0.0701	S	500

TUBE CHECKERS FOR DEALER USE
Their Uses and Their Limitations

A customer brings his tubes into a radio store to have them tested when he thinks they have approached the end of their useful life. It is neither possible nor practical for the dealer to run a complete characteristic test on each tube to determine whether or not it is fit for further use. Fortunately, however, comparatively simple testing equipment will separate the satisfactory from the unsatisfactory tubes with adequate accuracy.

Such equipment gives the best results when used on tubes manufactured with a high degree of uniformity, since usually only one of the more important tube characteristics are checked by simple tube testers. When checking only one characteristic the assumption —which is not always correct—is that the other characteristics are normal and therefore may be neglected as test factors.

In discussing the application of tube testers for dealer use it is desirable to make clear at the start what is to be accomplished by tube checker equipment.

Tube checkers should assist the dealer in two ways:

1. By providing a means for determining whether a person who has brought in some used tubes is a logical customer for new tubes.
2. By building customer confidence and promoting the sale of new tubes.

To accomplish these results, the tube checker must be properly designed, first, from the engineering viewpoint, and secondly, from the merchandising viewpoint as a sales aid.

Engineering Requirements

From the engineering viewpoint, the most important requirements of a tube checker are accuracy of results and simplicity of operation. Practically, good design means a proper balance between these two requirements. Extreme accuracy is of little value, if the equipment is too complicated for operation by non-technical salespeople. Simplicity without adequate accuracy for the job means false conclusions as to the condition of the tubes being tested.

Rejection Limits

In setting up the low limit of performance for used tubes, that is, the point at which the customer should renew them in order to obtain normal performance, it must be borne in mind that the function which the tube performs and the voltage conditions under which it operates largely determine performance in any individual socket of a receiver.

Some form of mutual conductance measurement has been generally used as an indicator of tube merit. The practice in tube testing equipment, until recently, was to allow a fixed percentage reduction below the average of new tubes to establish the rejection point. Recent practice has been to allow different percentages, depending on the type of service for which the tube was designed, in an endeavor to more closely correlate test results with tube performance in a receiver.

This statement of recent practice should answer many questions as to the difference between rejection values in various makes and models of tube testing equipment. The effect of this new program, of course, is to assure the dealer of satisfied customers, since the adjustment of the rejection limits to the usual tube function, rather than an arbitrary basis, gives meter indications more comparable to actual performance in the radio receiver.

Accuracy

Accuracy is a relative word and simply means precision necessary for the job. In the case of tube checkers, *the job is to determine whether or not a given tube is satisfactory for operation in a radio receiver.* Actually, the design factors of radio receivers vary between different manufacturers and even socket positions in sets of the same manufacturer, placing different requirements on the same type of tube. It is only possible, therefore, to give approximate values for the point at which a tube may be considered worn-out. Under these conditions, moderate accuracy of test equipment is all that is required or can be utilized.

For the purpose of dealer use it is not necessary that a tube checker show the exact condition of a tube in terms of mutual conductance, plate drain, or other electrical characteristics. These terms have no significance for the non-technical customer and salesperson. All that is necessary is a reading which can be easily interpreted with the required accuracy. In fact, a classification of results such as "Satisfactory," or "Unsatisfactory" has much to recommend it from the standpoint of simplicity. The customer more readily recognizes under such a system that when a tube tests "Unsatisfactory" the wise thing to do is to buy a new one.

Simplicity of Tester Operation

Simplicity of operation is most essential for the benefit of both the customer and the salesperson. The results should be presented so clearly to the customer that he has no trouble in drawing his own conclusions as to whether his tube is fit for further operation or not. If such is the case, the customer's confidence in the dealer is increased and the salesman's time is saved by the elimination of long explanations which are often misinterpreted and misunderstood.

Sales Requirements

The tube checker should be useful in assisting the salesperson in making a sale by enabling the customer to visualize for himself the condition of his tubes. The customer likes to see for himself whether his tubes are good or bad. He likes the feeling of assurance that comes from the fact that he has just had his tubes tested and knows their condition. Thus, a tube checker serves as an added inducement for people to come into the store and also furnishes a means by which a dealer can give that additional service which is so productive of sales.

Summary

A good tube checker will have the following distinguishing features:

1. Indicates shorted tube elements.
2. Indicates tube value by some form of mutual conductance measurement.
    a. Direct reading method.
    b. Shift of grid bias method.
3. Has a line voltage control with an indicating voltmeter to take care of variations in line supply voltage.
4. Has pre-heater for heater type tubes.
5. Presents results quickly, clearly, and simply to both the salesman and the customer.
6. Is simple to operate.
7. Is built for service.

A tube checker for dealer use is not a final court of appeals which will accurately define a tube's merit, but it is a useful and helpful selling tool, when properly employed.

"Ten Commandments of Retail Selling"

1. Greet each customer with a smile.
2. Give each customer your entire attention.
3. Always have your customer's interest at heart.
4. Never become impatient.
5. Never speak discourteously.
6. Always try to get any item called for that you do not have in stock.
7. Be honest with your customer.
8. Give your customer reason to appreciate your service.
9. Keep your customer satisfied and happy.
10. Always remember to say "Thank you".

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.

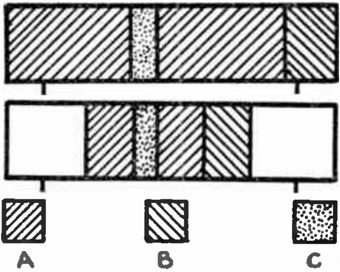
The foregoing methods of calculations cannot be used in connection with receivers employing a bleeder circuit to obtain grid bias.

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



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.

Examples:	A	B	C
10 ohms	Brown-(1)	Black- (0)	Black- (No Ciphers)
200 ohms	Red- (2)	Black- (0)	Brown-(One "
3,000 ohms	Orange-(3)	Black- (0)	Red- (Two "
3,400 ohms	Orange-(3)	Yellow-(4)	Red- (Two "
40,000 ohms	Yellow-(4)	Black- (0)	Orange-(Three "
44,000 ohms	Yellow-(4)	Yellow-(4)	Orange-(Three "
43,000 ohms	Yellow-(4)	Orange-(3)	Orange-(Three "

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 24,000 ohms or 26,000 ohms and be so coded.

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	Ounce = 28.35 Gram
Gram = .0353 Ounce	Lb. = .454 Kilog'm
Kilogram = 2.205 Lb.	Ton(Sht) = 907.03 Kilog'm
Kilogram = .0011 Ton(Sht)	Ton(Sht) = .907 Met. Ton
Met. Ton = 1.1025 Ton(Sht)	Ton(Sht) = 2,000 Lb.
Grain = .0684 Gram.	

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.

DIAMETER, WEIGHTS AND RESISTANCE OF COPPER WIRE

No. AWG.	Diameter Mils	Area, Circular Mils	Weight, Bare Wire: Pounds per 1000 Ft.	Weight, Bare Wire: Pounds per Mile	Resistance at 25°C. (77°F.): Ohms per 1000 Ft.	Resistance at 25°C. (77°F.): Ohms per Mile	Resistance at 25°C. (77°F.): 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	38.25
25	17.90	320.4	0.970	5.12	33.00	174.3	30.30
26	15.94	254.1	0.769	4.06	41.6	219.5	24.04
27	14.20	201.5	0.610	3.220	52.4	276.8	19.07
28	12.64	159.8	0.484	2.556	66.1	349.2	15.13

DIAMETER, WEIGHTS AND RESISTANCE OF COPPER WIRE

No. AWG	Diameter Mils	Area, Circular Mils	Weight, Bare Wire: Pounds per 1000 Ft.	Weight, Bare Wire: Pounds per Mile	Resistance at 25°C. (77°F.): Ohms per 1000 Ft.	Resistance at 25°C. (77°F.): Ohms per Mile	Resistance at 25°C. (77°F.): 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: Rubber Insulation	Amperes: Other Insulation	Circular Mils	Amperes: Rubber Insulation	Amperes: 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

$R_t = R_{25}\,[1 + 0.00385\,(t - 25)]$, where

R_t = the resistance in ohms at a temperature, t.

R_{25} = the resistance in ohms at 25 degrees, Centigra

t = the temperature of wire in degrees, Centigra

Temp. C.=5/9 (Temp. F.)−32.

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

SPECIFIC RESISTANCE OF METALS AND ALLO AT ORDINARY TEMPERATURES

SUBSTANCE	Specific Resistance Microhms per cm³	Relative Conductance	SUBSTANCE	Specific Resistance Microhms per cm³	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

Conversion Table—Kilocycles to Wavelength

Kilocycles	Wavelength Meters	Kilocycles	Wavelength Meters
550	545.1	1030	291.1
560	535.4	1040	288.3
570	526.0	1050	285.5
580	516.9	1060	282.8
590	508.2	1070	280.2
600	499.7	1080	277.6
610	491.5	1090	275.1
620	483.6	1100	272.6
630	475.9	1110	270.1
640	468.5	1120	267.7
650	461.3	1130	265.3
660	454.3	1140	263.0
670	447.5	1150	260.7
680	440.9	1160	258.5
690	434.5	1170	256.3
700	428.3	1180	254.1
710	422.3	1190	252.0
720	416.4	1200	249.9
730	410.7	1210	247.8
740	405.2	1220	245.8
750	399.8	1230	243.8
760	394.5	1240	241.8
770	389.4	1250	239.9
780	384.4	1260	238.0
790	379.5	1270	236.1
800	374.8	1280	234.2
810	370.2	1290	232.4
820	365.6	1300	230.6
830	361.2	1310	228.9
840	356.9	1320	227.1
850	352.7	1330	225.4
860	348.6	1340	223.7
870	344.6	1350	222.1
880	340.7	1360	220.4
890	336.9	1370	218.8
900	333.1	1380	217.3
910	329.5	1390	215.7
920	325.9	1400	214.2
930	322.4	1410	212.6
940	319.0	1420	211.1
950	315.6	1430	209.7
960	312.3	1440	208.2
970	309.1	1450	206.8
980	305.9	1460	205.4
990	302.8	1470	204.0
1000	299.8	1480	202.6
1010	296.9	1490	201.2
1020	293.9	1500	199.9

Winding Turns per linear Inch

B & S Gauge No.	D.C.C.	S.C.C.	Enamel
6	5.44	5.60	
7	6.08	6.23	
8	6.80	6.94	
9	7.64	7.68	
10	8.51	8.55	
11	9.58	9.60	
12	10.62	10.80	
13	11.88	12.06	
14	13.10	13.45	14.00
15	14.68	14.90	16.00
16	16.40	17.20	18.00
17	18.10	18.80	21.00
18	20.00	21.00	23.00
19	21.83	23.60	27.00
20	23.91	26.40	29.00
21	26.20	29.70	32.00
22	28.58	32.00	36.00
23	31.12	34.30	40.00
24	33.60	37.70	45.00
25	36.20	41.50	50.00
26	39.90	45.30	57.00
27	42.60	49.40	64.00
28	45.50	54.00	71.00
29	48.00	58.80	81.00
30	51.10	64.40	88.00
31	56.80	69.00	104.00
32	60.20	75.00	120.00
33	64.30	81.00	130.00
34	68.60	87.60	140.00
35	73.00	94.20	160.00
36	78.50	101.00	190.00
37	84.00	108.00	195.00
38	89.10	115.00	205.00
39	95.00	122.50	215.00
40	102.50	130.00	230.00
41	112.00	153.00	240.00
42	124.00	168.00	253.00
43	140.00	192.00	265.00
44	153.00	210.00	275.00

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)

Formulae

A.C.

$$I = \frac{E}{Z}$$

$$I = \frac{P}{E\cos\phi}$$

D.C.

$$I = \frac{E}{R}$$

$$I = \frac{P}{E}$$

Capacity of condensers in parallel

$$C = C_1 + C_2$$

Capacity of condensers in series

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}$$

Resistances in parallel.

$$R = \frac{R_2 \times R_1}{R_2 + R_1}$$

Resistances in series.

$$R = R_1 + R_2$$

Resistance, inductance and capacity in series

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

Inductive reactance.

$$X = \omega L$$

Capacitative reactance.

$$X = \frac{1}{\omega C}$$

Net Reactance.

$$X = X_L - X_c$$

At resonance in series circuit,

$$f = \frac{1}{2\pi}\sqrt{LC}$$

in parallel circuit

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L}}$$

Oscillation constant of series resonance.

$$\omega = \frac{1}{\sqrt{LC}}$$

Wavelength of series resonance.

$$\lambda = \omega\sqrt{LC}$$

Frequency of series resonance.

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Current in series circuit at resonance.

$$I_r = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

Mutual inductance measurement.

$$M = \frac{L_1 - L_2}{4}$$

Where
C capacity in farads
C_1 capacity of first condenser
C_2 capacity of second condenser
cos ϕ = power factor
E in volts
f cycles per second
I in amperes
L inductance in henrys
L_1 = inductance fields aiding
L_2 = inductance fields opposing
M = mutual inductance

R in ohms
X in ohms
X_L in ohms
X_c in ohms
Z in ohms
λ wavelength in meters
π 3.1416
ω $2 \pi f$
P in watts

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	×	1,000,000,000	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

Symbols

E_f........Filament (or heater) terminal voltage

E_b........Average plate voltage (d-c)

I_b ....Average plate current (d-c)

E_p........A-C component of plate voltage (effective value)

I_p........A-C component of plate current (effective value)

E_c........Average grid voltage (d-c)

I_c.........Average grid current (d-c)

E_g........A-C component of grid voltage (effective value

I_g........A-C component of grid current (effective value)

E_{ff}.......Filament (or heater) supply voltage

E_{bb}.......Plate supply voltage (d-c)

E_{cc}.......Grid supply voltage (d-c)

E_{c1}, E_{c2}, E_{c3} Average voltage of grids 1, 2, 3, . . Grids are numbered in order of their proximity to the cathode

E_{cc1}, E_{cc2}, E_{cc3} Supply voltage of grids 1,2,3, ...

μ........Amplification factor

r_p........Plate resistance

s_m........Grid plate transconductance (also mutual conductance, g_m)

R_p........Plate load resistance

Z_p........Plate load impedance

D-C......Direct Current (as adjective)

A-C......Alternating Current (as adjective)

RMS.....Root Mean Square

U.P.O.....Undistorted power output

C_{gk}.......Grid-cathode (or filament) capacitance

C_{pk}.......Plate-cathode (or filament) capacitance

C_{g1p}......Effective grid-plate capacitance in a tetrode (cathode (or filament) and screen grounded)

$C_{g1}(k+g_2)$..Direct interelectrode capacitance of grid to cathode (or filament) and screen

$C_p(k+g_2)$..Direct interelectrode capacitance of plate to cathode (or filament) and screen

NOTE: These symbols which, in general, are new, conform with those under consideration by the Institute of Radio Engineers.

Vacuum Tube Formulae

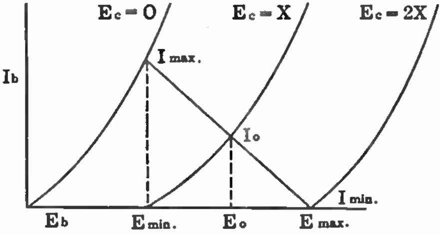
Plate Conductance $g_p = \frac{di_p}{de_p}$

Plate Resistance $r_p = \frac{1}{g_p}$

Transconductance $s_m = \frac{di_p}{de_g}$

Amplification Factor $\mu = \frac{s_m}{g_p} = s_m r_p$

$U.P.O. = \frac{1}{8}(I_{max.} - I_{min.})(E_{max.} - E_{min.})$



% Second Harmonic Distortion =

$$\frac{\frac{I_{max.} + I_{min.}}{2} - I_o}{I_{max.} - I_{min.}} \times 100 = \frac{\frac{E_{max.} + E_{min.}}{2} - E_o}{E_{max.} - E_{min.}} \times 100$$

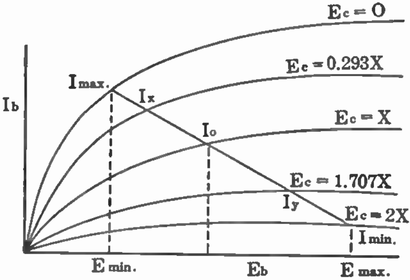
Voltage Amplification =

$$\frac{s_m}{\frac{1}{r_p} + \frac{1}{z_p}} = \frac{s_m r_p z_p}{r_p + z_p} = \frac{\mu z_p}{r_p + z_p}$$

When:

s_m is expressed in michromhos, and
r_p, z_p are expressed in megohms

Vacuum Tube Formulae
Pentodes



$$R_p = \frac{E_{max.} - E_{min.}}{I_{max.} - I_{min.}}$$

$$\text{U. P. O.} = \frac{1}{32}\left[(I_{max.} - I_{min.}) + 1.414\,(I_x - I_y)\right]^2 R_p$$

% Second Harmonic Distortion

$$= \frac{I_{max.} + I_{min.} - 2I_o}{(I_{max.} - I_{min.}) + 1.414\,(I_x - I_y)} \times 100$$

% Third Harmonic Distortion

$$= \frac{I_{max.} - I_{min.} - 1.414\,(I_x - I_y)}{I_{max.} - I_{min.} + 1.414\,(I_x - I_y)} \times 100$$

%Total Distortion

$$= \sqrt{(\%\ \text{2nd Harmonic Dist})^2 + (\%\ \text{3rd Harmonic Dist})^2}$$

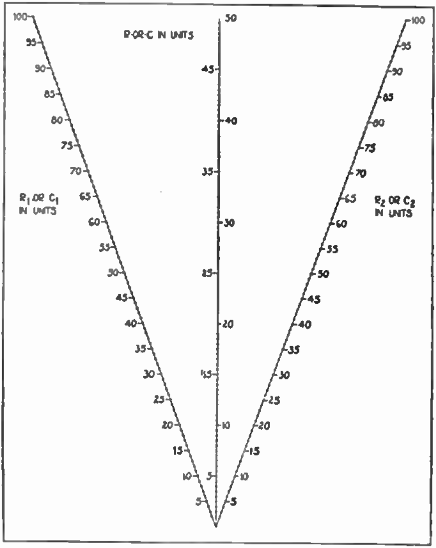
Series Resistances, Parallel Capacities

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

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

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 straight-edge from unit desired on the left oblique line to unit desired on right oblique line. Point at which straight edge 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.

Wavelength—Frequency

To convert wavelength in meters to frequency in cycles.

$$f = \frac{v}{\lambda}$$

To convert frequency in cycles to wavelength in meters

$$\lambda = \frac{v}{f}$$

Where: f = frequency in cycles per second.
λ = wavelength in meters.
v = 299,820,000 meters per second, the speed of radio waves in space.

Self-Indicating Resistance Chart

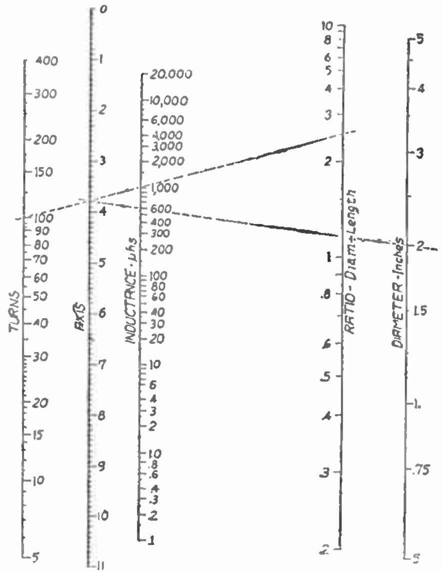
RESISTANCES — IN — OHMS

VOLTAGE — IN — VOLTS										
10	10,000	5,000	3,333	2,500	2,000	1,666	1,428	1,250	1,111	1,000
9	9,000	4,500	3,000	2,250	1,800	1,500	1,285	1,125	1,000	900
8	8,000	4,000	2,666	2,000	1,600	1,333	1,142	1,000	888	800
7	7,000	3,500	2,333	1,750	1400	1,166	1,000	875	777	700
6	6,000	3,000	2,000	1,500	1,200	1,000	857	750	666	600
5	5,000	2,500	1,666	1,250	1,000	833	714	625	555	500
4	4,000	2,000	1,333	1,000	800	666	572	500	444	400
3	3,000	1,500	1,000	750	600	500	428	375	333	300
2	2,000	1,000	666	500	400	333	286	250	222	200
1	1,000	500	333	250	200	166	143	125	111	100
	.001	.002	.003	.004	.005	.006	.007	.008	.009	.010

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.

Coil Turns, Inductance and Diameter

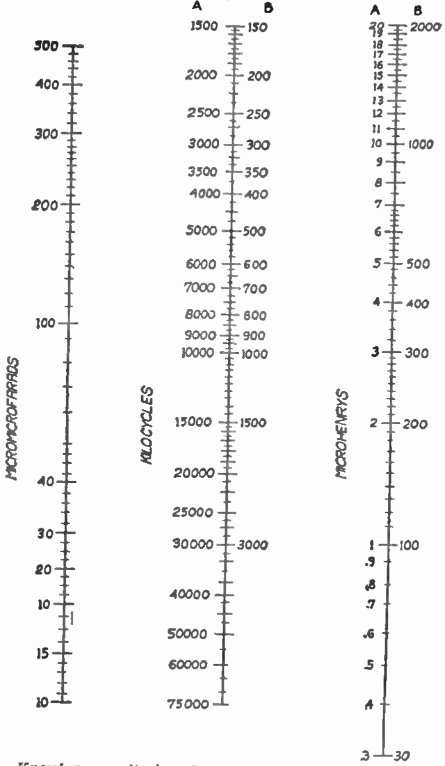


Knowing the turns of a coil, its length of winding, and the diameter, the inductance may be found by using a straight edge from the turns column to the ratio (length of winding) column, intersecting the axis column; then a second line from the intersection of the axis column to the diameter column. The inductance in microhenries will be the point where the second line intersects the inductance column. In the above chart the first line is laid from 100 turns to 2.5 ratio (which is length of winding) this first line intersecting the axis at 3.8 on the scale. The second line is from 3.8 on the axis scale to the 2 inch diameter, intersecting the inductance column at 600 microhenries.

Knowing the diameter, ratio and the inductance, the number of turns may be found by reversing the process. As shown in the chart, draw a line from 2 inch diameter through the 600 microhenries intersecting axis at 3.8 on the scale; then run line from 3.8 on axis scale to 2.5 on ratio (length of winding) the extension of this line cutting the turns scale at 100 which is the number of turns.

After finding number of turns, consult wire table to determine size of wire which will permit given number of turns in a given length of winding.

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.

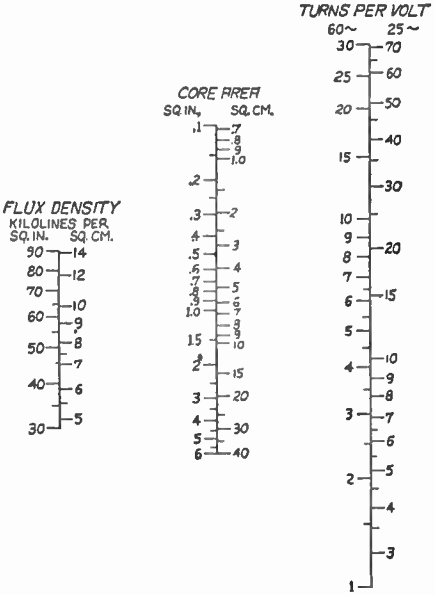
Knowing the condenser capacity and the inductance of the coil, the frequency to which the coil will tune can be found by running a line from the micromicrofarads column to the microhenries column, the point of intersection on the kilocycle column will be the frequency of coil and condenser.

Knowing the kilocycles and the inductance, the size of condenser to be used to cover that frequency can be found in the

(over

same manner indicated; extension of a straight line from microhenries through kilocycles will terminate on the micro-microfarads line.

Transformer Turns-Per-Volt Chart



Knowing the flux density and the core area, the turns per volt for either a primary or secondary may be determined by merely drawing a straight line the flux density column through the core area column, the extension of the line terminating in the turns per volt column.

Flux density is a quality of the kind of iron used. The flux density of different types of core material may be found by referring to any of the standard works on electricity.

For convenience the flux density column is divided into kilolines per square inch and kilolines per square centimeter. The core area is also divided into square inches and square centimeters. The turns per volt column gives values for sixty cycle on the left of the column and for twenty-five cycle on the right.

Citizens Radio Call Book, 1930

Cunningham RADIO TUBES

CHARACTERISTICS CHART

POWER AMPLIFIERS

TYPE	PURPOSE	BASE	SOCKET CONNECTIONS	DIMENSIONS MAX. OVERALL: LENGTH	DIMENSIONS MAX. OVERALL: DIAM.	CATHODE TYPE	RATING: FILAMENT (OR HEATER) VOLTS	RATING: FILAMENT (OR HEATER) AMPERES	RATING: FILAMENT (OR HEATER) SUPPLY	RATING: PLATE MAX. VOLTS	RATING: SCREEN MAX. VOLTS	PLATE SUPPLY VOLTS	NEGATIVE GRID BIAS VOLTS: D C ON FIL.	NEGATIVE GRID BIAS VOLTS: A C ON FIL.	SCREEN VOLTS	PLATE CURRENT MILLI-AMP.	SCREEN CURRENT MILLI-AMP.	A C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICROMHOS	VOLTAGE AMPLIFICATION FACTOR	OHMS LOAD FOR STATED POWER OUTPUT	POWER OUTPUT MILLIWATTS
C - 10	POWER AMPLIFIER	MEDIUM 4-PIN	FIG. 1	5 5/8"	2 3/16"	FILAMENT	7.5	1.25	A C or D C	425	—	250 350 425	18.0 27.0 35.0	22.0 31.0 39.0	—	10.0 16.0 18.0	—	6000 5150 5000	1330 1550 1600	8.0 8.0 8.0	13000 11000 10200	400 900 1600
CX-112-A	POWER AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 13/16"	FILAMENT	5.0	0.25	D C	180	—	135 180	9.0 13.5	—	—	6.2 7.6	—	5300 5000	1600 1700	8.5 8.5	8700 10800	115 260
CX-220	POWER AMPLIFIER	SMALL 4-PIN	FIG. 1	4 1/8"	1 7/16"	FILAMENT	3.3	0.132	D C	135	—	90 135	16.5 22.5	—	—	3.0 6.5	—	8000 6300	415 525	3.3 3.3	9600 6500	45 110
C - 31	POWER AMPLIFIER	SMALL 4-PIN	FIG. 1	4 1/8"	1 9/16"	FILAMENT	2.0	0.130	D C	180	—	135 180	22.5 30.0	—	—	8.0 12.3	—	4100 3600	925 1050	3.8 3.8	7000 5700	185 375
C - 33	POWER AMPLIFIER	MEDIUM 5-PIN	FIG. 8	4 11/16"	1 13/16"	FILAMENT	2.0	0.26	D C	135	135	135	13.5	—	135	14.5	3.0	50000	1450	70	7000	700
C - 38	POWER AMPLIFIER	SMALL 5-PIN	FIG. A	4 17/32"	1 9/16"	HEATER	6.3	0.3	D C	135	135	135	13.5	—	135	9.0	2.5	102000	975	100	13500	525
C - 41	POWER AMPLIFIER	MEDIUM 6-PIN	FIG. 15	4 1/4"	1 9/16"	HEATER	6.3	0.4	A C or D C	180	180	125.0 167.5	10.0 12.5	10.0 12.5	125.0 167.5	11.0 17.0	2.0 3.0	100000 85000	1525 1800	150 150	11000 9500	850 1250
C - 45	POWER AMPLIFIER	MEDIUM 4-PIN	FIG. 1	5 5/8"	2 3/16"	FILAMENT	2.5	1.5	A C or D C	275	—	180 250	30.0 48.5	31.5 50.0	—	31.0 34.0	—	1650 1610	2125 2175	3.5 3.5	2700 3900	825 1600
C - 46	POWER AMPLIFIER CLASS A D	MEDIUM 5-PIN	FIG. 9	5 5/8"	2 3/16"	FILAMENT	2.5	1.75	A C or D C	250	—	250	31.5	33.0	—	22.0	—	2380	2360	5.6	6400	1250
C - 46	POWER AMPLIFIER CLASS B	MEDIUM 5-PIN	FIG. 7	5 5/8"	2 3/16"	FILAMENT	2.5	1.75	A C or D C	400	—	300 400	0 0	0 0	Power output values are for 2 tubes operating at indicated plate-to-plate load. For other characteristics refer to Manual text.						5200 5800	16000 20000

C - 47	POWER AMPLIFIER	MEDIUM 5-PIN	FIG. 4	5 3/8"	2 1/16"	FILAMENT	2.5	1.75	A C or D C	250	250	250	15.0	16.5	250	31.0	6.0	60000	2500	150	7000	2700
C - 48	POWER AMPLIFIER TETRODE	MEDIUM 6-PIN	FIG. 14	5 3/8"	2 1/16"	HEATER	30	0.4	D C	125	100	95 125	-20.0 -22.5	—	95 100	47.0 50.0	9.0 9.0	10000 10000	2800 3800	28 28	2000 2900	1600 2500
CX-350	POWER AMPLIFIER	MEDIUM 4-PIN	FIG. 1	6 1/4"	2 11/16"	FILAMENT	7.5	1.25	A C or D C	450	—	350 400 450	59.0 66.0 80.0	63.0 70.0 84.0	—	45.0 55.0 55.0	—	1900 1800 1800	2000 2100 2100	3.8 3.8 3.8	4100 3670 4350	2400 3400 4600
C - 59	POWER AMPLIFIER TRIODE †	MEDIUM 7-PIN	FIG. 10	5 3/8"	2 1/16"	HEATER	2.5	2.0	A C or D C	250	—	250	28.0	28.0	—	26.0	—	2400	2600	6.0	5000	1250
C - 59	POWER AMPLIFIER PENTODE *	MEDIUM 7-PIN	FIG. 10	5 3/8"	2 1/16"	HEATER	2.5	2.0	A C or D C	250	250	250	18.0	18.0	250	35.0	9.0	40000	2500	100	6000	3000
C - 59	POWER AMPLIFIER CLASS B °	MEDIUM 7-PIN	FIG. 10	5 3/8"	2 1/16"	HEATER	2.5	2.0	A C or D C	400	—	300 400	0	0	Power output values are for two tubes operating at indicated plate-to-plate load. For other characteristics, refer to Technical Bulletin.						4600 6000	15000 20000
C - 71-A	POWER AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 13/16"	FILAMENT	5.0	0.25	A C or D C	180	—	90 135 180	16.5 27.0 40.5	19.0 29.5 43.0	—	12.0 17.5 20.0	—	2250 1960 1850	1330 1520 1620	3.0 3.0 3.0	3200 3500 5350	125 370 790
C - 89	POWER AMPLIFIER TRIODE †	SMALL 6-PIN	FIG. 14	4 11/16"	1 9/16"	HEATER	6.3	0.4	D C	180	—	160	20.0	—	—	17.0	—	3000	1570	4.7	7000	300
C - 89	POWER AMPLIFIER PENTODE *	SMALL 6-PIN	FIG. 14	4 11/16"	1 9/16"	HEATER	6.3	0.4	D C	180	180	163 180	17.0 18.0	—	163 180	17.0 20.0	2.5 3.0	70000 82500	1575 1635	125 135	9000 8000	1250 1500
C - 89	POWER AMPLIFIER CLASS B °	SMALL 6-PIN	FIG. 14	4 11/16"	1 9/16"	HEATER	6.3	0.4	D C	180	—	180	0	—	Power output values are for two tubes operating at indicated plate-to-plate load For other characteristics, refer to Technical Bulletin.						13600 9400	2500 3500

●Two grids tied together. ‡Grid next to plate tied to plate
*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.

RECTIFIERS

C - 80	FULL-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 2	5 3/8"	2 1/16"	FILAMENT	5.0	2.0	A C	A-C Voltage per Plate (Volts RMS) ..... 350 400 550 For d-c output voltage, refer to D-C Output Current (Maximum MA.) .. 125 110 135 curves in Manual. The 550 volt rating is permissible only with filter circuits having an input choke of at least 20 henries.
CX-381	HALF-WAVE RECTIFIER	MEDIUM 4-PIN	FIG. 2	6 1/4"	2 1/16"	FILAMENT	7.5	1.25	A C	A-C Plate Voltage (Maximum Volts RMS) ... 700 For d-c output voltage delivered to filter of typical D-C Output Current (Maximum MA.) ..... 85 rectifier circuit refer to curves in Manual.
C - 82	FULL-WAVE MERCURY-VAPOR RECTIFIER	MEDIUM 4-PIN	FIG. 2	4 11/16"	1 13/16"	FILAMENT	2.5	3.0	A C	Maximum A-C Voltage per Plate .... 500 Volts, RMS Maximum Peak Inverse Voltage ... 1400 Volts Maximum D-C Output Current, Continuous .125 Milliamperes Maximum Peak Plate Current .... 400 Milliamperes Approximate Tube Voltage Drop .... 15 Volts
C - 83	FULL-WAVE MERCURY-VAPOR RECTIFIER	MEDIUM 4-PIN	FIG. 2	5 3/8"	2 1/16"	FILAMENT	5.0	3.0	A C	Maximum A-C Voltage Per Plate .... 500 Volts, RMS Maximum Peak Inverse Voltage ... 1400 Volts Maximum D-C Output Current, Continuous . 250 Milliamperes Maximum Peak Plate Current .... 800 Milliamperes Approximate Tube Voltage Drop .... 15 Volts
C - 866	HALF-WAVE MERCURY-VAPOR RECTIFIER	MEDIUM 4-PIN	FIG. 16	6 3/8"	2 1/16"	FILAMENT	2.5	5.0	A C	Maximum Peak Inverse Voltage .... 7500 Volts For additional information refer to Maximum Peak Plate Current .... 0.6 Ampere Technical Bulletin Approximate Tube Voltage Drop .... 15 Volts

DETECTORS AND AMPLIFIERS

TYPE	PURPOSE	BASE	SOCKET CONNECTIONS	DIMENSIONS MAX. OVERALL		CATHODE TYPE	RATING					PLATE SUPPLY VOLTS	NEGATIVE GRID BIAS VOLTS		SCREEN VOLTS	PLATE CURRENT MILLI-AMP.	SCREEN CURRENT MILLI-AMP.	A C PLATE RESISTANCE OHMS	MUTUAL CONDUCTANCE MICRO-MHOS	VOLTAGE AMPLIFICATION FACTOR	OHMS LOAD FOR STATED POWER OUTPUT	POWER OUTPUT MILLI-WATTS
							FILAMENT (OR HEATER)			PLATE MAX. VOLTS	SCREEN MAX. VOLTS											
				LENGTH	DIAM.		VOLTS	AMPERES	SUPPLY				D C ON FIL.	A C ON FIL.								
CX-300-A	DETECTOR	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 11/16"	FILAMENT	5.0	0.25	D C	45	—	45	Grid Return to (—) Filament		—	1.5	—	30000	666	20	—	—
CX-301-A	DETECTOR, AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 11/16"	FILAMENT	5.0	0.25	D C	135	—	90 135	4.5 9.0	—	—	2.5 3.0	—	11000 10000	725 800	8.0 8.0	—	—
C - 11 CX- 12	DETECTOR, AMPLIFIER	WD 4-PIN MEDIUM 4-PIN	FIG. 12 FIG. 1	4 1/4" 4 11/16"	1 3/16" 1 3/16"	FILAMENT	1.1	0.25	D C	135	—	90 135	4.5 10.5	—	—	2.5 3.0	—	15500 15000	425 440	6.6 6.6	—	—
CX-112-A	DETECTOR, AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 11/16"	FILAMENT	5.0	0.25	D C	180	—	90 135	4.5 9.0	—	—	5.2 6.2	—	5600 5300	1500 1600	8.5 8.5	—	—
C - 22	RADIO FREQ. AMPLIFIER	MEDIUM 4-PIN	FIG. 4	5 5/32"	1 13/16"	FILAMENT	3.3	0.132	D C	135	67.5	135 135	1.5 1.5	—	45 67.3	1.7 3.7	0.6* 1.3*	725000 325000	375 500	270 160	—	—
C - 24-A	RADIO FREQ. AMPLIFIER	MEDIUM 5-PIN	FIG. 8	3 5/32"	1 13/16"	HEATER	2.5	1.75	A C or D C	275	90	180 250	3.0 3.0	3.0 3.0	90 90	4.0 4.0	1.7 max.	400000 600000	1000 1025	400 615	—	—
C - 24-A	BIASED DETECTOR	MEDIUM 5-PIN	FIG. 9	5 5/32"	1 13/16"	HEATER	2.5	1.75	A C or D C	275	90	275‡	5 approx.	5 approx.	20 to 45		Plate current to be adjusted to 0.1 milliampere with no signal.					
C - 26	AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 11/16"	FILAMENT	1.5	1.05	A C or D C	180	—	90 135 180	6.0 9.0 13.5	7.6 10.6 14.5	—	2.9 5.5 6.2	—	8900 7600 7300	935 1100 1150	8.3 8.3 8.3	—	—
C -327	AMPLIFIER	MEDIUM 5-PIN	FIG. 8	4 11/16"	1 11/16"	HEATER	2.5	1.75	A C or D C	275	—	90 135 180 250	6.0 9.0 13.5 21.0	6.0 9.0 13.5 21.0	—	2.7 4.5 5.0 5.2	—	11000 9000 9000 9250	820 1000 1000 975	9.0 9.0 9.0 9.0	—	—
C -327	BIASED DETECTOR	MEDIUM 5-PIN	FIG. 8	4 11/16"	1 11/16"	HEATER	2.5	1.75	A C or D C	275	—	250‡	30.0 approx.	30.0 approx.	—		Plate current to be adjusted to 0.2 milliampere with no signal.					
C - 30	DETECTOR, AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 1/4"	1 9/16"	FILAMENT	2.0	0.06	D C	180	—	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	—	—
C - 32	RADIO FREQ. AMPLIFIER	MEDIUM 4-PIN	FIG. 4	5 5/32"	1 13/16"	FILAMENT	2.0	0.06	D C	180	67.5	135 180	3.0 3.0	—	67.5 67.5	1.7 1.7	0.4 max.	950000 1200000	640 650	610 780	—	—

C - 32	BIASED DETECTOR	MEDIUM 4-PIN	FIG. 4	5 5/32"	1 13/16"	FILAMENT	2.0	0.06	D C	180	67.5	174‡	6 approx.	—	67.5		Plate current to be adjusted to 0.2 milliampere with no signal					
C - 34	SUPER-CONTROL R-F AMPLIFIER	MEDIUM 4-PIN	FIG. A	5 5/32"	1 13/16"	FILAMENT	2.0	0.06	D C	180	67.5	67.5 135 180	3.0 min.	—	67.5 67.5 67.5	2.7 2.8 2.8	1.1 1.0 1.0	400000 600000 1000000	560 600 620	224 360 620	—	—
C - 35	SUPER-CONTROL R-F AMPLIFIER	MEDIUM 5-PIN	FIG. 8	5 5/32"	1 13/16"	HEATER	2.5	1.75	A C or D C	275	90	180 250	3.0 min.	3.0 min	90 90	6.3 6.5	2.5 max.	300000 400000	1020 1050	305 420	—	—
C - 36	RADIO FREQ. AMPLIFIER	SMALL 5-PIN	FIG. D	4 9/32"	1 9/16"	HEATER	6.3	0.3	D C	180	90	135 180	1.5 3.0	—	67.5 90	3.0 3.1	1.7 max	300000 350000	1050 1050	315 370	—	—
C - 36	BIASED DETECTOR	SMALL 5-PIN	FIG. D	4 9/32"	1 9/16"	HEATER	6.3	0.3	D C	180	67.5	135†	6.0 approx.	—	67.5	Plate current to be adjusted to 0.1 milliampere with no signal						
C - 37	AMPLIFIER	SMALL 5-PIN	FIG. 6	4 1/4"	1 9/16"	HEATER	6.3	0.3	D C	180	—	90 135 180	6.0 9.0 13.5	—	—	2.6 4.3 4.7	—	11500 10000 10000	780 900 900	9.0 9.0 9.0	—	—
C - 37	BIASED DETECTOR	SMALL 5-PIN	FIG. 8	4 1/4"	1 9/16"	HEATER	6.3	0.3	D C	180	—	90 135	10.0 15.5	—	—	Plate current to be adjusted to 0.2 milliampere with no signal						
C - 39	SUPER-CONTROL R-F AMPLIFIER	SMALL 5-PIN	FIG. A	4 17/32"	1 9/16"	HEATER	6.3	0.3	D C	180	90	90 135 180	3.0 3.0 3.0	—	90 90 90	4.4 4.4 4.5	1.3 1.2 1.2	375000 540000 750000	960 980 1000	360 530 750	—	—
CX-340	VOLTAGE AMPLIFIER	MEDIUM 4-PIN	FIG. 1	4 11/16"	1 13/16"	FILAMENT	5.0	0.25	D C	180	—	135† 180†	1.5 3.0	—	—	0.2 0.2	—	150000 150000	200 200	30 30	—	—
C - 55	DUPLEX-DIODE TRIODE ▢	SMALL 6-PIN	FIG. 13	4 17/32"	1 9/16"	HEATER	2.5	1.0	A C or D C	250	—	250	20	20	—	8.0	—	7500	1100	8.3	20000	350
C - 56	AMPLIFIER	SMALL 5-PIN	FIG. 6	4 1/8"	1 9/16"	HEATER	2.5	1.0	A C or D C	250	—	250	13.5	13.5	—	5.0	—	9500	1450	13.8	—	—
C - 56	BIASED DETECTOR	SMALL 5-PIN	FIG. 8	4 1/8"	1 9/16"	HEATER	2.5	1.0	A C or D C	250	—	250§	20 approx	20 approx	—		Plate current to be adjusted to 0.2 milliampere with no signal					
C - 57	RADIO FREQ AMPLIFIER	SMALL 6-PIN	FIG. 11	4 25/32"	1 9/16"	HEATER	2.5	1.0	A C or D C	250	100	250	3.0	3.0	100	2.0	0.5	exceeds 1.5 meg	1225	exceeds 1500	—	—
C - 57	BIASED DETECTOR	SMALL 6-PIN	FIG. 11	4 25/32"	1 9/16"	HEATER	2.5	1.0	A C or D C	250	100	275‡	6.0 approx	6.0 approx.	100		Plate current to be adjusted to 0.1 milliampere with no signal					
C - 58	SUPER-CONTROL R-F AMPLIFIER	SMALL 6-PIN	FIG. 11	4 25/32"	1 9/16"	HEATER	2.5	1.0	A C or D C	250	100	250	3.0 min	3.0 min	100	8.2	2.0	800000	1600	1280	—	—
C - 85	DUPLEX-DIODE TRIODE ▢	SMALL 6-PIN	FIG. 13	4 17/32"	1 9/16"	HEATER	6.3	0.3	D C	250	—	135 180 250	10.5 13.5 20.0	—	—	3.7 6.0 8.0	—	11000 8500 7500	750 975 1100	8.3	25000 20000 20000	75 160 350
C - 299 CX-299	DETECTOR & AMPLIFIER	SMALL 4-NUB SMALL 4-PIN	FIG. 10 FIG. 1	3 1/2" 4 1/8"	1 3/16" 1 3/16"	FILAMENT	3.3	0.063	D C	90	—	90	4.5	—	—	2.5	—	15500	425	6.6	—	—

• For Grid leak Detection—plate volts 45, grid return to + filament or to cathode
†Applied through plate coupling resistor of 250000 ohms.
*Maximum.

§Applied through plate coupling resistor of 50000 ohms.
‡Applied through plate coupling resistor of 100000 ohms.

‡Applied through plate coupling resistor of 250000 ohms or 500 henry choke shunted by 0.25 megohm resistor
▢Characteristics are for Triode Unit only

REGULATORS

TYPE	PURPOSE	BASE	SOCKET CONNECTIONS	DIMENSIONS MAX. OVERALL			
				LENGTH	DIAM.		
CX-376	VOLTAGE REGULATOR	MEDIUM 4-PIN	—	$5\frac{3}{8}$"	$2\frac{1}{16}$"	Designed to keep output voltage of B-Eliminators constant when different values of "B" current are supplied.	Operating Voltage .... 90 Volts D C Starting Voltage .... 125 Volts D C Operating Current .... 10-50 Milliamperes
C -376	CURRENT REGULATOR (BALLAST TUBE)	MOGUL	—	6"	$2\frac{1}{16}$"	Designed to insure constant input to power operated radio receivers despite fluctuations in line voltage.	Operating Current .... 1.7 Amperes Voltage Range .... 40-60 Volts
C -386	CURRENT REGULATOR (BALLAST TUBE)	MOGUL	—	6"	$2\frac{1}{16}$"	Designed to insure constant input to power operated radio receivers despite fluctuations in line voltage.	Operating Current .... 1.05 Amperes Voltage Range .... 40-60 Volts

The first digits of many type numbers have been dropped. These types are identified now by the last two digits only.

Other Cunningham Radio Tubes of special interest to the radio amateur and experimenter are:

C-841, Voltage or R-F Power Amplifier
C-842, A-F Power Amplifier and Modulator
C-852, 100 Watt Oscillator and R-F Power Amplifier
C-864, Amplifier Detector of Low Microphonic Design
C-865, 12.5 Watt Screen Grid Oscillator and R-F Power Amplifier
C-868, Phototube

Technical Bulletins on these types may be obtained by writing to

COMMERCIAL ENGINEERING SECTION, E. T. CUNNINGHAM, INC., HARRISON, NEW JERSEY

TOP VIEWS OF SOCKET CONNECTIONS

(See characteristics charts)

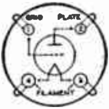


Fig. 1

Fig. 2

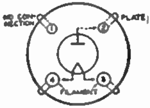


Fig. 3

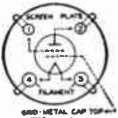


Fig. 4

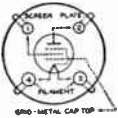


Fig. 4A

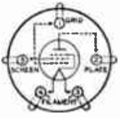


Fig. 6

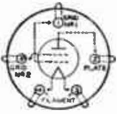


Fig. 7

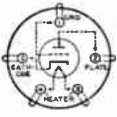


Fig. 8

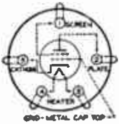


Fig. 9

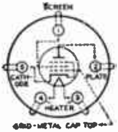


Fig. 9A

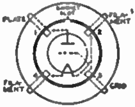


Fig. 10

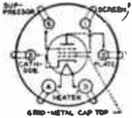


Fig. 11

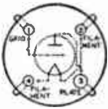


Fig. 12

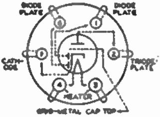


Fig. 13

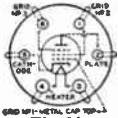


Fig. 14

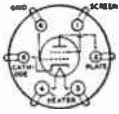


Fig. 15

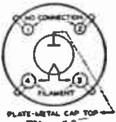


Fig. 16

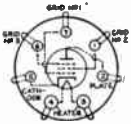


Fig. 18

Interchangeable Tube Types

The purpose of this list is to explain which Cunningham Radio Tube types are interchangeable with tube types of other manufacturers, having similar or different type designations.

The following simple rule applies:

In general, the last two digits and following letter of a type number are the significant type designation. For example: The CX-371-A manufactured by E. T. Cunningham, Inc., can be used to replace the FY-71-A of another manufacturer since only the '71-A has significance in designating the tube type. Similarly, the C-327 is interchangeable with the MZ-527 of another manufacturer; '27 is the essential type designation.

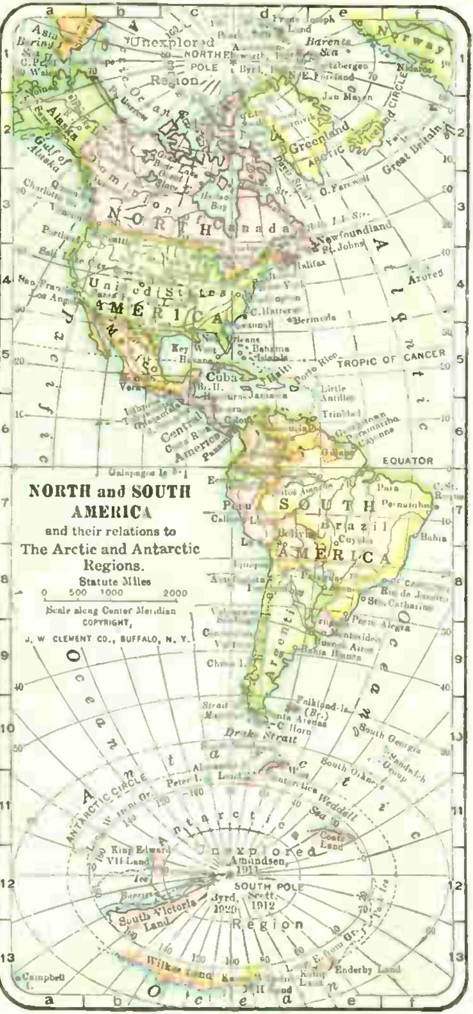
It will be noted that recently introduced types of Cunningham Radio Tubes carry only two digits in the type designation, such as C-56, CX-82, etc.

Listed below are the more popular Cunningham Radio Tube type numbers with the corresponding type numbers used by other manufacturers. The list also includes type numbers of tubes which are interchangeable with but superseded by later models.

Cunningham Radio Tubes	Interchangeable with
CX-112-A	'12, '12-A
CX-371-A	'71, '71-A, '71-B
CX-300-A	'00, '00-A
CX-301-A	'01, '01-A
C-324-A	'24, '24-A
C-347	'47, PZ
C-335	'35, '51
CX-350	'50, 585, 586
CX-380	'13
CX-381	'16, '16-B

The following Cunningham Radio Tubes are interchangeable with the types given below under the specified operating conditions:

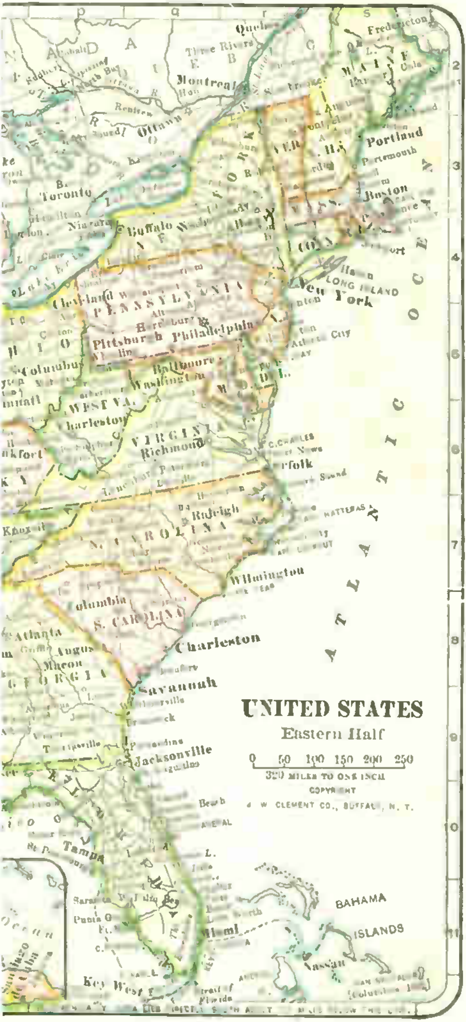
Cunningham Radio Tubes	Interchangeable with	Under these operating conditions only
C-336	64, 64-A	
C-337	67, 67-A	
C-338	68, 68-A	When used in auto sets.
C-239	65, 65-A	
CX-83	'88	When the receiver's power transformer will stand one ampere additional filament current.
CX-83	986	
CX-83	'80-M	
C-336	'36-A	
C-337	'37-A	When used in D-C line operated receivers, and auto sets.
C-338	'38-A	
C-239	'39-A	

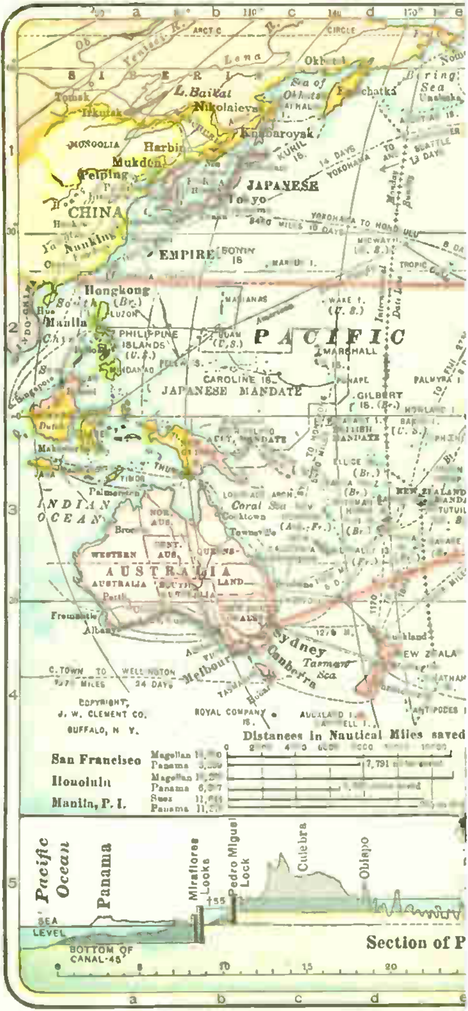

NORTH and SOUTH AMERICA
and their relations to
The Arctic and Antarctic
Regions.
Statute Miles
0 500 1000 2000
Scale along Center Meridian
COPYRIGHT,
J. W. CLEMENT CO., BUFFALO, N. Y.
Unexplored
NORTH POLE
Region
Greenland
Iceland
Norway
Barents Sea
Jan Mayen
Great Britain
ARCTIC CIRCLE
Alaska
Gulf of Alaska
Asia
Canada
Hudson Bay
Newfoundland
St. Johns
Halifax
Azores
United States
NORTH AMERICA
Bermuda
C. Hatteras
New Orleans
Key West
Havana
Bahama Islands
Cuba
Haiti
Porto Rico
TROPIC OF CANCER
Little Antilles
Trinidad
Central America
Panama
EQUATOR
Galapagos Is.
Peru
Bolivia
SOUTH AMERICA
Brazil
Para
Pernambuco
Bahia
Rio de Janeiro
Porto Alegre
Buenos Aires
Bahia Blanca
Falkland Is. (Br.)
C. Horn
Drake Strait
South Georgia
South Orkneys
Weddell Sea
Coats Land
ANTARCTIC CIRCLE
Peter I.
King Edward VII Land
Amundsen, 1911
SOUTH POLE
Byrd, 1929
Scott, 1912
South Victoria Land
Wilkes Land
Enderby Land
Kemp Land
Campbell I.
Antarctic
Unexplored
Region
Atlantic
Ocean
Pacific

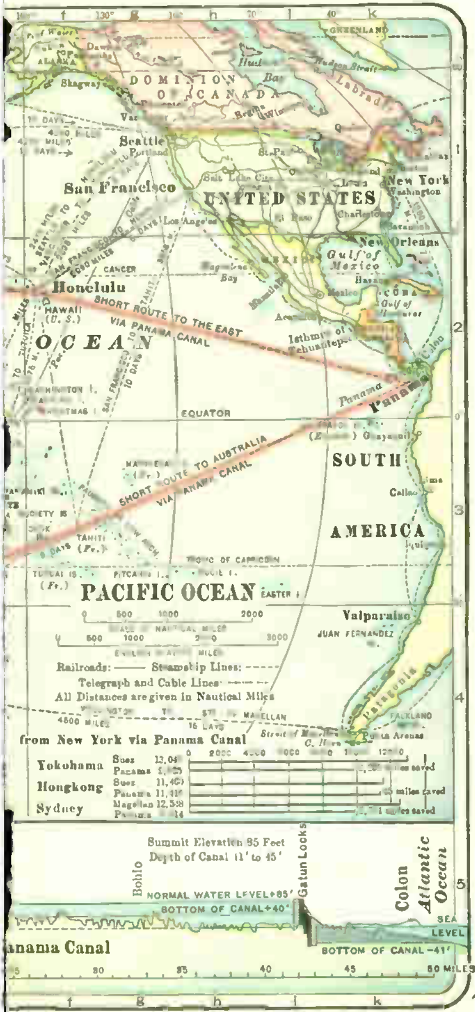

WASHINGTON
OREGON
IDAHO
MONTANA
NEVADA
UTAH
CALIFORNIA
ARIZONA
ALASKA
PACIFIC OCEAN
Olympia
Seattle
Tacoma
Spokane
Astoria
Portland
Salem
Columbia R.
The Dalles
Pendleton
Baker
Boise
Helena
Butte
Pocatello
Ogden
Salt Lake City
Great Salt L.
Virginia City
Carson City
Sacramento
San Francisco
Oakland
Reno
Tonopah
Goldfield
Los Angeles
San Bernardino
San Diego
Pasadena
Santa Barbara
Bakersfield
Stockton
Kingman
Prescott
Phoenix
Tucson
Tombstone
Bisbee
Flagstaff
Globe
Eureka
Redding
Fresno
Visalia
Barstow
Needles
Oceanside
San Jacinto
Colorado R.
Great Salt L. Desert
Bering Sea
Bering Strait
G. of Alaska
Nome
Fairbanks
St. Michael
Juneau
Sitka
Pribilof Is.
Aleutian Is.
Hermosillo
Guaymas


SASKATCHEWAN
Regina
Moose Jaw
Winnipeg
MANITOBA
Great Falls
Glendive
Lewistown
Livingston
Fort Custer
Miles City
Minot
NORTH DAKOTA
Grand Forks
Fargo
Jamestown
Bismarck
SOUTH DAKOTA
Pierre
Deadwood
Aberdeen
Watertown
Sioux Falls
Hot Springs
WYOMING
Lander
Douglas
Rawlins
Rock Spgs.
Laramie
Cheyenne
Sheridan
Buffalo
Newcastle
Chadron
Alliance
Ainsworth
Sioux City
NEBRASKA
Brokenbow
Grand Island
Kearney
North Platte
Omaha
Lincoln
Beatrice
COLORADO
Denver
Leadville
Aspen
Gunnison
Pueblo
Cripple Cr.
La Junta
Walsenburg
Trinidad
Creede
Alamosa
Silverton
Grand Jc.
Delta
Montrose
Akron
Greeley
KANSAS
Wichita
Beloit
Salina
Topeka
Medicine Lodge
Arkansas City
Tierra Amarilla
Santa Fe
Las Vegas
Albuquerque
NEW MEXICO
Socorro
Magdalena
Puerto de Luna
Roswell
Tularosa
Silver City
Las Cruces
Deming
Carlsbad
Clayton
Mora
Folsom
OKLAHOMA
Kingfisher
Oklahoma City
Guthrie
Perry
Mangum
Duncan
Purcell
Wewoka
Denison
Sherman
Childress
Quanah
Wichita Falls
Seymour
Henrietta
Plainville
Lubbock
Llano Estacado
Sweetwater
Colorado
Big Spring
Midland
Fort Worth
Dallas
Corsicana
Abilene
Albany
Coleman
Dublin
San Angelo
Waco
Temple
Lampasas
Burnett
Menard
Junction
Austin
Kerrville
San Antonio
Brenham
Columbus
Victoria
Del Rio
Uvalde
Pearsall
Porfirio Diaz
Eagle Pass
Cotulla
Laredo
San Diego
Beeville
Port Lavaca
El Paso
Ciudad Juarez
Pecos
Sierra Blanca
Ft. Stockton
Alpine
Rio Grande
TEXAS
MEXICO
Casas Grandes
Montezuma
UNITED STATES
Western Half
0 50 100 150 200 250 300
320 MILES TO ONE INCH
COPYRIGHT,
J. W. CLEMENT CO., BUFFALO, N. Y.
f
g
h
i
k
1
2
3
4
6
7
8
9
10
11


Lake of the Woods
Grand Forks
Crookston
Lake Superior
Duluth
Minneapolis
St. Paul
WISCONSIN
La Crosse
Madison
Milwaukee
Detroit
Lansing
Sioux Falls
Sioux City
Des Moines
Chicago
Toledo
Omaha
Peoria
Lincoln
INDIANA
Indianapolis
ILLINOIS
Springfield
Topeka
St. Louis
Jefferson City
Evansville
Louisville
Nevada
Salem
Springfield
Poplar Bluff
Nashville
Muskogee
Oklahoma City
Ft. Smith
Little Rock
Memphis
Chattanooga
Arkansas
ARKANSAS
Helena
Birmingham
MISSISSIPPI
ALABAMA
Dallas
Marshall
Tyler
Shreveport
Jackson
Montgomery
Waco
TEXAS
Alexandria
Mobile
Baton Rouge
Hearne
Rockland
Beaumont
Pensacola
Houston
N. Orleans
Gulf of
Galveston
THE DELTA
Havana
Matanzas
Cienfuegos
Port Lavaca
Rockport
Corpus Christi
CUBA.
Same Scale as Main Map.
Havana is 100 Miles (½ inch)
south of Key West.
Caribbean Sea
Brownsville


UNITED STATES
Eastern Half
0 50 100 150 200 250
COPYRIGHT
W. CLEMENT CO., BUFFALO, N. Y.
Fredericton
Quebec
Three Rivers
Montreal
Ottawa
Portland
Portsmouth
Boston
Toronto
Buffalo
Cleveland
PENNSYLVANIA
New York
LONG ISLAND
Philadelphia
Pittsburgh
Atlantic City
Baltimore
Washington
Columbus
WEST VA.
Charleston
VIRGINIA
Richmond
Norfolk
C. CHARLES
Raleigh
CAPE HATTERAS
Wilmington
Columbia
S. CAROLINA
Charleston
Atlanta
Macon
Savannah
Brunswick
Jacksonville
Tampa
Miami
Key West
BAHAMA
ISLANDS
Nassau
ATLANTIC OCEAN


SIBERIA
L. Baikal
Nikolaievsk
Tomsk
Irkutsk
MONGOLIA
Harbin
Mukden
Peiping
Khabarovsk
KURIL IS.
JAPANESE
EMPIRE
CHINA
Nanking
Hongkong (Br.)
Manila
LUZON
PHILIPPINE ISLANDS (U.S.)
MINDANAO
Sea of Okhotsk
Bering Sea
WAKE I. (U.S.)
GUAM (U.S.)
MARIANAS
PACIFIC
MARSHALL IS.
CAROLINE IS.
JAPANESE MANDATE
GILBERT IS. (Br.)
PALMYRA I.
HOWLAND I.
TIMOR
INDIAN OCEAN
Coral Sea
AUSTRALIA
WESTERN AUSTRALIA
NOR. AUS.
CENT. AUS.
Perth
Fremantle
Albany
Sydney
Canberra
Melbourne
Tasman Sea
NEW ZEALAND
YOKOHAMA TO SEATTLE 13 DAYS
YOKOHAMA TO HONOLULU 10 DAYS
C. TOWN TO WELLINGTON 24 DAYS
COPYRIGHT, J. W. CLEMENT CO. BUFFALO, N. Y.
ROYAL COMPANY IS.
Distances in Nautical Miles saved
San Francisco
Honolulu
Manila, P. I.
Magellan
Panama
Suez
7,791
Pacific Ocean
Panama
Miraflores Locks
Pedro Miguel Lock
Culebra
Obispo
SEA LEVEL
BOTTOM OF CANAL-45
Section of P


GREENLAND
ALASKA
Dawson
Shagway
Hudson Strait
Labrador
DOMINION OF CANADA
Hudson Bay
Seattle
Portland
San Francisco
Salt Lake City
New York
Washington
UNITED STATES
Los Angeles
El Paso
Charleston
Savannah
New Orleans
Gulf of Mexico
MEXICO
Magdalena Bay
Havana
CUBA
Mexico
Acapulco
Honolulu
HAWAII (U. S.)
CANCER
SHORT ROUTE TO THE EAST VIA PANAMA CANAL
Isthmus of Tehuantepec
Colon
Panama
OCEAN
EQUATOR
SOUTH AMERICA
SHORT ROUTE TO AUSTRALIA VIA PANAMA CANAL
Callao
Lima
TAHITI (Fr.)
PITCAIRN I.
EASTER I.
PACIFIC OCEAN
Valparaiso
JUAN FERNANDEZ
Patagonia
FALKLAND
Punta Arenas
Strait of Magellan
C. Horn
0 500 1000 2000
SCALE OF NAUTICAL MILES
0 500 1000 2000 3000
Railroads: Steamship Lines:
Telegraph and Cable Lines:
All Distances are given in Nautical Miles
from New York via Panama Canal
Yokohama Suez Panama
Hongkong Suez 11,460 Panama
Sydney Magellan 12,538 Panama
miles saved
Summit Elevation 85 Feet
Depth of Canal 41' to 45'
Bohio
Gatun Locks
Colon
Atlantic Ocean
NORMAL WATER LEVEL+85'
BOTTOM OF CANAL+40'
SEA LEVEL
BOTTOM OF CANAL -41'
Panama Canal
30 35 40 45 50 MILES
f g h i k


MAP OF
CENTRAL EUROPE
Scale of Statute Miles
Orkney Islands
Wick
Rattray Head
Glasgow
North Sea
NORWAY
Skagerrak
DENMARK
Hamburg
Bremen
GREAT BRITAIN
Liverpool
The Wash
NETHERLANDS
ENGLAND
GERMANY
Brussels
BELGIUM
Rennes
Versailles
Paris
Laval
Troyes
FRANCE
Bern
Lyon
Milan
Munich
Nice
Marseille
Toulon
Gulf of Lions
Perpignan
Gerona
SPAIN
Barcelona
Valencia
Sardinia
Porto Vecchio
C. Carbonara
Tyrrhenian

Stockholm
Gotland
SWEDEN
Kalmar
Karlskrona
Baltic Sea
Windau
Mitau
Ostrof
Valdai
RUSSIA
(U. S. S. R.)
Vitebsk
Orsha
Vilnu
Baranovichi
Bialystok
Berlin
Warsaw
POLAND
Kovel
Lublin
Kalisz
Kief
Berdichef
CZECHO-SLOVAKIA
Vienna
Budapest
HUNGARY
RUMANIA
Fokshani
Alps
Bucharest
Fiume
JUGO
Belgrade
SLAVIA
Dinaric Alps
Krajova
Danube
Rustchuk
BULGARIA
Varna
Balkan Mts.
Sliven
Burgas
Nish
Sofia
Prizrend
Constantinople
Durazzo
Tirana
Brindisi
Otranto
Ancona
Macerata
Ascoli Piceno
Pescara
Chieti
Campobasso
Foggia
Bari
ITALY
Sea
C. S. Maria di Leuca
Catanzaro
Ionian Sea
Reggio di Calabria
Etna
Catania
Caltanissetta
Sicily
Olympus
GREECE
Athens
Cyclades


EUROPE, ASIA, AFRICA AND AUSTRALIA.
Railroads :——— Steamship Lines :——— Submarine Cables :———
Distances on Map are in Nautical Miles.
References.
9 Rumania
10 Jugo-Slavia
11 Bulgaria
12 Lithuania
13 Latvia
14 Esthonia
5 Austria
6 Hungary
7 Czecho-Slovakia
8 Poland
SPITZBERGEN
NORTH CAPE
JAN MAYEN I.
LOFOTEN IS.
Archangel
ARCTIC
UNION
Kara Sea
BRITISH ISLES
RUSSIA
EUROPE
Orenburg
Astrakhan
RUSSIAN TURKESTAN
PERSIA
Teheran
Delhi
Bombay
Arabian Sea
Red Sea
ARABIA
EGYPT
LIBYA
SAHARA
AFRICA
SUDAN
ANGLO-EGYPT. SUDAN
ABYSSINIA
KENYA
BELGIAN KONGO
UNION OF SOUTH AFRICA
Walvis Bay
Port Nolloth
Durban
Port Elizabeth
CAPE OF GOOD HOPE
Cape Town
MADEIRA Port.
CANARY
RIO DE ORO
ASCENSION I. Br.
ST. HELENA Br.
TRISTAN DA CUNHA Br.
SEYCHELLES IS. Br.
MALDIVE
MADAGASCAR
ST. PAUL
KERGUELEN I.
SEA LEVEL
Atlantic Ocean
Vertical Scale 20 times the Horizontal Scale.
MT. BLANC
KILIMANJARO
KENIA
MT. ELBRUZ
MUSTAGH ATA
MT. ETNA
AFRICA
ARABIA
Arabian Sea
Section along the

NEW SIBERIA IS.
SIBERIA
OF SOCIALIST SOVIET REPUBLICS
(RUSSIA)
A S I A
Sea of Okhotsk
Bering Sea
Bering Strait
MONGOLIA
Peiping
JAPAN
Shanghai
CHINA
Nanking
Pacific
TROPIC OF CANCER
Ocean
PHILIPPINE IS.
JAPANESE MANDATE
SUMATRA
DUTCH EAST INDIES
AUSTRALIA
QUEENSLAND
Perth
Sydney
Auckland
ZEALAND
TROPIC OF CAPRICORN
SCALES ALONG THE EQUATOR.
STATUTE MILES.
NAUTICAL MILES.
KILOMETERS.
COPYRIGHT J. W. CLEMENT Co., BUFFALO, N. Y.
SEA LEVEL
Tropic of Cancer.
30,930
Greatest Depth


ALASKA
and the
KLONDIKE REGION.
SCALE OF MILES.
KILOMETERS
KLONDIKE GOLD REGION
Forty Mile
Ft. Reliance
Dawson
Sixty Mile Post
Ogilvie
Stewart R.
C A N A D A
Dawson
Ft. Reliance
Circle
Fairbanks
Nome
St. Michael
Nulato
Kaltag
ASIA
ST. LAWRENCE
Bering Sea
Gulf of Alaska
Juneau
Pacific Ocean
HAWAII.
SCALE OF MILES.
Honolulu
OAHU
MAUI
KAUAI
HAWAII
Kailua
Dutch Harbor
ALEUTIAN IS.
UMNAK
Nikolski
COPYRIGHT,
J. W. CLEMENT CO., BUFFALO, N. Y.
BRITISH
COLUMBIA
VANCOUVER
C. NEWENHAM
Bristol Bay
Togiak
Ft. Alexander