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RADIO REVIEW

Reg. U.S. Pat. Off

Combined With

Radio Listeners' Guide and Call Book

Edited by S. Gernsback

The Radio Set Owner's Book of Information and 16 Page Radio Encyclopedia

CARL W. BERTSCH

Published by the CONSRAD CO. Inc. NEW YORK CITY

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RADIO REVIEW

Reg. U.S. Pat. Off.

Combined With

Radio Listeners' Guide and Call Book

Volume I

Number 9

JUNE, 1926

Contents *of* This Issue

RADIO REVIEW, Combined with RADIO LISTENERS' GUIDE AND CALL BOOK
VOLUME I, NUMBER 9 — JUNE, 1926

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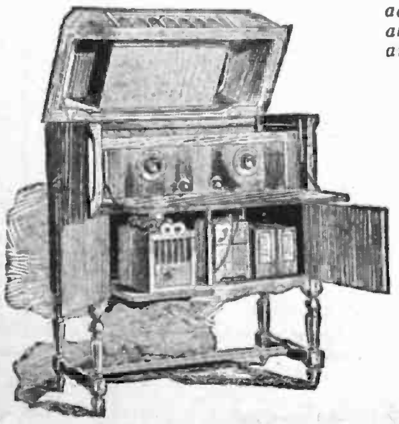

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Radio Review Combined With Radio Listeners' GUIDE and CALL BOOK

Sidney Gernsback, Editor W. G. Many, Managing Editor

THE CONSRAD COMPANY, Inc., 64 Church Street, New York, N. Y.
PUBLISHERS

RADIO BROADCAST STATIONS OF THE UNITED STATES

with Time Table

Indexed Alphabetically by Call Letters

The following list of stations has been so arranged that it can be readily referred to in finding the location, name, power, wave length, frequency and time of a station, providing the call letters are known.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KD	**KDKA—Pittsburgh, Pa.** (Transmitter is in East Pittsburgh)—Westinghouse Elec. & Mfg. Co......	Var.	309.1	970	Eastern	Mon., 7:15 to 8; 9:45; 11:55 am; 12 am; 4:20; 5;45; 6:30; 8; 8:15; 9:55 pm; Tue., 7:15 to 8 am; 9:45; 10; 11:55 am; 12 am; 4:20; 5:45; 6:30; 8; 8:15; 8:30; 9:55; 11:35 pm; Wed., 7:15; 8; 9:45; 11:55 am; 12 am: 4:20; 5:45; 6:30; 8; 8:15; 9; 9:55 pm; Thu., 7:15; 9:45; 11:55 am; 12 am; 4:20; 5:45; 6:30; 8; 8:15; 8:30; 9; 9:55; 11 pm; Fri., 7:15; 9:45; 10; 11:55 am; 12 am; 12:20; 4:20; 5:45; 6:30; 8; 8:15; 9; 9:30; 9:55; 10:10 pm; Sat., 11:55 am; 12 am; 5:45; 6:39; 8; 8:30; 9:55 pm. Sun.: 11 am; 4; 4:45; 6:10; 6:30; 7:15; 7:45 pm.
	KDLR—Devils Lake, N. D.—Radio Elec. Co...........	5	231	1300	Central	Daily: 12:10 am and 6:15; 9:30 to 12 pm Mon. Sun. and Holidays: 11 am; 4 pm.
	KDYL—Salt Lake City, Utah.—Newhouse Hotel......	50	246	1220	Pacific	
KF	**KFAB—Lincoln, Nebr.**—Nebraska Buick Auto Co.....	1000	340.7	880	Central	Daily: 3:15 to 3:45; 5:30 to 6:30; 8:30 to 10:30 Thu.. silent; 12 to 2 am Sat. Sun. and Holidays: 4 to 5 pm; 9 to 11 pm.
	KFAD—Phoenix, Ariz.—Electrical Equipment Co......	100	272.6	1100	Mountain	Mon.. silent; Tue.. 6 to 7 pm; 8 to 9 pm; Wed.. 6 to 7 pm; 8 to 9 pm; 9 to 11 pm; Thu., 6 to 7 pm; 8 to 9 pm; Fri., 6 to 7 pm; 8 to 9 pm; Sat.. 6 to 7 pm; 8 to 9 pm. Sun.: 11 am to 12:30 pm.
	KFAF—San Jose, Calif.—Alfred E. Fowler, Montgomery Hotel..................................	50	217.3	1380	Pacific	
	KFAU—Boise, Idaho—Independent School District of Boise..................................	750	280	1070	Mountain	Mon., Wed., Fri., 12:30 to 1 pm; Tue., 12:30 to 1 pm; 7:30 to 9:30 pm; Thu., 12:30 to 1 pm; 8 to 10 pm; Sat., 12:30 to 1 pm; 7:30 to 9 pm.
	KFBB—Havre, Mont.—F. A. Buttrey Co..............	50	275	1090	Mountain	Daily: 12:45 to 1:30 pm only.
	KFBC—San Diego, Cal.—W. K. Azbill, 5038 Cliff Place.	50	215.7	1390	Pacific	
	KFBK—Sacramento, Calif.—Kimball-Upson Co., 607 K St..................................	100	248	1210	Pacific	Mon., 6 to 7 pm; Thu., 7:30 to 10 pm; Sat., 7:30 to 10 pm.
	KFBL—Everett, Wash.—Leese Bros., 2814 Rucker Ave.	100	224	1340	Pacific	Daily: 7:30 to 8:30 pm.
	KFBS—Trinidad, Colo.—School Dist. No. 1............	15	238	1260	Mountain	
	KFBU—Laramie, Wyo.—The Cathedral, Bishop N. S. Thomas..................................	500	270	1110	Mountain	
	KFCB—Phoenix, Ariz.—Nielsen Radio Supply Co., 311 N. Central Ave.........................	100	238	1260	Mountain	Mon., 7:30 to 8:30 pm; Wed., 8 to 9 pm; Sat.. 7 to 8 pm and 11 pm to 1 am. Sun. and Holidays: 9:30 to 10:30 am.
	KFDD—Boise, Idaho—St. Michaels Episcopal Cathedral	50	278.6	1080	Mountain	Sun.: 11 am to 12:30 pm; 7:30 pm to 9:15 pm.
	KFDM—Beaumont, Tex.—Magnolia Petroleum Co...	500	315.6	950	Central	

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KF	KFDX—Shreveport, La.—1st Baptist Church	100	250	1200	Central	
	KFDY—Brookings, S. Dakota—South Dakota State College	100	273	1100	Central	Daily: 12:15 pm; Tue., 11 am; Thu., 7:30 pm.
	KFDZ—Minneapolis, Minn.—H. O. Iverson, 2510 Thomas Ave. South	10	231	1300	Central	Tue., 9 pm. Sun.; 5:45 pm.
	KFEC—Portland, Oregon—Meier & Frank Co.	50	248	1210	Pacific	Daily: 12 am; 4 to 5 pm.
	KFEL—Denver, Colo.—Eugene P. O'Fallon	50	254	1180	Mountain	Mon., 11 am; 2 pm; 5 pm; Tue., 11 am; 2 pm; 5 pm; 9 pm; 10 pm; Wed., 11 am; 2 pm; 5 pm; Thu., 11 am; 2 pm; 5 pm; 8 pm; 9 pm; 10 pm; Fri., 11 am; 2 pm; 5 pm; Sat., 11 am; 2 pm; 5 pm. Sun. and Holidays: 9 am only.
	KFEQ—Oak, Nebr.—John L. Scroggin	500	268	1120	Central	Daily: 2 to 3:15 pm. Sun. and Holidays: 4 to 6 pm; 8:30 to 10 pm.
	KFEY—Kellogg, Idaho—Bunker Hill & Sullivan Mining & Concentrating Co.	10	233	1290	Pacific	Mon. and Wed., 8 pm. Sun.; 7:30 pm; 11 am.
	KFFP—Moberly, Mo.—First Baptist Church	50	242	1240	Central	Alternate Thu., at 8 pm. Sun.: 9:45 am; 10:45 am; 7:30 pm.
	KFGQ—Boone, Iowa—Crary Hardware Co.	10	226	1330	Central	Tues., 10 to 11 pm; 8:30 to 9:30 pm, Fri.
	KFH—Wichita, Kans.—Hotel Lassen	500	268	1120	Central	Daily: 9 am; 10 am; 11 am; 12 am; 1 pm; 2 pm; 10 to 11 pm. Sun.: 9:40 to 10:40 am; 10 to 11 pm.
	KFHA—Gunnison, Colo.—Western State College of Colo	50	252	1190	Mountain	Tue. and Fri., 7:30 to 9:30.
	KFHL—Oskaloosa, Iowa—Penn College	10	240	1250	Central	Mon., 9:45 am; Tue., 9:45 am and 7:15 pm; Wed., silent; Thu., 9:45 am; Fri., 9:45 am and 7:15 pm; Sat., silent. Sun.: 4 pm.
	KFI—Los Angeles, Calif.—Earle C. Anthony, Inc., Packard Motor Car Bldg	4000	467	640	Pacific	Mon., 10:45 and 11:05 am; Wed. and Fri., 10:45 am; 5:30 pm to 11 pm daily and to 2 am on Sat. Sun., 10 am and 4 pm; 5:30 to 11 pm.
	KFIF—Portland, Ore.—Benson Polytechnic School	100	248	1210	Pacific	Tue., 8:15 to 9:15 pm.
	KFIO—Spokane, Wash.—North Central Radio Club, North Central High School	100	265.3	1130	Pacific	Fri., 8 to 9:30 pm.
	KFIQ—Yakima, Wash.—I. M. Miller	100	256	1170	Pacific	Wed., 7 pm; Sat., 7 pm. Sun.: 11 am; 3:30 pm; 7:30 pm.
	KFIZ—Fondulac, Wis.—Daily Commonwealth & Wis. Radio Sales, 22 Forest Ave	100	273	1100	Central	
	KFJB—Marshalltown, Iowa—Marshall Electric Co.	10	248	1210	Central	
	KFJC—Junction City, Kans.—Episcopal Church	10	218.8	1370	Central	
	KFJF—Oklahoma, Okla.—National Radio Mfg. Co.	500	261	1150	Central	Mon., 9:40 am; 12:15 pm; 2:15 pm; 6 pm; 6:30 to 7:30 pm and 8:15 to 10:45 pm. First Mon. of each month, 8 pm. Tue., 9:40 am; 12:15 pm; 2:15 pm; 6 pm; 6:30 to 7:30 pm; 10 pm. Wed., 9:40 am; 12:15 pm; 2:15 pm; 6 pm; 6:30 to 7:30 pm; 7:40 pm; 8:15 to 10:30 pm; and 11 to 12 pm; Thu. Fri. and Sat., 9:40 am; 12:15 pm; 2:15 pm; 6 pm; 6:30 to 7:30 pm; 8:15 to 10:45 pm. Sun.: 9:40 am; 10 am; 11 am; 12:15 pm; 7:30 pm; 10 pm.
	KFJI—Astoria, Ore.—Liberty Theatre (E. E. Marsh)	10	246	1220	Pacific	
	KFJM—Grand Forks, N. D.—University of N. D.	100	278	1080	Central	Mon., 6 to 7 pm; Tue., 6 to 7 pm; Wed., 6 to 7 pm; Thu., 8:45 to 10 pm; Fri., 6 to 7 pm; Sat., 6 to 7 pm. Sun.: 6 to 7 pm.
	KFJR—Portland, Ore.—Ashley C. Dixon & Son (Associated with Ralph Schneeloch Co.), 1350 East 36th St.	50	263	1140	Pacific	Mon., 7:30 to 8:45 pm; Tue., 7:15 to 8:15 pm; 9 to 10:30 pm; Wed., 7:30 to 8:30 pm; Thu., 7:30 to 8:30 pm; 9 to 10:30 pm; Sat., 1:30 to 3 pm.
	KFJY—Fort Dodge, Iowa—Tunwall Radio Co., 13 N. 10th St.	50	246	1220	Central	Mon., 5:45 pm; Tue., 5:45 pm; Wed., 5:45 pm; Thu., 5:45 pm; 6 pm; 7 pm; Fri., 5:45 pm; 6 pm; Sat., 5:45 pm; 11 pm.
	KFJZ—Fort Worth, Tex.—Southwestern Baptist Theological Seminary	50	254	1180	Central	
	KFKA—Greeley, Colo.—Colorado State Teachers College	50	273	1100	Mountain	Tue., 8 to 9 pm; Thu., 8 to 9 pm; Wed., 10 to 11 am.
	KFKU—Lawrence, Kans.—University of Kansas	500	275	1090	Central	Mon., 7 pm to 8 pm; Thu., 7 pm to 8 pm.
	KFKX—Hastings, Neb.—Westinghouse Elec. & Mfg. Co.	5000	288.3	1040	Central	
	KFKZ—Kirksville, Mo.—F. M. Henry, 402 So. High St	10	226	1330	Central	
	KFLR—Albuquerque, N. Mex.—University of New Mexico	100	254	1180	Mountain	
	KFLU—San Benito, Tex.—San Benito Radio Club	20	236	1270	Central	Mon. Thu. Sat., 8 to 9 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KF KFLV	Rockford, Ill.—Swedish Evangelical Mission Church	100	229	1310	Central	
KFLX	Galveston, Tex.—Geo. R. Clough, 1214 40th St.	10	240	1250	Central	
KFLZ	Anita, Iowa—Walnut Grove Co.	100	273	1100	Central	Daily: 11:50 am and 12:30 pm. Sun. and Holidays: 8:30 pm to 10 pm.
KFMR	Sioux City, Iowa—Morningside College	100	261	1150	Central	
KFMW	Houghton, Mich.—M. G. Sateren, 127 Blanche St.	50	263	1140	Central	Sun.: 2 to 4 pm.
KFMX	Northfield, Minn.—Carleton College	500	336.9	890	Central	Daily time signals: 10:25 to 10:30 am; Tue., 9:30 to 10 pm; Wed., 9 to 10 pm; Fri., 10 to 11 pm. Sun.: 7 to 8 pm.
KFNF	Shenandoah, Iowa.—Henry Field Seed & Nursery Co.	1000	263	1140	Central	Daily: 7 to 8 am; 10 to 11 am; 12:15 to 1:35 pm; 2:45 to 4 pm; 7 to 9 pm. Sun.: 10:45 to 12:15 pm; 2:30 to 4 pm; 6:30 to 8:30 pm.
KFOA	Seattle, Wash.—Rhodes Department Store	1000	454.3	660	Pacific	Daily: 10 am to 10:45 am; 12:30 pm to 1:30 pm; 3 to 4 pm; 4:15 to 5 pm; 6 to 6:30 pm; 6:45 to 8:15 pm; 8:15 to 10 pm; 10 to 11 pm. No Sun. broadcast. Holidays same as regular schedule.
KFOB	Burlingame, Calif.—KFOB Inc.	50	226	1330	Pacific	Tue., 8 to 12 pm; Thu., 8 to 12 pm; Sat., 5:30 to 6 pm.; 8 to 12 pm.
KFON	Long Beach, Calif.—Nichols & Warinner, Inc., Markwell Building	500	233	1290	Pacific	Daily: 2:30 to 4:30 pm; 6:30 to 11 pm. Sun. and Holidays: 2:30 to 4 pm; 7:45 to 11 pm.
KFOO	Salt Lake City, Utah—Latter Day Saints University	250	236	1270	Pacific	Station KFOO is not operating this year.
KFOR	David City, Neb.—David City Tire & Elec. Co.	100	226	1330	Central	Mon., 7 to 8 pm; Thu., 7 to 9 pm. Sun.: 3:30 to 4 pm.
KFOT	Witchita, Kans.—College Hill Radio Club (College Hill Methodist Church)	50	231	1300	Central	Fri., 12 to 2 am; Sat., 11:15 pm to 1:30 am. Sun.: 11 to 1 pm and 7:30 to 9 pm.
KFOX	Omaha, Neb.—Technical High School (Board of Education)	100	248	1210	Central	No regular schedule.
KFOY	St. Paul, Minn.—Beacon Radio Service (M. G. Goldberg), 711 Dayton Ave.	50	252	1190	Central	
KFPL	Dublin, Tex.—C. C. Baxter, 205 Grafton St.	15	252	1190	Central	
KFPM	Greenville, Tex.—The New Furniture Co.	10	242	1240	Central	Mon., 1 pm and 9 pm; Tue., 1 pm; Wed., 1 pm and 8 pm; Thu., 1 pm; Fri., 1 pm and 9 pm; Sat., 1 pm. Sun.: 11 am.
KFPR	Los Angeles, Calif.—Los Angeles County Forestry Dept.	500	230.6	1300	Pacific	
KFPW	Carterville, Mo.—St. Johns M. E. Church, South. (L. E. Stewart)	20	258	1160	Central	Tue., 8 to 9 pm; Fri. 8 to 9 pm. Sun.: 1 to 2 pm.
KFPY	Spokane, Wash.—Symons Investment Co.	100	266	1130	Pacific	Mon., 7 to 8 pm; 9:30 to 10:30 pm; Wed., 7 to 8 pm; 9 to 12 midnight; Thu., 7 to 8 pm; 10 to 11 pm; Fri., 7 to 8 pm; Sat., 7 to 8 pm; 11 pm to 12 midnight. Sun.: 9:55 to 10:40 am; 9 to 10 pm.
KFQA	St. Louis, Mo.—The Principia, 5539 Page Ave. * (KFQA and KMOX sharing use of same transmitter. Not yet permitted to use full power.)	*5000	280.2	1070	Central	Sun.: 8 pm.
KFQB	Fort Worth, Tex.—Searchlight Publishing Co., 408 Throckmorton St., Broadcasting from First Baptist Church	1000	508.2	590	Central	Sundays only: 8:30 to 9:30; 10 to 11 am; 3 to 5; 6:30 to 9:30; 11 to 12 pm.
KFQP	Iowa City, Iowa.—Geo. S. Carson, Jr., 906 E. College St.	10	223.7	1340	Central	Wed., 8 to 9 pm.
KFQU	Alma (Holy City), Calif.—W. E. Riker	100	217.3	1380	Pacific	Daily: 9 to 10 pm. Sun. and Holidays: 11 am to to 12 am; 9 to 10 pm.
KFQW	North Bend, Wash.—Carl F. Knierim	50	215.7	1390	Pacific	
KFQZ	Hollywood, Calif.—Taft Radio & Broadcasting Co., Inc., 5653 DeLongpre Ave.	50	226	1330	Pacific	Daily: 8 to 11 pm. Sun. and Holidays: 8 to 11 pm.
KFRB	Beeville, Tex.—Hall Bros.	250	248	1210	Central	
KFRC	San Francisco, Calif.—City of Paris Dry Goods Co.	50	267.7	1120	Pacific	Mon., 10 to 11 am; 5:30 to 10 pm; Tue., 11 to 12:30 pm; 5:30 to 11 pm; Wed., 10 to 12 am; 5:30 to 12 pm; Thu., 11 to 12 am; 4 to 10 pm; Fri., 12 to 12:30 pm; 4 to 11 pm; Sat., 11 to 11:30 am; 4 pm to 1 am. No change for holidays. Sun.: 6:30 to 12 pm.
KFRU	Columbia, Mo.—Stephens College. A Junior College for Women	500	499.7	600	Central	Mon., 4:30pm; 6;15 pm., Tue., 8;45 am; 4:30 pm; 6:15 pm; Wed., 4:30 pm; 6:30 pm; 9pm; Thu., 8:45 am; 4:30 pm; 6:15 pm; Fri., 4:30 pm; 6:15 pm; 12 midnight; Sat., 4:30pm. Sun., 7:30 am. 9:30 am; 4 pm; 7:30 pm.
KFRW	Olympia, Wash.—United Churches of Olympia.	50	218.8	1370	Pacific	
KFSG	Los Angeles, Calif.—Echo Park Evangelistic Assn., 1100 Glendale Blvd.	500	275	1090	Pacific	

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KF KFUL	Galveston, Texas—Thos. Groggan and Bros. Music Co., 2126 Market St	50	258	1160	Central	
KFUM	Colorado Springs, Colo.—Corley Mountain Highway	100	239.9	1250	Mountain	Mon., 8 to 10 pm; Thu., 8 to 10 pm. Sun.: 11 am and 9 pm.
KFUO	St. Louis, Mo.—Concordia Theological Seminary	500	545.1	550	Central	Mon., 3 pm and 8 pm; Tue., 3 pm and 6:30 pm; Wed., 3 pm and 9:15 pm; Thu., 3 pm; Fri., 3 pm and 9:30 pm; Sat., 7:45 pm. Sun.: 4 pm and 9:15 pm.
KFUP	Denver, Colo.—Fitzsimons General Hospital	50	234	1280	Mountain	
KFUR	Ogden, Utah—Peery Building Co., 420 Twenty-fifth St	50	224	1340	Pacific	
KFUS	Oakland, Calif.—Louis L. Sherman, 529 Twenty-eighth St	50	256	1170	Pacific	Daily: 6:30 to 7:30 pm. Sun.: 9 am; 2:30 to 3:30 pm; 3:30 to 4:30 pm.
KFUT	Salt Lake City, Utah—University of Utah	100	261	1150	Pacific	Tue., 12 to 1 pm; Thu., 12 to 1 pm.
KFUU	Oakland, Calif.—H. C. Colburn and E. L. Mathewson, Flint Motor Car Building	100	220	1360	Pacific	Daily: 10:45 am to 11:45 am; 6:30 to 7:30 pm; 8 to 10:30 pm. Sun.: 8 to 10 pm.
KFVD	San Pedro, Calif.—McWhinnie Elec. Co., 1825 So. Pacific Ave	50	205.4	1460	Pacific	
KFVE	St. Louis, Mo.—Film Corp. of America, 6800 Delmar Blvd	500	240	1250	Central	
KFVG	Independence, Kans.—First Methodist Episcopal Church	15	236	1270	Central	
KFVI	Houston, Texas—Fifty-sixth Cavalry Brigade, Headquarters Troop	10	240	1250	Central	
KFVN	Fairmont, Minn.—Carl E. Bagley	50	227	1320	Central	Mon. Wed. and Fri., 9 pm. Sun.: 3 pm.
KFVS	Cape Girardeau, Mo.—Hirsch Battery and Radio Co	50	224	1340	Central	Daily: 12:15 pm; Thu., 7 pm. Sun.: 11 am and 7 pm.
KFVW	San Diego, Calif.—Airfan Radio Corp., 402 B. St.	500	245.8	1222	Pacific	Daily: 9 pm to 1 am.
KFVY	Albuquerque, N. Mexico—Radio Supply Co., 407 West Central Ave	10	250	1200	Mountain	
KFWA	Ogden, Utah—Browning Bros. Co., 2451 Kiesel Ave	500	261	1150	Pacific	
KFWB	Hollywood, Calif.—Warner Bros. Pictures (Inc.), 5842 Sunset Blvd	500	252	1190	Pacific	
KFWC	San Bernardino, Calif.—L. E. Wall	50	211.1	1420	Pacific	Mon., silent; Tue., 8 am to 12 am; 1 pm to 1 am; Thu., 8 am to 12 am; 1 pm to 1 am; Fri., 8 to 12 pm; Sat., 8 to 12 am. Sun.: 8 am to 1 pm.; 7 pm to 2 am.
KFWF	St. Louis, Mo.—St. Louis Truth Center, Rev. Emil C. Hartmann, 4030 Lindell Blvd	250	214.2	1400	Central	Tue., 7 pm; 8 pm; Thu., 10:45 am; 12 am; 7:45 pm; 9 pm. Sun.: 10:45; 7:45; 9 pm.
KFWH	Chico, Calif.—F. Wellington Morse, Jr., 522 Grand Ave., Oakland, Calif	100	254	1180	Pacific	
KFWI	San Francisco Calif. (Transmitter is in So. San Francisco, Calif.)—Tom Catton	500	226	1330	Pacific	Mon., 10:45 to 11:30 am; 1 to 2; 6:30 pm to 1 am; Tue., 11 to 1 am; Wed., 10:45 to 11:30 am; 1 to 2; 6:30 pm to 1 am; Thu., Silent; Fri., 10:45 to 11:30 am; 6:30 pm to 1 am; Sat., 1:30 to 3:30 am. Sun.: 1 to 2; 8 to 12:30 pm.
KFWM	Oakland, Calif.—Oakland Educational Society, 1520 8th Ave	500	207	1450	Pacific	Mon., 8 to 10; Tue., 2 to 2:30; Wed., 2 to 2:30; Thu., 8 to 10; Fri., 2 to 2:30; Sat., 8 to 10. Sun.; 9:30 to 11 am; 1 to 2 pm.
KFWO	Avalon, Catalina Island, Calif.—Major Lawrence Mott, Signal Corps, U. S. Army	250	211.1	1420	Pacific	Mon., 12:30 to 1:30 pm; 6 to 10 pm; Tue., 12:30 to 1:30 pm; 5 to 9 pm; Wed., 12:30 to 1:30 pm; 6 to 10 pm; Thu., 12:30 to 1:30 pm; 6 to 9 pm; Fri., 12:30 to 1:30 pm; 6 to 11 pm; Sat., 12:30 to 1:30 pm; 6 to 9 pm. Sun.: 12:30 to 1:30 pm; 5 to 10 pm.
KFWU	Pineville, La.—Louisiana College	100	238	1260	Central	
KFWV	Portland, Ore.—Wilbur Jerman, 385 East Fifty-eighth St., So	50	212.6	1410	Pacific	
KFXB	Big Bear Lake, Calif.—Bertram O. Heller	500	202.6	1480	Pacific	Daily: 5 to 5:30 pm; 8 to 8:30 pm. Sun.: silent.
KFXD	Logan, Utah—Service Radio Company	10	205.4	1460	Mountain	
KFXF	Colorado Springs, Colo.—Pikes Peak Broadcasting Co., 226 Hagerman Bld	500	250	1200	Mountain	
KFXH	El Paso, Texas—Bledsoe Radio Co., 2857 Montana St	50	242	1240	Central	
KFXJ	Edgewater, Colo.—R. G. Howell	10	215.7	1390	Mountain	Daily: 9 to 11 am; 5:30 to 6:30 pm. Night programs pending.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KF	**KFXR—Oklahoma, Okla.**—Classen Film Finishing Co., 132½ W. Main Street	15	214.2	1400	Central	
	KFXY—Flagstaff, Ariz.—Mary M. Costigan (Orpheum Theatre)	50	205.4	1460	Mountain	
	KFYF—Oxnard, Calif.—Carl's Radio Den, 207—5th St.	10	205.4	1460	Pacific	Daily: 5:05 to 6 pm; 9 to 11 pm on 2nd and 4th Thu. each month. Programs on Tue. and Thu. by special announcement.
	KFYJ—Houston, Texas—(Portable) Houston Chronicle Pub. Co.	10	238.0	1260		
	KFYO—Texarkana, Texas—Buchanan-Vaughan Co.	10	209.7	1430	Central	
	KFYR—Bismark, N.D.—Hoskins Meyer, 200 Fourth St.	10	248	1210	Central	Daily: 6:30 to 7:30 pm. Extra hours on extra programs. Sun.: 3 to 5 pm.
KG	**KGO—Oakland, Calif.**—General Electric Co.	4000	361.2	830	Pacific	Mon., 7:15; 7:45; 8:15; 8:30; 10:40; 11:30 am; 1:30; 3; 4 to 5:30; 5:30 to 6; 6 to 6:55; 8 to 10 pm; Tue., 7:15; 7:45; 8:15; 8:30; 11:30 am; 1:30; 4 to 5:30; 6 to 6:55; 8 to 10 pm; Wed., 7:15; 7:45; 8:15; 8:30; 11:30 am; 1:30; 3; 4 to 5:30; 6 to 6:55 pm; Thu., 7:15; 7:45; 8:15; 8:30; 10:40; 11:30 am; 1:30; 4 to 5:30; 8 to 10 pm; Fri., 7:15; 7:45; 8:15; 8:30; 11:30 am; 1:30; 3; 4 to 5:30; 5:30 to 6; 6 to 6:55 pm; Sat., 7:15; 7:45; 8:15; 8:30; 11:30 am; 12:30; 4 to 5:30; 8 to 10 pm. Sun.: 11 am; 3:30 to 5 pm; 7:45 pm.
	KGTT—San Francisco, Calif.—Glad Tidings Temple and Bible Inst.	50	207	1450	Pacific	Tue., 2:30 to 3:30 pm; 8 to 10 pm; Wed., 2:30 to 3:30 pm; 8 to 10 pm; Thu.. 2:30 to 3:30 pm; Fri., 2:30 to 3:30 pm; 8 to 10 pm. Sun.: 2:30 to 5 pm; 8 to 10 pm.
	KGW—Portland, Ore.—The Oregonian Pub. Co.	1000	492.5	610	Pacific	Mon., 6 to 10 pm; Tue., 6 to 12 pm; Wed., 6 to 11 pm; Thu., 6 to 10 pm; Fri., 6 to 12 pm; Sat., 6 to 12 pm. Sun.: 7 to 10 pm.
	KGY—Lacey, Wash.—St. Martins College	50	246	1220	Pacific	Tue., 8:30 to 9:30 pm; Thu., 8:30 to 9:30 pm. Sun.: 8:30 to 9:30 pm.
KH	**KHJ—Los Angeles, Calif.**—Times Mirror Co., 100 N. Broadway	500	405.2	740	Pacific	Daily: 12:30 to 1:30 pm; 6:30 to 10 pm; Wed., same only 2:30 to 3:30 pm. Sun. and Holidays: 4 to 5 pm; 8 to 10 pm; also Sun.: 10 am to 12 am.
	KHQ—Spokane, Wash.—Louis Wasmer, Peyton Building	500	273	1100	Pacific	
KJ	**KJBS—San Francisco, Calif.**—Julius Brunton and Son Co., 1380 Bush St.	5	220	1360	Pacific	Daily: 9 to 10:40 am; 2 to 2:30 pm; Mon. and Wed., 8 to 10 pm; Fri., 8 to 11:30 pm. Sun.: 5 to 6:30 pm.
	KJR—Seattle, Wash.—Vincent I. Kraft	1000	384.4	780	Pacific	Daily: 10:30 to 11:30 am; 11:30 to 12; 5 to 6; 7 to 8:30; 8:30 to 10; Thu., 10 to 12 pm. Sun.: 11 to 12:30; 7 to 9; 9 to 10:30.
KL	**KLDS—Independence, Mo.**—Reorganized Church of Jesus Christ of Latter Day Saints	1000	440.9	680	Central	Mon., 12:15 to 11 pm; Tue., 6:30 am; 12:15; 2:30; 8 pm; Wed., 12:15; 6 pm; Thu., 12:15; 2:30; 8 pm; Fri., 6:30 am; 12:15; 2:30 pm; Sat., 8 pm. Sun.: 11 am; 3; 6:30; 9:15 pm.
	KLS—Oakland, Calif.—Warner Bros. Radio Supplies Co., 2201 Telegraph Ave.	250	250	1200	Pacific	Sun.: 10 am and 11 am.
	KLX—Oakland, Calif.—The Oakland Tribune	500	508	590	Pacific	Mon., 6:30 to 7:30 pm and 8 to 10:30 pm; Tue., 3 to 5 pm; 7 to 7:30 pm; Wed., 3 to 5 pm; 6:30 to 7:30 pm; 8 to 10:30 pm; Thu., 3 to 5 pm; 7 to 7:30 pm; Fri., 3 to 5 pm; 7 to 7:30 pm; 8 to 10:30 pm; Sat., 3 to 5 pm; 7 to 7:30 pm. No Sun. broadcasting. Holidays same as usual.
	KLZ—Denver, Colo.—Reynolds Radio Co., 1534 Glenarm Street	250	266	1130	Mountain	Mon., 3 to 4 pm; 6 to 7 pm; 8 to 1 am; Tue., 6:30 to 9 pm; 10 to 11 pm; Wed., 3 to 4 pm; 6 to 7 pm; 8 to 10 pm; Thu. Silent; Fri., 6 to 7 pm; 8 to 10 pm; Sat., 3 to 4 pm; 6:30 pm to 1 am. Sun.: 5 to 6 pm; 6:30 to 8 pm; 9 to 10:30 pm.
KM	**KMA—Shenandoah, Iowa**—May Seed and Nursery Co.	500	252	1190	Central	Mon., 5:30 to 7; 9; 11:30 am to 12:30 pm; 6 to 7; 9 to 11 pm; Tue., 5:30 to 7; 9; 11:30 am to 12:30 pm; 2; 6 to 7; 9 to 11 pm; Wed., 5:30 to 7; 9; 11:30 am to 12:30 pm; 2 6 to 7 9 to 11 pm; Thu., 5:30 to 7; 9; 11:30 am to 12:30 pm; 2 to 3; 4 to 5; 6 to 7; 9 to 11 pm; Fri., 5:30 to 7; 9; 11:30 am to 12:30 pm; 2 to 3; 6 to 7; 9 to 11 pm; Sat., 5:30 to 7; 9; 11:30 am to 12:30 pm; 2; 6 to 7; 9 to 11 pm. Sun.: 12:15; 4 to 5· 5 to 6 pm.
	KMJ—Fresno, Calif.—Fresno Bee	50	234	1280	Pacific	
	KMMJ—Clay Center, Nebr.—M. M. Johnson Co.	1000	229	1310	Central	
	KMO—Tacoma, Wash.—Love Elec. Co., 738 Pacific Ave.	100	250	1200	Pacific	
	KMOX—St. Louis, Mo. (Transmitter is in Kirkwood, Mo.)—Voice of St. Louis, Inc.	1500	280.2	1070	Central	Daily: 8:40 to 12:40, Market Reports at Half Hour Intervals; 12:30 to 1:30; 3 to 5 pm; 6 to 11:30 pm; Thu., Silent after 5 pm. Sun.: 9 to 10:30 pm.
	KMTR—Hollywood, Calif.—K. M. Turner Radio Corp., 1517 N. Wilton St.	500	238	1260	Pacific	Daily: 9 am; 2:30 pm; 5 pm; 6 pm; 8 to 10 pm; Tue. Thu. Sat., 9:30 pm; Mon. Wed. Fri., 10 to 11 pm. No regular broadcast on Sun.
KN	**KNRC—Los Angeles, Calif.**—Kierulff and Ravenscroft, 1630 So. Los Angeles St.	250	208	1440	Pacific	Mon., 1 to 3 pm; 5:45 to 10 pm; Tue., 1 to 3 pm; 5:45 to 10 pm; Wed., 1 to 3 pm; 5:45 to 10 pm; Thu., 2 to 3 pm; 5:45 to 10 pm; Fri., 2 to 3 pm; 5:45 to 10 pm; Sat., 2 to 3 pm; 5:45 to 11 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KN KNX	**Los Angeles, Calif.**—Los Angeles Evening Express, 6116 Hollywood Blvd	1000	336.9	890	Pacific	
KO KOA	**Denver, Colo.**—General Electric Co., 1370 Krameria St	5000	322.4	930	Mountain	Mon., 11:45 am to 1:15 pm; 6 to 10 pm; Tue., 11:45 am to 1:15 pm; 3:15 to 4:30; 6 to 8:30 pm; Wed., 11:45 am to 1:15 pm; 6 pm to 12 pm; Thu., 11-45 to 1:15 pm; 3:15 to 4:30; 6 to 8 pm; Fri., 11:45 to 1:15 pm; 3:15 to 4:30; 6 to 10 pm; Sat., 11:45 to 1:15 pm; 9 pm to 12 pm. Sun.: App. 11 am; 4; 7:30 pm.
KOAC	**Corvallis, Ore.**—Oregon Agricultural College	500	280.2	1070	Pacific	Mon., 12:15 to 12:45 pm; 7 to 8:30 pm; Wed., 2 to 3 pm; 7:20 to 8:15 pm; Thu., 2 to 3 pm; Fri., 7:30 to 9 pm.
KOB	**State College, N. Mex.**—New Mexico College of Agriculture and Mechanic Arts	1000	348.6	860	Mountain	Daily: 11:55 am to 12:30 pm; 9:55 pm to 10:10 pm; Mon., 7:30 to 8:30 pm; Fri., 7:30 to 8:30 pm.
KOCH	**Omaha, Nebr.**—Central High School	250	258	1160	Central	Mon., 8:30 to 10; Tue., 8-30 to 10; Thu., 8:30 to 10. Sun.: 3:30 pm.
KOCW	**Chickasha, Okla.**—Oklahoma College for Women	200	252	1190	Central	
KOIL	**Council Bluffs, Iowa**—Mona Motor Oil Co.	500	278	1080	Central	Mon., 6 pm to midnight; Tue., Thu., Fri., 6 to 9 pm; 11 to 12 pm; Wed., Silent; Sat., 6 to 9 pm; 11 to 1 am. Sun.: 11 am; 4; 7 to 9 pm; 11 to 12 pm.
KOWW	**Walla Walla, Wash.**—Blue Mountain Radio Association. (Frank A. Moore)	500	256	1170	Pacific	
KP KPO	**San Francisco, Calif.**—Hale Bros. and the San Francisco Chronicle	1000	428.3	700	Pacific	Mon., 7 to 8:30 am; 1 to 2; 2:30 to 4:30; 5:15 to 7:30; 8 to 11 pm; Tue. Wed. and Thu., same as Mon.; Fri., 7 to 8:30 am; 12:45 to 2 pm; 4 to 7:30 and 8 to 11 pm; Sat., 7 to 8:30 am; 2:30 to 5:30; 6 to 7:30 and 8 to 12 pm. Sun.: 9:45 to 10:45 am; 5 to 10 pm.
KPPC	**Pasadena, Calif.**—Pasadena Presbyterian Church	50	229	1310	Pacific	Wed., 7:15 to 9 pm. Special broadcasts as announced. Sun.: 10:30 am to 12:30 pm; 6:45 pm to 9 pm.
KPRC	**Houston, Texas**—Houston Post Dispatch	500	296.9	1010	Central	Daily: Fri., silent 10:55 am; 11 am; 12 am; 5:30 pm; 7:30 pm; 8 pm; 8:30 pm; 9 pm; 9:30 pm; Daily and Sun.: 11 pm Wed. and Sat. only. Sun.: 10:45 am; 7 pm; 9:30 pm.
KPSN	**Pasadena, Calif.**—The Star-News	1000	315.6	950	Pacific	Mon., Silent; Tue., 8 to 9 pm; Wed., silent; Thu., 8 to 9 pm; Fri., silent; Sat., 8 to 10 pm. Sun.: 8:45 to 9:45 pm.
KQ KQP	**Portland, Ore.** (Transmitter is 6 miles west of City)—H. B. Read, 441 Sixth St	1000	319	940	Pacific	
KQV	**Pittsburgh, Pa.**—Doubleday-Hill Electric Co., 719 Liberty Ave	500	275	1090	Eastern	Mon., 10:30 to 11 am; 3 to 4:30 pm; Tue., 10:30 to 11 am; 3 to 4:30 pm; 6:30 to 7:30; Wed., 10:30 to 11 am; 3 to 4:30 pm; Thu., 10:30 to 11 am; 3 to 4:30 pm; Fri., 10:30 to 11 am; 3 to 4:30 pm; Sat., 10:30 to 11 am; 3 to 4:30 pm.
KQW	**San Jose, Calif.**—First Baptist Church of San Jose, Montevina Ave	500	231	1300	Pacific	Mon. Tue. Wed. Thu. Fri. 6:30; 7. Sun.: 9:40 to 12:30; 7:30 to 9:30.
KR KRE	**Berkeley, Calif.**—Berkeley Daily Gazette	100	256	1170	Pacific	Daily: 11:15 am to 11:45 am; 5:30 pm to 6 pm; Mon. and Thu., 8 to 10 pm; Tue., 9 to 10; Fri., 9 pm to 1 am; Sat., 8 pm to 1 am. Sun. and Holidays: 10 to 11 am; 6:30 to 7:30 pm; 8 to 9 pm.
KS KSAC	**Manhattan, Kans.**—Kansas State Agricultural College	500	340.7	880	Central	
KSD	**St. Louis, Mo.**—Pulitzer Publishing Co.—The St. Louis Post Dispatch	500	545.1	550	Central	Mon., 9:40; 10:40; 11:40; 12:40 pm; 1:40; 2:40; 3:40 pm; 7; 9 to 10:30 pm; Tue., 7 to 11 pm; Wed., 7 to 9:15 pm; Thu., 7 to 11 pm; Fri., 7 to 9:20; 10 to 11 pm; Sat., 7 to 7:45; 8 to 11 pm. Mon. Wed. and Fri., 10 am and 11 am. Sun.: 6:15 to 9:15 pm.
KSL	**Salt Lake City, Utah**—Radio Service Corp. of Utah, 505 Templeton Bldg	1000	299.8	1000	Mountain	Mon., 7:30 am; 6 pm to 11 pm; Tue., 7 pm to 11 pm; Wed., 7:30 am; 10 am; 6 to 11:30 pm; Thu. 7 pm to 11 pm; Fri., 7:30 am; 10 am; 6 pm to 11 pm; Sat., 7:15 pm to 11 pm. Sun.: 11 am; 4 pm to 11 pm.
KSMR	**Santa Maria, Calif.**—Santa Maria Valley R. R. Co	100	209.7	1430	Pacific	Mon. Wed. and Fri., 7:45 to 8:15 pm; Tue. Thu. and Sat., 7 to 10 pm.
KSO	**Clarinda, Iowa**—A. A. Berry Seed Co	500	242	1240	Central	Mon., 12:30 pm to 7 pm; Tue., 12:30 pm to 7 pm; Wed., 12:30 pm to 7 pm; Thu., 12:30 pm; 3 pm to 4:30; 7 pm; Fri., 12:30 pm; 7pm; Sat., 12:30 pm.
KT KTAB	**Oakland, Calif.**—The Associated Broadcasters	1000	240	1250	Pacific	Daily: 9 to 9:30 am; 12 to 1 pm; 8 to 10 pm. Sun.: 9:45 to 10:45 am; 11 am to 12:30; 7:45 to 9:15 pm; 9:30 to 11 pm.
KTBI	**Los Angeles, Calif.**—Bible Institute of Los Angeles	750	293.9	1020	Pacific	
KTBR	**Portland, Ore.**—Brown's Radio Shop, 172 Tenth St	50	263	1140	Pacific	Mon., 1:30 to 2:30 pm; 8:45 to 9:45 pm; Tue., 1:30 to 2:30 pm; 8:30 to 9 pm; Wed., 1:30 to 2:30 pm; 8:30 to 10:30 pm; Thu., 1:30 to 2:30 pm 6:15 to 7:15 pm; Fri., 1:30 to 2:30 pm; 6 to 10 pm. Sat., 3 to 4 pm; 11:30 to 1:30 am. Sun.: 3 to 4 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
KT	**KTCL—Seattle, Wash.**—American Radio Telephone Co.	1000	305.9	980	Pacific	
	KTHS—Hot Springs Nat'l Park, Ark.—New Arlington Hotel Co.	750	374.8	800	Central	Mon., 12:30 to 1 pm; 9 to 11:30 pm; Tue., 9 to 11:30 pm; Wed., 12:30 to 1 pm; 9 to 11:30 pm; Thu., 12:30 to 1 pm; 9 to 11:30 pm; Fri., 12:30 to 1:30 pm; 9 to 11:30 pm; Sat., 12:30 to 1:30 pm; 9 to 11:30 pm. Sun.: 11 am to 12:15 pm; 9 pm to 12:45 am.
	KTNT—Muscatine, Iowa—Norman Baker	500	256	1170	Central	Daily: 12 to 12:30 pm; 6:45 to 7:45 pm; 9 to 10:30 pm; 11 to 12 pm; Sat., silent; 9:30 each Mon. Night "Common Sense Talks," by N. Baker. Sun.: 9 to 10:30 pm.
	KTW—Seattle, Wash.—The First Presbyterian Church of Seattle, Wash.	1500	454.3	660	Pacific	Sun.: 11 am to 12:30 pm; 3 to 4:30 pm; 7:30 pm to 10 pm.
KU	**KUOA—Fayetteville, Ark.**—University of Arkansas	750	299.8	1000	Central	Mon., 7:30 to 9; Tue., 8 to 10; Thu., 8 to 10.
	KUOM—Missoula, Mont.—State University of Montana	500	244	1230	Mountain	Daily: 6:30 pm; Mon. and Thu., 8 pm. Sun.: 9:15 pm.
	KUSD—Vermillion, S. D.—University of South Dakota	100	278	1080	Central	Wed., 8 to 10 pm. Sun.: 3:30 pm; 9 pm.
	KUT—Austin, Texas—University of Texas	500	231	1300	Central	Mon., 8 pm; Wed., 8 pm. Sun.: 11 am; 3:30 pm.
KV	**KVOO—Bristow, Okla.**—Voice of Oklahoma	500	375	800	Central	Daily: 7 to 9 am; 11:30 to 12:30 pm; 3 to 4; 6 to 9 pm. Sun.: 12:30 to 7 pm (continuous); 7:30 to 9 pm.
KW	**KWCR—Cedar Rapids, Iowa**—H. F. Paar, 1444 Second Ave., E.	500	278	1080	Central	Mon., 9 to 10:30; Wed., 9 to 10:30; Fri., 9 to 10:30; Afternoon programs, 4:15 pm; Mon. Wed. and Fri. Sun.: 11 am; 5:15 pm; 9:30 pm.
	KWG—Stockton, Calif.—Portable Wireless Telephone Co., 530 East Market St.	50	248	1210	Pacific	
	KWKC—Kansas City, Mo.—Wilson Duncan Broadcasting Studios, Werby Building	100	236	1270	Central	Tue., 7 and 9 pm; Wed., 7 and 9 pm; Thu., 7 and 9 pm; Fri., 7 and 9.
	KWKH—Shreveport, La. (Transmitter is in Kennonwood, La.)—W. K. Henderson Iron Works and Supply Co.	1000	329	911	Central	Mon., 8 to 9 pm; Tue., 9-12 pm; Wed., Silent or special program; Thu., 8 to 9 pm; Fri., 9 to 12 pm; Sat., 9 to 12 pm. Sun.: 9:30 to 10:30 am; 5 to 6 pm.
	KWSC—Pullman, Wash.—State College of Washington	500	348.6	860	Pacific	
	KWUC—Le Mars, Iowa—Western Union College	50	252	1190	Central	Mon., 7:30 to 9 pm; Wed., 8 to 9 pm; Fri., 7 to 8 pm. Sun.: 3 to 4 pm.
	KWWG—Brownsville, Texas—Chamber of Commerce	500	278	1080	Central	Daily: 12 noon; 6 pm; Mon. and Thu., 8:30 pm; Tue. and Fri., 12:01 am. Sun.: 11 am.
KY	**KYW—Chicago, Ill.**—Westinghouse Electric and Mfg. Co.	2000	536	560	Central	Daily: 11 am; 12 am; 1 pm; 2:35 to 4 pm; Tue. Thu. and Sat., 5:45 to 6; 6:30 to 7 pm; 8 to 12 pm. Sun. and Holidays: 11 am; 2:30; 4:30; 7 and 9:30 pm.
KZ	**KZM—Oakland, Calif.**—Preston D. Allen, 13th and Harrison Streets	100	240	1250	Pacific	Daily except Sunday: 6:30 to 7 pm.
NA	**NAA—Arlington, Va.**—United States Navy	1000	434.5	690	Eastern	Daily: 10:05 to 10:20; 11:55 to noon; 3:45 to 4; 9:55 to 10; 10:05 to 10:20 pm; Wed., 7:45 to 8 pm; 8:45 to 9:20 pm; Fri., 8:45 to 9:20 pm.
WA	**WAAD—Cincinnati, Ohio**—Ohio Mechanics Institute	25	258	1160	Central	
	WAAF—Chicago, Ill.—Chicago Daily Drovers Journal	200	278	1080	Central	
	WAAM—Newark, N. J.—I. R. Nelson, 1 Bond St.	500	263	1140	Eastern	Mon., 11 to 12 am; 6 to 11 pm; Tue., 10:15 to 12 am; 6 to 11 pm; Wed., 11 to 12 am; 6 to 11 pm; Thu., 11 to 12 am; 6 to 7:30 pm; Fri., 10:15 to 12 am; 6 to 11 pm; Sat., 6 to 11 pm. Sun.: 11 am to 12:30 pm.
	WAAW—Omaha Neb.—Omaha Grain Exchange	500	384.4	780	Central	Daily except Sat., 9:30 am; 9:45 every half hour to 1:15 pm. Last Broadcast on Sat., 12:45 pm. Evenings at 8 pm. Broadcast only market reports.
	WABB—Harrisburg, Pa.—Harrisburg Radio Co.	10	204	1470	Eastern	
	WABC—Ashville, N. C.—Asheville Battery Co., 19 Haywood St.	20	254	1180	Central	
	WABI—Bangor, Me.—First Universalist Church	100	240	1250	Eastern	Sun.: 10:30 to 12 am; 7:30 to 9:30 pm.
	WABO—Rochester, N. Y.—Lake Ave. Baptist Church	100	258	1160	Eastern	Sun.: 10:30 to 12 am; 7:30 am to 9 pm.
	WABQ—Haverford, Pa.—Haverford College Radio Club	100 1000	261	1150	Eastern	Mon., 7:30 pm. to 12:30 am; Fri., 7:30 pm. to 12:30 am.
	WABR—Toledo, Ohio—Scott High School	50	263	1140	Eastern	Program variable, depending upon the activities in and about school.
	WABW—Wooster, Ohio—College of Wooster	50	206.8	1450	Eastern	9:30 to 10 on Tue., Wed. and Thu. Otherwise very irregular as broadcast college programs.
	WABX—Mount Clemens, Mich. (near)—Henry B. Joy, 1830 Penobscot Bldg., Detroit, Mich.	500	246	1220	Central	
	WABY—Philadelphia, Pa.—John Magaldi, Jr., 815 Kimball St.	50	242	1240	Eastern	

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WA						
WABZ	**New Orleans, La.**—Coliseum Place Baptist Church	50	275	1090	Central	Sun.: 11 to 12:30 pm; 7:30 to 9 pm.
WADC	**Akron, Ohio**—Allen T. Simmons	500	258	1160	Eastern	Mon., 11 am to 12 am; 6:30 to 7:30 pm; Tue., 1 am to 3 am; 11 am to 12 am; 6:30 to 7:30 pm; 8 to 11 pm; Wed., 11 to 12 am; 6:30 to 7:30 pm; Thu., 11 am to 12 am; 6:30 to 7:30 pm; 9:30 to 11 pm; Fri., 11 am to 12 am; 6:30 to 7:30 pm; 8 to 11 pm; Sat., 11 am to 12 am; 6:30 to 7:30 pm. Sun.: 12:30 to 1:30 pm; 6:30 to 7:30 pm.
WAFD	**Port Huron, Mich.**—Albert B. Parfet Co., 1432 Military Road	500	275	1090	Eastern	Mon., 8 to 10 pm; Wed., 8 to 10 pm; Fri., 8 to 10 pm; Sat., 8 to 10 pm. Sun. and Holidays: 12:30 am to 2 am; 10 am to 12 am; 7:30 pm to 9:15 pm.
WAGM	**Royal Oak, Mich.**—Robert L. Miller	50	225.4	1330	Eastern	Mon., 7:30 pm to 12:30 am; Wed., 7:30 pm to 10:30 pm; Fri., 7:30 pm to 10:30 pm.
WAHG	**Richmond Hill, N. Y.**—A. H. Grebe and Co	500	315.6	950	Eastern	Mon., 11:50 am; 12:02; 8; 9:45; 9:55; 10:15; 10:30; 12 pm; Tue., 11:55 am; 12:02 pm; Wed., 11:50 am; 12:02; 8:45; 9:20; 9:55; 10:02; 10:30 pm; Thu., 11:55 am; 12:02 pm; Fri., 11:50 am; 12:02; 8; 9; 9:55; 10:02; 10:30 pm; Sat., 11:55 am; 12:10 pm. Sun.: Silent.
WAIT	**Taunton, Mass.**—A. H. Waite and Co., Inc., 32 Weir St	10	229	1310	Eastern	Wed., 7 to 8 pm; Fri., 7 to 8 pm.
WAIU	**Columbus, Ohio**—American Insurance Union	500	293.9	1020	Eastern	Mon., 11:55 am to 4 pm; 6 pm to 7:15 pm; 8 pm to 9:30 pm; 10 pm to 12 pm; Tue., 11:55 am to 1 pm; 2 pm to 4 pm; 6 to 7 pm; 9:15 pm to 1 am; Wed., 11:55 am to 1 pm; 2 to 4 pm; 6 to 7 pm; Thu., 11:55 am to 1 pm; 2 to 4 pm; 6 to 7 pm; Fri., 11:55 am to 1 pm; 2 to 4 pm; 6 to 7 pm; 8 to 9:30 pm; 10 pm to 1 am; Sat., 11:55 am to 1 pm; 2 to 4 pm; 9:15 pm to 1 am. Sun. 2 pm to 4 pm; 6 pm to 7 pm.
WAMD	**Minneapolis, Minn.**—Hubbard and Company and Radisson Radio Corp	1000	243.8	1230	Central	Daily: 12 am to 12:15 pm; 6:15 pm; 6:55 pm; 7 pm; 7:05 pm; 7:10 pm; 8 pm; 11 pm. Sun.: 10:30 am; 3 pm; 6:15 pm; 6:45 pm; 9:30 pm.
WAPI	**Auburn, Ala.**—Extension Service Alabama Polytechnic Institute	1000	248	1210	Central	Mon., 7 to 8:30 pm; Tue., 7 to 8:30 pm; Wed., silent; Thu., 7 to 8:30 pm; Fri., 8 to 11 pm; Sat., 6:30 to 10 pm. Sun.: Irregular.
WARC	**Medford Hillside, Mass.**—American Radio and Research Corp	100	261	1150	Eastern	
WATT	**Boston, Mass.** (Portable)—Edison Electric Illuminating Company of Boston	100	243.8	1230		
WB						
WBAA	**Lafayette, Ind.**—Purdue University	250	273	1100	Central	Daily: 9:50 am; Mon. and Fri., 7:15 pm.
WBAK	**Harrisburg, Pa.**—Pennsylvania State Police	500	275	1090	Eastern	Daily except Sun.: 10 to 1:30 to 5:45; 7:30; 12 am
WBAL	**Baltimore, Md.**—Consolidated Gas, Electric Light and Power Co	5000	246	1220	Eastern	Mon., 6 pm to 8 pm; Tue., 7:30 pm to 10 pm; Wed., Silent; Thu., 6 pm to 8 pm; Fri., 7:30 pm to 10 pm; Sat., Silent. Sun.: 6:30 to 7:30 pm.
WBAO	**Decatur, Ill.**—James Millikin University	100	270	1110	Central	
WBAP	**Fort Worth, Texas**—Carter Publishing Co., Inc.	1500	475.9	630	Central	Daily: 6; 7:30; 9:30; 11 pm; Wed., Silent. Sun.: 11 am; 5; 9:30 pm.
WBAX	**Wilkes-Barre, Pa.**—John H. Stenger, Jr., 66 Gildersleeve St	100	256	1170	Eastern	
WBBL	**Richmond, Va.**—Grace-Covenant Presbyterian Church	50	229	1310	Eastern	Tue., 8 pm to 10 pm. Sun.: 11 am and 7:45 pm.
WBBM	**Chicago, Ill.**—Atlass Investment Co., 1554 Howard St	1500	225.4	1330	Central	Mon., 4 to 7 pm; Tue., 4 to 6 pm; 8 to 12 pm. Wed., 4 to 6 pm; 8 to 10 pm; 12 pm to 2 am; Thu., 4 to 6 pm; 8 to 12 pm; Fri., 4 to 6 pm; 8 to 10 pm; Sat., 4 to 6 pm; 8 pm to 2 am; Sun.: 12:30. to 2 pm; 4 to 6 pm; 8 to 10 pm; 12 to 3 am.
WBBP	**Petoskey, Mich.**—Petoskey High School	200	238	1260	Central	Tue., 9 to 10:30 pm; Fri., 8 to 9:30 pm. Sun. and Holidays: 10:30 to 12 am; 3 to 4 pm.
WBBR	**Rossville, N. Y.**—People's Pulpit Assn., 124 Columbia Heights, Brooklyn, N. Y.	500	272.6	1100	Eastern	Mon., 8 to 9 pm; Thu., 8 to 9 pm; Fri., 8 to 9 pm. Sun.: 10 am to 12:30 pm; 2 to 4 pm; 9 to 10:30 pm
WBBS	**New Orleans, La.**—First Baptist Church	50	252	1190	Central	Sun.: 11 am and 7:45 pm.
WBBW	**Norfolk, Va.**—Ruffner Junior High School	50	222	1350	Eastern	
WBBY	**Charleston, S. C.**—Washington Light Infantry	10	267.9	1120	Eastern	Community furnishes artists about once a week.
WBBZ	**Chicago, Ill.** (Portable)—C. L. Carrell, 1506 No. American Building	50	215.7	1390		
WBCN	**Chicago, Ill.**—Foster and McDonnell, 728 West Sixty-fifth St	500	266	1130	Central	Daily: 9:45 to 11 am; 12 am to 1 pm; 3 to 6 pm; 7 to 8 pm; 10 to 12 pm. Sun.: 10:45 am to 12:30 pm; 4 to 6; 7:30 to 9:15 pm.
WBDC	**Grand Rapids, Mich.**—The Baxter Laundry Company	500	256.4	1170	Eastern	Mon., 12:30 pm to 1:30 pm; 5:30 to 6 pm; 7 to 8 pm; Tue., 12:30 to 1:30 pm; 5:30 to 6 pm; 7 to 8 pm; Wed., 12:30 pm to 1:30 pm; 5:30 pm to 6 pm; 7 to 8 pm; Thu., 12:30 pm to 1:30 pm; 5:30 pm to 6:30 pm; Fri., 12:30 pm to 1:30 pm; 5:30 pm to 6 pm; 7 to 8 pm; Sat., 5:30 pm to 6 pm; 7 to 7:40 pm; 7:50 to 8 pm. Sun.: 11 to 12:15 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WB WBES	**Takoma Park, Md.**—Bliss Electrical School....	100	222	1350	Eastern	
WBNY	**New York, N. Y.**—Shirley Katz, 145 W. 45th St.	500	209.7	1430	Eastern	Mon., 7 pm to 11 pm; Tue., 7 pm to 11 pm; Wed., 7 pm to 11 pm; Thu., 7 pm to 11 pm; Fri., 7 pm to 11 pm; Sat., Silent. Sun.: 2:30 pm to 6 pm.
WBOQ	**Richmond Hill, N. Y.**—A. H. Grebe & Co., 70 Van Wyck Boulevard....................	100	236	1270	Eastern	
WBRC	**Birmingham, Ala.**—Bell Radio Corporation, 1913 Fifth Ave., N........................	50	248	1210	Central	Mon., 8 to 10 pm; Wed., 8 to 10 pm; Sat., 9 pm to midnight.
WBRE	**Wilkes-Barre, Pa.**—Baltimore Radio Exchange, 17 West Northampton St.................	100	231	1300	Eastern	Mon., 2 to 3:30 pm; Tue., 2 to 4 pm; Wed., 2 to 3:30 pm; 8:30 to 11:30 pm; Thu., 2 to 4 pm; Fri. 2 to 3:30 pm; 8:30 to 12 midnight; Sat., 2 to 4:30 pm; Sun: 9 to 12 Midnight
WBT	**Charlotte, N. C.**—Charlotte Chamber of Commerce....................................	250	275	1090	Eastern	Daily 6 to 7 and 9 to 11 pm. Sun.: 11 am and 7:30 pm.
WBZ	**Springfield, Mass.** (Transmitter is in East Springfield)—Westinghouse Elec. and Mfg. Co.	2000	331.1	900	Eastern	Daily: 6:25 to 10 pm and sometimes to 10:30 pm. Sun. and Holidays: 10:50 am and 7 to 10 pm.
WBZA	**Boston, Mass.**—Westinghouse Electric and Mfg. Co..................................	250	242	1240	Eastern	
WC WCAC	**Storrs, Conn.**—Connecticut Agricultural College....................................	500	275	1090	Eastern	Mon., 8 to 9 pm; Wed., 8 to 9 pm; Fri., 8 to 9 pm.
WCAD	**Canton, N. Y.**—St. Lawrence University.....	250	263	1140	Eastern	Mon., 11 am to 11:20 am; Tue., 11 am to 11:20 am; Wed., 11 am to 11:20 am; 8 pm to 11 pm; Thu., 11 am to 11:20 am; 7:30 to 11 pm; Fri., 11 am to 11:20 am; 7:30 to 11 pm; Sat., 11 am to 11:20 am.
WCAE	**Pittsburgh, Pa.**—Pittsburgh Press and Kaufmann and Baer Co., 6th and Smithfield Streets	500	461.3	650	Eastern	Mon., 10:45 am; 12:30 pm; 4:30 pm; 6, 7, 8, 9, 10, 11 pm; Tue., 12:30 pm; 4:30, 6, 7, 8, 9, 10, 11 pm; Wed., 10:45 am; 12:30 pm; 4:30 pm; 6, 7, 8, 9, 10, 11 pm; Thu., 12:30 pm; 4:30, 6, 7, 8, 9, 10, 11 pm; Fri., 10:45 am; 12:30 pm; 4:30 pm; 6, 7, 8, 9, 10, 11 pm; Sat., 12:30 pm; 4:30 pm; 6, 7, 8, 9, 10, 11 pm. Sun.: 10:45 am; 4 pm; 6:30 pm; 7:20 pm; 9:15 pm.
WCAJ	**University Place, Neb.**—Nebraska Wesleyan University................................	500	254	1180	Central	Mon., 4:30 pm; Tue., 4:30 pm; Wed., 4:30 pm; 8 pm; Thu., 4:30 pm; Fri., 4:30 pm; 7 pm. Occasionally Chapel talks, 10 am.
WCAL	**Northfield, Minn.**—St. Olaf College..........	500	336.9	890	Central	Mon., 9:45 am; 8:30 pm; Tue., 9:45 am; Wed., 9:45 am; Thu., 7 pm; Fri., 9:45 am; 7:30 pm 8:30 pm; Sat., 9:45 am. Sun.: 8:30 am; 9:15 pm.
WCAM	**Camden, N. J.**—Galvin Radio Supply Co., 516 Market St..............................	250	236	1270	Eastern	
WCAO	**Baltimore, Md.**—Albert A. and A. Stanley Brager, 842 N. Howard St.................	100	275	1090	Eastern	
WCAP	**Washington, D. C.**—Chesapeake and Potomac Telephone Co...............................	500	469	640	Eastern	Mon., 6 to 11 pm; Tue., Silent; Wed., 6 pm to 12 midnight; Thu., Silent; Fri., 6 pm to 12 midnight; Sat., Silent. Sun.: 11 am; 4 pm; 6:20 pm; 7:20 pm; 9:15 pm.
WCAR	**San Antonio, Texas**—Southern Radio Corp. of Texas, 101 West Pecan St.................	2000	263	1140	Central	Daily (except Sun.): 8 to 10 pm.
WCAT	**Rapid City, S. D.**—South Dakota State School of Mines..................................	50	240	1250	Mountain	
WCAU	**Philadelphia, Pa.**—Universal Broadcasting Co. (Durham and Co.).....................	500	276.6	1080	Eastern	Mon., 6:30 to 12 midnight; Tue., 6:30 to 12 midnight; Wed., 6:30 pm to 1 am; Thu., 6:30 to 12 midnight; Fri., 6:30 to 12 midnight; Sat., Silent. Sun.: 11 am to 12:30 pm; 5 pm to 11 pm.
WCAX	**Burlington, Vt.**—Extension Service, University of Vermont..............................	100	252	1190	Eastern	Fri., 7 to 8 pm.
WCBA	**Allentown, Pa.**—Charles W. Heimbach, 1015 Allen St....................................	200	254	1180	Eastern	Mon., 2 am to 3 am; 7:30 pm to 9 pm; Wed., 2 am to 3 am; 7:30 pm to 11 pm; Fri., 6:45 pm to 11 pm; Sat., 9 pm to 12 midnight. Sun.: 10 am; 5:30 pm; 7 pm; 9 pm.
WCBD	**Zion, Ill.**—Wilbur G. Voliva................	5000	344.6	870	Central	Tue., 8 to 10:30 pm; Wed., 12:30 to 1 pm; Thu., 2:30 to 3:45; 8 to 10:30 pm. Sun.: 9 to 10:45 am; 8 to 10:30 pm.
WCBE	**New Orleans, La.**—Uhalt Bros., 1219 No. Rampart St....................................	5	263	1140	Central	Daily: 10:30 am to 11:30 am; 7:30 pm to 8:30 pm. Sun., and Holidays: 12:30 pm to 2:30 pm; 8 pm to 9 pm; 9:30 pm to 11:30 pm.
WCBH	**Oxford, Miss.** (near)—University of Mississippi	50	242	1240	Central	Tue., 9 pm; Thu., 9 pm; Sat., 9 pm.
WCBM	**Baltimore, Md.**—Hotel Chateau, Charles St. and North Ave............................	50	229	1310	Eastern	Mon., 10 pm; Thu., 10 pm. Sun.: 9:45 pm.
WCBQ	**Nashville, Tenn.**—First Baptist Church......	100	242	1240	Central	Thu., 8 pm. Sun.: 1st and 3rd Sun., 7:30 pm; 2nd and 4th Sun.: 11 am.
WCBR	**Providence, R. I.** (portable)—Chas. H. Messter, 42 Doyle Ave...........................	100	209.7	1430		Daily: 4 to 5 pm; 8 to 10 pm. Sun.: 3 to 5 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WC WCCO	**St. Paul - Minneapolis, Minn.**—Washburn - Crosby Co.	5000	416.4	720	Central	Mon., 9:30 am; 10:30 am; 10:45 am; 11:30 am; 12 am; 1:30 pm; 2 pm; 2:30 pm; 3 pm; 4 pm; 5:30 pm; 6:30 pm; 7:45 pm; 8 pm; 9 pm; 10 pm; Tue., 9:30 am; 10:30 am; 11:30 am; 1:30 pm; 2 pm; 2:30 pm; 3 pm; 3:30 pm; 4 pm; 5:30 pm; 6:15 pm; 7:30 pm; 9:30 pm; 10 pm; Wed., 9:30 am; 10:30 am; 10:45 am; 11:30 am; 1:30 pm; 2 pm; 2:30 pm; 3 pm; 4 pm; 5:30 pm; 6:30 pm; 7:30 pm; 9 pm; 10 pm; 10:05 pm; 11:30 pm; Thu., 9:30 am; 10:30 am; 11:30 am; 12 am; 1:30 pm; 2 pm; 3 pm; 4 pm; 5:30 pm; 7 pm; 10 pm; 10:05 pm; 10:30 pm; Fri., 9:30 am; 10:30 am; 10:45 am; 11:30 am; 1:30 pm; 2 pm; 3 pm; 4 pm; 5:30 pm; 6 pm; 6:15 pm; 7:45 pm; 8 pm; 8:15 pm; 9 pm; 10 pm; 10:05 pm; Sat., 9:30 am; 10:30 am; 11:30 am; 12:30 pm; 1:30 pm; 2:30 pm; 6:15 pm; 8 pm; 8:15 pm; 10 pm; 10:05 pm; Sun.: 10:50 am; 3 pm; 4:10 pm; 6:20 pm; 8:15 pm; 9:15 pm.
WCLO	**Camp Lake, Wis.**—C. E. Whitmore	50	230.6	1300	Central	Daily except Sun.: 3:30 to 5 pm; 7:39 to midnight.
WCLS	**Joliet, Ill.**—Harold M. Couch	150	214.2	1400	Central	Tue., 11 am; 7 pm to 8 pm; 8:30 pm to 12 midnight; Wed., 8:30 pm to 12 midnight; Thu., 11 am; 7 to 8 pm; Fri., 8:30 pm to 12 midnight; Sat., 11 am; 7 to 8 pm; and 9 pm to 12 midnight. Sun.: 11 am; 2:30 pm; 10 pm to 12 midnight.
WCOA	**Pensacola, Fla.**—City of Pensacola	500	222	1350	Central	Mon., Wed. and Fri., 10:30 am; 12:30 pm; 7 pm to 11 pm. Sun.: 12:30 pm.
WCSH	**Portland, Me.**—Henry P. Rines, Congress Square Hotel Co.	500	256.3	1170	Eastern	Mon., 12 am to 1:30 pm; 6:15 to 7:30 pm; 8:30 pm to 9:15 pm; Tue., 10:30 to 11:15 am; 12 am to 1:30, pm; 3 to 5 pm; 6 to 7:45 pm; 8 to 10:30 pm; Wed., 12 am to 1:30 pm; 6:15 to 7:30 pm; 9 to 11:30 pm; Thu., 10:30 am; 11:15 am; 12 am to 1:30 pm; 4 to 5 pm; 6:15 to 7:45 pm; 9 to 9:30 pm; Fri., 12 am to 1:30 pm; 3 to 4:30 pm; 6 to 7:30 pm; 9 to 10 pm; Sat., 12 am to 1 pm; 6:15 to 11:30 pm. Sun., 10:30 am to 12 am; 1:30 to 2:30 pm; 4 to 5:30 pm; 6 to 7 pm; 7:20 to 10 pm.
WCSO	**Springfield, Ohio**—Wittenberg College	100	248	1210	Central	
WCWS	**Providence, R. I.** (Portable)—Chas. W. Selen, 69 Exchange St	100	209.7	1430		Mon., 8 to 9 pm; Tue., 8 to 9 pm; Wed., 8 to 10 pm; Thu., Silent night; Fri., 7:30 to 10:30 pm; Sat., 8 to 9 pm. Sun.: Silent.
WCX	**Pontiac, Mich.**—Detroit Free Press	5000	516.9	580	Eastern	Mon., 4 pm; 6 to 7 pm; 8 to 9 pm; Tue., 4 pm; 6 to 7 pm; 8 to 9 pm; 10 pm; Wed., 4 pm; 6 to 7 pm; 8 to 9 pm; Thu., 4 pm; 6 to 7 pm; 8 to 9 pm; Fri., 4 pm; 6 to 7 pm; 8 to 9 pm; 10 to 11 pm. Sun.: 7:15 pm.
WD WDAD	**Nashville, Tenn.**—Dad's Auto Accessory and Radio Store, 160 Eighth Ave., North	150	226	1330	Central	Daily except Thu.: 11:45 am to 1 pm; 3:30 pm to 5 pm; 8 pm to 10 pm; Thu., Silent. Sun.: 3 to 5 pm.
WDAE	**Tampa, Fla.**—Tampa Daily Times	250	273	1100	Eastern	
WDAF	**Kansas City, Mo.**— The Kansas City Star	1000	365.6	820	Central	Mon., 10:45 am to 11:05 am; 6 to 7 pm; 8 to 10 pm; 11:45 pm to 1 am; Tue., 3:30 to 4:30 pm; 6 to 7 pm; 11:45 pm to 1 am; Wed., same as Mon.; Thu., same as Tue.; Fri., same as Mon.; Sat., same as Tue. Sun.: 3 to 4 pm; 4 to 4:45 pm.
WDAG	**Amarillo, Texas**—J. Laurance Martin, 605 East Fourth Street	100	263	1140	Central	
WDAH	**El Paso, Texas**—Trinity Methodist Church	50	267.7	1120	Mountain	Wed., 8:30 to 10 pm. Sun. Morning and Evening Church Services.
WDAY	**Fargo, N. D.**—Radio Equipment Corp., 119 Broadway	50	261	1150	Central	
WDBE	**Atlanta, Ga.**—J. M. High Co., 35 Cone St.	100	270	1110	Central	Tue., 7 to 8 pm; Fri., 7 to 8 pm.
WDBJ	**Roanoke, Va.**—Richardson-Wayland Electric Corp., 106 Church Ave., S. W.	50	229	1310	Eastern	Daily: 12 to 1 pm; 5:30 to 6 pm; Wed. and Sat., 9 to 11 pm; Mon., 8 to 9 pm. Sun.: 7:30 to 9 pm.
WDBK	**Cleveland, Ohio**—S. J. Broz, Mgr. of Broz Furniture, Hardware and Radio Store, 13920 Union Ave	50	327	917	Eastern	Tue., 8:30 pm to midnight; Fri., 8:30 pm to midnight.
WDBO	**Winter Park, Fla.**—Central Florida Broadcast Station, Inc	500	240	1250	Eastern	Daily: 7; 7:10; 7:30; 9 pm (except Wed.); Wed. only, 8 pm; Fri. only, 7:45 pm. Sun.: 11 am; 7:30 pm.
WDBZ	**Kingston, N. Y.**—Boy Scouts of America (Ulster County Council)	10	233	1290	Eastern	
WDGY	**Minneapolis, Minn.**—Geo. W. Young, 2219 North Bryant Ave	500	263	1140	Central	Mon., 6 to 8; Wed., 7 to 9; Thu., 6 to 7; 9 to 10; Fri., 8 to 9. Sun.: 1 to 3; 7 to 8.
WDOD	**Chattanooga, Tenn.**—Chattanooga Radio Co., Inc., 615 Market St.	500	256	1170	Central	Mon., 6:30 to 10 pm; Tue., 9 to 9:30 pm; Wed., 6:30 to 10 pm; Fri., 6:30 to 10 pm. Sun.: 11 to 12 noon; 4 to 5:15 pm; 7:30 to 9 pm; 9:15 pm to 10:15 pm.
WDRC	**New Haven, Conn.**—Doolittle Radio Corporation, 115 Crown St.	100	268	1120	Eastern	
WDWF	**Providence, R. I.**—Dutee W. Flint and Lincoln Studios, Inc.	500	440.9	680	Eastern	Sun.; 9:45 am; 4:45 pm (Oct. to May).

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WD WDZ	**Tuscola, Ill.**—Jas. L. Bush	100	278	1080	Central	Mon. to Sat., incl: 9 am Markets every half hour to 1 pm; 1:15 pm; 2:40 pm. No regular hours for musical programs.
WE WEAF	**New York, N. Y.**—American Telephone and Telegraph Co., 195 Broadway	5000	491.5	610	Eastern	Mon., 6:45 to 8; 10:45 am to 12:20 pm; 4 to 6; 6 to 12 pm; Tue., 6:45 to 8; 11 am to 12 am; 4 to 6; 6 to 12 pm; Wed., 6:45 to 8; 10:45 am to 12:20 pm; 4 to 6; 6 to 12 pm; Thu., 6:45 to 8; 11 am to 12 am; 4 to 6; 6 to 12 pm; Fri., 6:45 to 8; 10:45 am to 12:20 pm; 4 to 6; 6 to 12 pm; Sat., 6:45 to 8; 4 to 6; 6 to 12 pm. Sun.: 2 to 10:15 pm.
WEAI	**Ithaca, N. Y.**—Cornell University	500	254	1180	Eastern	
WEAM	**North Plainfield, N. J.**—Borough of North Plainfield (W. G. Buttfield)	250	261	1150	Eastern	
WEAN	**Providence, R. I.**—The Shepard Co	500	270	1110	Eastern	Daily: 11:45 am to 10 pm. Sun.: 10:45 am; 1:30 pm; 7:30 pm.
WEAO	**Columbus, Ohio**—The Ohio State University	500	293.9	1020	Eastern	Mon., 9 am; 9:45 am; 11 am; 1 pm; 4 pm; Tue., 9 am; 9:45 am; 11 am; 1 pm; 4 pm; 7 pm; Wed., 9 am; 9:45 am; 11 am; 1 pm; 4 pm; 4:10 pm; 8 pm; Thu., 9 am; 9:45 am; 11 am; 1 pm; 4 pm; 8 pm; Fri., 9 am; 9:45 am; 11 am; 1 pm; 4 pm; Sat., 9 am; 9:45 am; 11 am; 1 pm; 4 pm.
WEAR	**Cleveland, Ohio**—Goodyear Tire and Rubber Co	1000	389.4	770	Eastern	Mon., 11 to 12:15 pm; 3:30 to 4:15 pm; 7 to 8 pm; Tue., 11 to 12:15 pm; 3:30 to 4:15 pm; 7 to 11 pm; Wed., 11 to 12:15 pm; 3:30 to 4:15 pm; 7 to 8 pm; Thu., 11 to 12:15 pm; 3:30 to 4:15 pm; 7 to 11 pm; Fri., 11 to 12:15 pm; 3:30 to 4:15 pm; 7 to 12 pm; Sat., 11 to 12:15 pm; 7 to 8 pm. Sun.: 3:30 to 5 pm; 7 to 10 pm.
WEAU	**Sioux City, Iowa**—Davidson Bros. Co	100	275	1090	Central	Daily: 9:35 am; 10:35 am; 11:35 am; 12:20 pm; 1:20 pm; 5 pm.
WEBC	**Superior, Wis.**—Superior Telegram-Ross Elec. Co., 1225 Tower St	100	242	1240	Central	Mon., 6:15 to 8 pm; Tue., Silent; Wed., 8 to 10 pm; Thu., Silent; Fri., 6:15 to 8 pm; Sat., 10 to 12 pm. Sun.: 10:30 to 12 am; 3 to 4:30 pm.
WEBD	**Anderson, Ind.**—Electrical Equipment and Service Co	15	246	1220	Central	
WEBE	**Cambridge, Ohio**—Roy W. Waller, 319 Wall Ave	10	234	1280	Eastern	
WEBH	**Chicago, Ill.**—Edgewater Beach Hotel Co., 5349 Sheridan Road	2000	370	810	Central	Daily except Mon.: 7 pm to 8 pm; 9 pm to 10 pm; 11 pm to 12 midnight. Sun.: 5 pm to 9 pm.
WEBJ	**New York, N. Y.**—Third Ave. Railway Co., 2396 Third Ave	500	272.6	1100	Eastern	Tue. and Fri., 7 to 9 pm; Wed., 8 to 10 pm.
WEBL	United States (Portable) Radio Corp. of America	100	226	1330		
WEBQ	**Harrisburg, Ill.**—Tate Radio Co., 700 West Robinson St	10	225.4	1330	Central	Daily: 7:15 pm. Sun.: 3 to 4 pm.
WEBR	**Buffalo, N. Y.**—Howell Broadcasting Co., Inc., 54 Niagara St	100	244	1230	Eastern	Mon., 6:15 to 11:30 pm; Tue., 6:15 to 7:30 pm; Wed., 6:15 to 11:30 pm; Thu., 6:15 to 7:30 pm; Fri., 6:15 to 11:30 pm; Sat., 6:15 to 7:30 pm. Sun.: 10:15 am to 11 pm.
WEBW	**Beloit, Wis.**—Beloit College	500	268	1120	Central	Mon., 8 to 9:30 pm. Sun.: 4:30 to 5:30 pm.
WEBZ	**Savannah, Ga.**—Savannah Radio Corp., 11 East York St	50	263	1140	Eastern	Mon., 2 pm; 6 pm; 8 pm; Tue., 2 pm; 6 pm; Wed., 2 pm; 6 pm; 8 pm; Thu., 2 pm; 6 pm; Fri., 2 pm; 6 pm; 8 pm; Sat., 2 pm; 6 pm.
WEEI	**Boston, Mass.**—The Edison Electric Illuminating Co. of Boston	500	348.6	860	Eastern	Daily: 6:45 am to 8 am; 10:15 am to 11:20 am; 2 pm to 5 pm; 6 pm to 11 pm. Sun.: 10:50 am to 10:15 pm.
WEHS	**Evanston, Ill.**—Robert E. Hughes	10	202.6	1480	Central	
WEMC	**Berrien Springs, Mich.**—Emmanuel College	500	286	1050	Central	Mon., 8 am; 8:15 pm; Tue., 8 am; Wed., 8 am; 8:15 pm; Thu., 8 am; Fri., 8 am; 9 pm. Sun.: 11 am; 8:15 pm.
WENR	**Chicago, Ill.**—All American Radio Corporation, 4201 Belmont Ave	1000	266	1130	Central	Mon., Silent; Tue., 1 to 3 pm; 6 to 7 pm; 8 to 9 pm; 9 to 10 pm; Wed., 1 to 3 pm; 6 to 7 pm; 8 to 10 pm; 12 pm to 1 am; Thu., 1 to 3 pm; 6 to 7 pm; 8 to 10 pm; Fri., 11 am to 12 am; 1 to 3 pm; 6 to 7 pm; 8 to 10 pm; 12 pm to 2 am; Sat., 1 to 3 pm; 6 to 7 pm; 8 to 10 pm; 12 pm to 2 am; Sun.: 2 to 3 pm; 3 to 4 pm; 6 to 7 pm; 9:30 to 12 pm.
WEW	**St. Louis, Mo.**—St. Louis University	1000	248	1210	Central	Mon., 9 am; 10 am; 2 pm; 5 pm; Tue., 9 am; 10 am; 2 pm; 5 pm; 7 pm; Wed., 9 am; 10 am; 2 pm; 5 pm; Thu., 9 am; 10 am; 2 pm; 5 pm; 7 pm; Fri., 9 am; 10 am; 2 pm; 5 pm; Sat., 9 am; 10 am; 2 pm; 5 pm. Sun.: 2 pm; 7:15 pm to 7:45 pm.
WF WFAA	**Dallas, Texas**—Dallas News and Dallas Journal	500	475.9	630	Central	
WFAM	**St. Cloud, Minn.**—Times Publishing Co., Inc.	10	273	1100	Central	No definite days. Mostly Mon., 8 to 10 pm.
WFAV	**Lincoln, Neb.**—University of Nebraska, Dept. of Electrical Engineering	500	275	1090	Central	
WFBC	**Knoxville, Tenn.**—First Baptist Church	50	250	1200	Central	
WFBD	**Philadelphia, Pa.**—Gethsemane Baptist Church	5	234	1280	Eastern	

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WF WFBE	**Seymour, Ind.**—Van DeWalle Music and Radio Co., 208 West Second St	10	226	1330	Central	
WFBG	**Altoona, Pa.**—The William F. Gable Co.	100	277.8	1080	Eastern	Daily: 11:45 to 12:45 pm; 3:30 pm to 4:15 pm; 6:30 to 7:30 pm; 7:45 pm to 8 pm; 8:30 to 10:30 pm; Thu. and Fri., special, 11:15 pm to 1:30 am. Sun.: 10:45 am to 12:30 pm; 3, 4, 5, 6, 7:30 and 9:15 pm.
WFBH	**New York, N. Y.**—Concourse Radio Corporation, Hotel Majestic	500	272.6	1100	Eastern	Mon., 2 to 7 pm; 11:30 pm to 2 am; Tue., 2 to 7 pm; 11:30 pm to 2 am; Wed., 2 to 8 pm; 11:30 to 2 am; Thu., 2 to 8 pm; 11:30 pm; Fri., 2 to 7 pm; 11:30 pm; Sat., 2 to 8 pm; 11:30 pm.
WFBJ	**Collegeville, Minn.**—St. John's University	100	236	1270	Central	Sun.: 5 to 5:45 pm.
WFBL	**Syracuse, N. Y.**—Onondaga Hotel	100	252	1190	Eastern	Mon., 12 to 1; 3 to 4; 6 to 8; Tue., 12 to 1; 3 to 4; 6 to 11; Wed., 12 to 1; 3 to 4; 6 to 8; Thu., 12 to 1; 3 to 4; 6 to 12:30 am; Fri., 12 to 1; 3 to 4; 6 to 11; Sat., 6 to 8; 10 to 11. Sun.: 3 to 9.
WFBM	**Indianapolis, Ind.**—Merchants Heat and Light Co.	250	268	1120	Central	Mon., 6 pm to 12 pm; Tue., 6 pm to 10:30 pm; Wed., 6 pm to 12 pm; Thu., 6 pm to 10:30 pm; Fri., 6 pm to 12 pm. Sun. and Holidays: 9:30 am to 12:30 pm; 2 to 5 pm; 7:30 to 9 pm.
WFBR	**Baltimore, Md.**—Fifth Infantry Maryland National Guard, Fifth Regt. Armory	100	254	1180	Eastern	Mon., 12 to 2 pm; Tue., 12 to 3 pm; 8 to 12 pm; Wed., 12 to 3 pm; Thu., 12 to 3 pm; 8 to 12 pm; Fri., 12 to 3 pm; Sat., 12 to 2 pm; 8 to 12 pm. Sun.: 11 am to 12:30 pm; 2 to 3:30 pm; 9 to 10:30 pm.
WFBZ	**Galesburg, Ill.**—Knox College	20	254	1180	Central	
WFDF	**Flint, Mich.**—Frank D. Fallain, Police Building	100	234	1280	Eastern	Mon., Wed. and Fri., 8 pm.
WFI	**Philadelphia, Pa.**—Strawbridge & Clothier	500	394.5	760	Eastern	Daily: am., 10 to 11; pm, 1 to 2; 3 to 4:30; 6 to 7:30; Tue. Thu. Sat., 8 pm to mid. Sun.: 4:30 to 6 pm; 9:30; or alternating 10:30 am to noon; 7:30 to 9:30 pm.
WFKB	**Chicago, Ill.**—Francis K. Bridgman, 4536 Woodlawn Ave	500	217.3	1380	Central	Mon., Silent; Tue., 7 to 10 pm; Wed., 7 to 10 pm; Thu., 7 to 10 pm; Fri., 7 to 10 pm; Sat., 7 to 10 pm.
WFRL	**Brooklyn, N. Y.**—Robt. M. Lacey and Jas. A. Bergner (Flatbush Radio Labs.), 1421 E. 10th St	100	205.4	1460	Eastern	On the Air every day but hours subject to change until after completion of new studios.
WG WGAL	**Lancaster, Pa.**—Lancaster Elec. Supply & Construction Co., 23 East Orange St	10	248	1210	Eastern	
WGBB	**Freeport, N. Y.**,Harry H. Carman, 217 Bedell St	100	244	1230	Eastern	Mon., 8 to 11 pm; Wed. and Fri., same as Mon Sun.: 10:40 am.
WGBC	**Memphis, Tenn.**—Radio Bible Class, First Baptist Church	10	278	1080	Central	Sun.: 9:30 to 10:30 am; 7:30 to 8:45 pm.
WGBF	**Evansville, Ind.**—Finke Furniture Co., 307 South Seventh St	500	236	1270	Cental	Mon., 7:15 am; 12:10 pm; Tue., 7:15 am; 12:10 pm; 7:15 pm to 10 pm; Wed., 7:15 am; 12:10 pm; Thu., 7:15 am; 12:10 pm; Fri., 7:15 am; 12:10 pm; 8 to 10 pm; 11 pm to 2 am; Sat., 7:15 am; 12:10. pm.
WGBI	**Scranton, Pa.**—Scranton Broadcasters, Inc., 608 Linden St	10	240	1250	Eastern	Mon., 5:15 to 6:30 pm; Tue., 5:15 to 6:30 pm; Wed., 5:15 to 6:30 pm; 8 to 12 pm; Thu., 5:15 to 6:30 pm; 8 to 12 pm; Fri., 5:15 to 6:30 pm; Sat., 5:15 to 6:30 pm; 8 to 11 pm. Sun.: 3 to 5 pm; 7 to 9 pm.
WGBM	**Providence, R. I.**—Theo. N. Saaty, 92 Dover St	30	234	1280	Eastern	
WGBR	**Marshfield, Wis.**—Geo. S. Ives, 731 West Fifth St	10	229	1310	Central	
WGBS	**New York, N. Y.**—(Transmitter is in Astoria, L. I.), Gimbel Bros	500	315.6	950	Eastern	Mon., 10 to 11 am; 1:30 to 2:30 pm; 3 to 4 pm; 6 to 7:30 pm; Tue., 10 to 11 am; 1:30 to 2:30 pm; 3 to 4 pm; 6 to 11:30 pm; Wed., same as Mon.; Thu., same as Tue.; Fri., same as Mon.; Sat., same as Tue. Sun.: 3:30 to 4:30 pm; 9:30 to 11:30 pm.
WGBU	**Fulford-by-the-Sea, Fla.**—Florida Cities Finance Co	500	278	1080	Eastern	
WGBX	**Orono, Me.**—University of Maine	500	234.2	1280	Eastern	Wed., 7:30 to 9 pm. Sun.: 2 to 3 pm.
WGCP	**Newark, N. J.**—D. W. May (Inc.), 325 Central Ave	500	252	1190	Eastern	Mon., 6; 6:15; 6:30; 8:30; 8:45; 9:45; 11; 11:15; 11:30; 11:45 pm; Tue., 7; 7:30; 7:45; 8; 8:15 pm; Wed., 7; 8; 8:30; 9; 9:30; 12 pm; 12:15; 12:30; 12:45; 1:15 am; Fri., 7; 7:15; 7:30; 7:45; 8; 8:15; 12 pm. Sun.: 5; 5:15; 7; 8; 8:30; 8:45; 9 pm.
WGES	**Chicago, Ill.**—(Transmitter is in Oak Park, Ill.), Coyne Electrical School	500	250	1200	Central	Mon., 5 pm; Tue., 5 to 7 pm; 8 to 9 pm; Wed., 11 pm to 1 am; Thu. Fri. Sat., same as Tue. Sun.: 10:15 am to 12 am; 5 to 7:40 pm; 11 pm to 12 pm.
WGHB	**Clearwater, Fla.**—(Transmitter is in Dunedin), The Chamber of Commerce of Clearwater, Fla.	500	266	1130	Eastern	Mon., 6:30 to 7:30 pm; 8:30 to 10 pm; 11:45 to 1 am; Tue. Wed. Thu. Fri. Sat., same as Mon.
WGHP	**Detroit, Mich.**—Geo. H. Phelps, 110 Rowena St	1500	270	1110	Eastern	

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WG WGMU	**Richmond Hill, N. Y.**—(portable), A. H. Grebe & Co.	100	236	1270		
WGN	**Chicago, Ill.**—The Tribune (Drake Hotel)	1000	303	990	Central	Mon. to Sat., incl., 9 am to 12 am; 12 am to 5 pm; Mon., 6 to 7 pm; Tue., to Sat., inc., 6 to 7 pm; 8 to 11 pm. Sun.: 12 m to 5 pm and 6:15 to 11 pm.
WGR	**Buffalo, N. Y.**—Federal Radio Corp., 1738 Elmwood Ave	750	319	940	Eastern	Mon., 10:45 am to 1 am; Tue., 10:45 am to 11 pm; Wed.. 10:45 am to 11 pm; Thu., 10:45 am to 11 pm; Fri., 10:45 am to 1 am; Sat.. 10:45 am to 11 pm. Sun.: 10:45 am to 12 am; 7:45 to 10:15 pm.
WGST	**Atlanta, Ga.**—Georgia School of Technology	500	270	1110	Central	Mon., 9 to 1 pm; Thu., 7 to 8 pm.
WGY	**Schenectady, N. Y.**—General Electric Co.	10000	379.5	790	Eastern	Mon., 2 to 3 pm; 6 to 9 pm; Tue.. 2 to 3 pm; 6 to 11 pm; Wed., 6 to 10 pm; Thu., 2 to 3 pm; 6 to 11 pm; Fri., 2 to 3 pm; 6 to 11:30 pm; Sat.. 9 to 12 pm. Sun.: 10:30 am to 12 am; 7:30 pm to 10 pm.
WH WHA	**Madison, Wis.**—University of Wisconsin	750	535.4	560	Central	Mon., 8 to 9 pm; Wed., 8 to 9 pm; Fri., 8 to 9 pm.
WHAD	**Milwaukee, Wis.**—Marquette University and Milwaukee Journal	500	275	1090	Central	Mon. and Tue., 12 am; 4; 6; 6:15; 8:30 pm; Wed., 12 am; 4; 6; 6:15; 10:30; 11:30 pm; Thu. and Fri., 12 am; 4; 6; 6:15; 8:30 pm; Sat., 12 am; 4; 6; 6:15 pm. Sun.: 3:30 pm.
WHAM	**Rochester, N. Y.**—University of Rochester (Eastman School of Music)	100	278	1080	Eastern	
WHAP	**New York, N. Y.**—W. H. Taylor Finance Corp., 426 West 31st St	500	240	1250	Eastern	Mon., 6:30 to 11 pm; Wed., 6:30 to 11 pm; Fri., 6:30 to 11 pm. Sun.: 2:30 to 4 pm.
WHAR	**Atlantic City, N. J.**—F. B. Cook's Sons, Owners, Seaside Hotel	500	275	1090	Eastern	Mon., 2 pm; 7:30 pm; 8 pm; 11 pm; Tue., 2 pm; 7:30 pm; 8 pm; Wed., Silent; Thu., 2 pm; 7:30 pm; 8 pm; 11 pm; Fri., 2 pm; 7:30 pm; 8 pm; Sat., 2 pm; 7:30 pm; 8 pm. Sun.: 10:45 am; 2:15 pm; 2:45 pm; 7:50 pm; 9 pm.
WHAS	**Louisville, Ky.**—Courier-Journal and Louisville Times	500	399.8	750	Central	Daily except Mon.: 7:30 to 9 pm. Sun.: 10 am; 4:30 to 5:30 pm.
WHAV	**Wilmington, Del.**—Wilmington Elec. Specialty Co., 405 Delaware Ave	50	266	1130	Eastern	Mon., 7 to 9 pm; Tue., 7 to 9 pm; Wed., 7 to 9 pm; Thu., 7 to 9 pm; Fri., 7 to 9 pm; Sat., 7 to 9 pm. Sun.: 7 to 9 pm.
WHAZ	**Troy, N. Y.**—Rensselaer Polytechnic Institute	500	379.5	790	Eastern	Mon., 9 to 12 pm; 2nd Mon. of each month from 12 pm to 1:30 am Tue.
WHB	**Kansas City, Mo.**—Sweeney Automotive and Elec. School, Sweeney Building	500	365.6	820	Central	Mon., 2 to 3 pm; 7 pm; 8 pm; Tue., 7 pm; 10 pm; Wed., 7 pm; 8 pm; Thu., 7 pm; 10 pm; Fri., 7 pm; 8 pm; Sat., Silent night. Sun.: 9:40 am; 12:30 pm; 8 pm; 9:15 pm; 11:15 pm; 1 am.
WHBA	**Oil City, Pa.**—Shaffer Music House	10	250	1200	Eastern	
WHBC	**Canton, Ohio**—Rev. E. P. Graham, 627 McKinley Ave., N. W	10	254	1180	Eastern	Mon., 8 to 8:30 pm.
WHBD	**Bellefontaine, Ohio**—Chas. W. Howard	20	222	1350	Central	
WHBF	**Rock Island, Ill.**—Beardsley Specialty Co., 217 Eighteenth St	100	222	1350	Central	Mon., 7 to 9 pm; Wed., 7 to 9 pm; Sat., 2 to 4 pm and 7 to 9 pm.
WHBG	**Harrisburg, Pa.**—John S. Skane, 1810 North Fourth St	20	231.6	1300	Eastern	Tue., Thu. and Sat., 12:01 to 1 pm; 5:30 to 11 pm; Sun.: 10:20 am to 12:01 pm; 1 to 2; 6:15 to 9 pm.
WHBH	**Culver, Ind.**—Culver Military Academy	100	222	1350	Central	
WHBJ	**Fort Wayne, Ind.**—Lauer Auto Co., 2315 South Calhoun St	50	234.4	1280	Central	Tue., 6 to 6:30 pm; 8 pm to 12 pm; Wed., 6 to 6:30 pm; Thu.. 6 to 6:30 pm; Fri., 6 to 6:30 pm; 8 to 12 pm; Sat., 6 to 6:30 pm. Sun.: 4 to 5 pm; 7 to 8 pm.
WHBL	**Chicago, Ill.**—(Portable), C. L. Carrell	50	215.7	1390		
WHBM	**Chicago, Ill.**—(Portable), C. L. Carrell, 1536 South State St	20	215.7	1390		
WHBN	**St. Petersburg, Fla.**—First Ave., Methodist Church	10	238	1260	Eastern	
WHBP	**Johnstown, Pa.**—Johnstown Automobile Co., 101 Main St	100	256	1170	Eastern	Mon., 12:30 pm to 1:30 pm; Tue., 12:30 pm to 1:30 pm; Wed., 12:30 pm to 1:30 pm; Thu.. 12:30 pm to 1:30 pm; Fri., 12:30 pm to 1:30 pm; Sat., 12:30 pm to 1:30 pm; 10 pm to 12 pm. Sun.: 2:30 to 4 pm.
WHBQ	**Memphis, Tenn.**—Men's Fellowship Class of St. Johns Methodist Episcopal Church South	50	233	1290	Central	
WHBU	**Anderson, Ind.**—Rivera Theatre and Bing's Clothing Store, 1002 Meridian St	10	218.8	1370	Central	Daily: 9 to 9:30 am; Wed., 7 to 9 pm; Fri., 7 to 9 pm. Sun.: 7 to 9 pm.
WHBW	**Philadelphia, Pa.**—D. R. Kienzle, 4916 Chestnut St	100	216	1390	Eastern	Mon., 8:30 to 10:30 pm and 11:15 pm to 12:15 am. Thu., 8:30 to 11 pm; Sat., 7:45 to 10 pm.
WHBY	**West De Pere, Wis.**—St. Norbert's College	50	250	1200	Central	Daily: 5 to 6 pm; Mon., 8 to 10 pm; other nights irregular.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WH WHDI	**Minneapolis, Minn.**—Wm. Hood Dunwoody Industrial Institute	500	278	1080	Central	Mon., 8 to 9 pm; Wed., 9 to 10 pm; Fri., 9 to 10 pm.
WHEC	**Rochester, N. Y.**—Hickson Electric Co., 36 South Ave	100	258	1160	Eastern	
WHK	**Cleveland, Ohio**—Radio Air Service Corp., 1220 Huron Road	1000	272.6	1100	Eastern	Daily except Fri.: 6:30 pm to 10:30 pm. Sun.: 9:30 am to 11 am; 6:30 pm to 10:30 pm.
WHN	**New York, N. Y.**—Loew's Inc., 1540 Broadway	500	360.1	833	Eastern	Daily: 2:15 pm to 5:30 pm; 7 pm to 12 pm. Sun. and Holidays: 11:30 to 12:30 pm; 12:30 to 1 pm; 2 to 3 pm; 3 to 4:30 pm; 5 to 5:30 pm; 7:30 to mid.
WHO	**Des Moines, Ia.**—Bankers Life Co., 6th & Grand	5000	526	570	Central	Mon., 9:45 am; 12 am; 2 pm; 7:30 pm; 11 pm; Tue., 9:45 am; 12 am; 2 pm; 7:30 pm; 11 pm; Wed., 9:45 am; 12 am; 2 pm; 3:30 pm; 7:30 pm; 11 pm; Thu., 9:45 am; 12 am; 2 pm; 7:30 pm; 11 pm; Fri., 9:45 am; 12 am; 2 pm; 3:30 pm; 7:30 pm; 11 pm; Sat., 9:45 am; 12 am; 2 pm; 7:30 pm; 11 pm. Sun.: 11 am; 4 pm; 7:30 pm; 11 pm. Holidays generally same as week days.
WHT	**Chicago, Ill.**—(Transmitter is in Deerfield, Ill.) Radiophone Broadcasting Corp., 410 North Michigan Blvd., Chicago, Ill.	3500	238	1260	Central	Mon., 10; 10:45; 11:15; 11:40; 11:50 am; 12 am; 12:45; 6; 7 pm; Tue., 10; 10:20; 10:45; 11; 11:40; 11:50 am; 12 am; 12:45; 6; 6:40; 6:50; 7:45; 9:15; 9:35; 9:50; 10:10; 11:30; 12 pm; Wed., 10; 10:45; 11:15; 11:40; 11:50 am; 12 am; 12:45; 6; 6:50; 7:54; 9:15; 9:30; 10:05; 11:15; 11:30; 12 pm; Thu., 10; 10:15; 10:45; 10:50; 11:40; 11:50 am; 12 am; 12:45; 6; 6:30; 6:45; 9:15; 9:30; 10:10; 11:30; 12 pm; Fri., 10; 10:45; 11; 11:40; 11:50 am; 12 am; 12:45; 6; 6:50; 7:45; 9:15; 9:30; 10:05; 11:30; 12 pm; Sat., 10; 10:45; 11; 11:40; 11:50 am; 12 am; 6; 6:50; 7:45; 9:15; 9:30; 9:50; 10; 11:30; 12 mid. Sun.: 12 am; 12:45; 1:15; 1:30; 1:45; 2; 2:30; 2:45; 5:30; 6; 6:30; 9:30; 10:30 pm.
WI WIAD	**Philadelphia, Pa.**—Howard R. Miller, 6318 North Park Ave	100	250	1200	Eastern	Tue., 9 pm; Fri., 9 pm.
WIAS	**Burlington, Iowa**—Home Electric Co	100	254	1180	Central	Mon., 8 to 9 pm; Fri., 8 to 9 pm. Sun.: 10:30 to 12 am.
WIBA	**Madison, Wis.**—Capital Times Studio, 237 West Gilman St	100	236.1	1270	Central	Mon., 8:45 to 10:30 pm; Wed., 8:45 to 10:30 pm; Fri., 9 to 10:30 pm; Sat., 10:45 to 12 pm.
WIBG	**Elkins Park, Pa.**—St. Paul's Protestant Episcopal Church	50	222	1350	Eastern	
WIBH	**New Bedford, Mass.**—Elite Radio Stores, 55 Hillman St	30	209.7	1430	Eastern	
WIBI	**Flushing, N. Y.**—Frederick B. Zittell, Jr., 49 Boerum Ave	50	218.8	1370	Eastern	
WIBJ	**Chicago, Ill.**—(Portable), C. L. Carrell, 1506 N. American Bldg	50	215.7	1390		
WIBM	**Chicago, Ill.**—(Portable), Billy Maine, 36 West Randolph St	10	215.7	1390	Central	Daily: 2:30 to 4:30 pm; 8 to 10 pm.
WIBO	**Chicago, Ill.**—Nelson Bros. Russo & Fiorito	1000	226	1330	Central	Mon., 2 to 4 pm; Tue., 2 to 4 pm; 6 to 8 pm; mid. to 3 am; Wed., 2 to 4 pm; 6 to 8 pm; 10 pm to 12 pm; Thu., 2 to 4 pm; 6 to 8 pm; mid. to 3 am; Fri., 2 to 4 pm; 6 to 8 pm; 10 pm to 2 am; Sat., 2 to 4 pm; 6 to 8 pm. Sun.: 10:15 am; 2 to 4 pm; 6 to 8 pm; 10 pm to 12 pm.
WIBR	**Weirton, W. Va.**—Thurman A. Owings	50	246	1220	Eastern	
WIBS	**Elizabeth, N. J.**—(Portable), Lieut. Thos. F. Hunter	10	202.6	1480		
WIBU	**Poynette, Wis.**—The Electric Farm	20	222	1350	Central	
WIBW	**Logansport, Ind.**—Dr. L. L. Dill, Barnes Bldg.	100	220	1360	Central	Mon., 4:15 to 5:15 pm; Tue., 4:15 to 5:15; 6 to 7 pm; Wed., 4:15 to 5:15 pm; Thu., 4:15 to 5:15; 8 to 9 pm; Fri., 4:15 to 5:15; 6 to 7 pm; Sat., 4:15 to 5:15 pm. Sun.: 7:30 to 8:30 pm.
WIBX	**Utica, N. Y.**—Grid-Leak (Inc.), 236 Genesee St.	150	205.4	1460	Eastern	Tue., 12 am to 1 pm; 6:30 to 9 pm; Thu., same as Tue.; Fri., same as Tue. Sun.: 10:30 to 12 am; 3 to 4 pm; 7 to 8 pm.
WIBZ	**Montgomery, Ala.**—A. D. Trum, 217 Catoma St	10	230.6	1300	Central	Tue., 8:30 to 9:30; Wed., 9 to 10; Thu., 11 to 12. Sun.: 9:30 to 10:30.
WIL	**St. Louis, Mo.**—St. Louis Star & Benson Radio Co	250	273	1100	Central	Mon., 10 to 12 pm; Tue., 4 to 5 pm; Wed., 9 to 11 pm; Thu., 4 to 5; 8 to 10 pm; Fri., 9 to 11 pm; Sat., 4 to 5; 10 to 12 pm.
WIOD	**Miami Beach, Fla.**—Carl G. Fisher Co	1000	247.8	1210	Eastern	Daily: 8:30 to 12:30 am; Tue., Silent. Sun.: 11 am to 12:15 pm; 8:45 to 9:45 pm.
WIP	**Philadelphia, Pa.**—Gimbel Bros.	500	508.2	590	Eastern	Daily: 6:45 am to 7:30 am; 10 am to 11 am; 1 to 2 pm; 3 to 4:30 pm; 6 to 7:30 pm; Tue., Thu. and Sat. also 8 pm to 12 pm. Sun.: 10:45 pm. to 12:30 pm; 4 pm to 5:30 pm. Alternate Sun.: 7:15 to 12 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WJ	**WJAD—Waco, Tex.**—Frank P. Jackson	500	352.7	850	Central	
	WJAG—Norfolk, Neb.—Norfolk Daily News	250	270	1110	Central	Daily: 12:15 pm. Evenings by special arrangement. Sun.: Special programs only by arrangement.
	WJAK—Kokomo, Ind.—J. A. Kautz, Kokomo Tribune, 1531 Washington St	50	254	1180	Central	Daily: 11:45 pm; Mon., 7:30 pm.
	WJAM—Cedar Rapids, Ia.—D. M. Perham, 322 Third Ave. W	100	268	1120	Central	
	WJAR—Providence, R. I.—The Outlet Co	500	305.9	980	Eastern	Mon., Wed. and Fri., 10 to 11 am; Daily: 11:05 pm; Mon., 7:45 to 11 pm; Tue., 7:30 to 10 pm; Wed., 7:30 to 11 pm; Thu., 7:45 to 11 pm; Fri., 7:45 to 10:30 pm; 11 to 12. Sun.: 6 pm to 10:15 pm.
	WJAS—Pittsburgh, Pa.—Pittsburgh Radio Supply House, 963 Liberty Ave	500	336.9	1090	Eastern	Daily: 2 pm; 7:45 pm; 8 pm to 12 pm.
	WJAX—Jacksonville, Fla.—City of Jacksonville	1000	336.9	890	Eastern	
	WJAZ—Chicago, Ill.—(Transmitter is in Mount Prospect, Ill.), Zenith Radio Corp., 312 South Michigan Ave	1500	322.4	930	Central	Mon., Silent; Tue., 9 pm to 1 am; Wed., 9 pm to 1 am; Thu., 9 pm to 12 pm; Fri., 9 pm to 1 am; Sat., 9 pm to 2 am. Sun.: 7 to 9 pm.
	WJBA—Joliet, Ill.—D. H. Lentz, Jr., 301 Whitley Ave.	50	206.8	1450	Central	
	WJBB—St. Petersburg, Fla.—Financial Journal, J. E. Dadsure, Publisher, 126 13th St. N	10	254	1180	Eastern	Daily: 2 to 4 pm; 7 pm to 12 pm.
	WJBC—LaSalle, Ill.—Hummer Furniture Co., 2nd & Joliet Sts	100	234.2	1280	Central	Daily: 12:30 to 1:30 pm; Mon., 8 to 10 pm. Sun.: 7 to 10 pm.
	WJBI—Red Bank, N. J.—Robt. S. Johnson, 63 Broad St.	250	218.8	1370	Eastern	
	WJBK—Ypsilanti, Mich.—Ernest F. Goodwin, 803 Congress St	10	233	1290	Central	
	WJBL—Decatur, Ill.—Wm. Gushard Dry Goods Co., 301 N. Water St	500	270	1110	Central	Mon., 9:30 to 11 pm; Wed., 9 to 10:30 pm; Sat., 9:30 to 11 pm. Sun.: 10:45 am; 3 to 4:30 pm.
	WJBO—New Orleans, La.—Valdemar Jensen, 119 S. St. Patrick St	100	268	1120	Central	Fri., 8 to 11 pm. Sun.: 2:30 to 4:30 pm; 12 pm to 1 am.
	WJBR—Omro, Wis.—Gensch & Stearns	50	227.1	1320	Central	Mon., 8 to 10:30 pm; Thu., 8 to 10:30 pm. Sun.: 2 to 4 pm; 8 to 10:30 pm.
	WJBU—Lewisburg, Pa.—Bucknell University	100	211.1	1420	Eastern	
	WJJD—Mooseheart, Ill.—Supreme Lodge, Loyal Order of Moose	500	370.2	810	Central	Daily: 12 to 1 pm; 2 to 3 pm; 4 to 5 pm; 5:30 to 7 pm; 8 to 9 pm; 10 to 11 pm; 12:30 to 2 am. Sun. and Holidays: 7:45 am; 9:40 am; 2:30 to 5 pm.
	WJR—Detroit, Mich.—(Transmitter is in Pontiac, Mich.), Jewett Radio & Phonograph Co.	5000	516.9	580	Eastern	
	WJY—New York, N. Y.—Radio Corp. of America	1000	405.2	740	Eastern	
	WJZ—New York, N. Y.—(Transmitter is in Bound Brook, N. J.), Radio Corp. of America	50,000	455	660	Eastern	Daily: 1 to 2 pm; 4 to 6 pm; 7 to 12 pm. Sun.: 9 to 12 am; 2 to 6 pm; 7 to 10:30 pm.
WK	**WKAF—Milwaukee, Wis.**—Kesselman O'Driscoll-Hotel Antlers Co., 130 Second St.	500 5000	261	1150	Central	Mon., 10 to 11 pm; Wed., 10 to 11 pm; Thu., 2 to 3 pm; 8:30 to 9:45 pm; Fri., 7 to 7:30 pm; 10 to 11 pm; Sat., 8:30 to 9:45 pm. Sun.: 4 to 6 pm.
	WKAR—East Lansing, Mich.—Michigan State College	1000	285.5	1050	Central	Mon., 12 to 12:30 pm; 8 to 9 pm; Tue., 12 to 12:30 pm; Wed., 12 to 12:30 pm; 7:45 to 9 pm; Thu., 12 to 12:30 pm; Fri., 12 to 12:30 pm; 7:45 to 9 pm; Sat., 12 to 12:30 pm. Sun.: Silent.
	WKAV—Laconia, N. H.—Laconia Radio Club	50	224	1340	Eastern	Fri., 7 pm. Sun.: Church Services.
	WKBB—Joliet, Ill.—Sanders Bros., 607 Jefferson St	100	214.2	1400	Central	
	WKBE—Webster, Mass.—K. & B. Electric Co., 59 Emerald Ave	100	231	1300	Eastern	Mon., 8 to 11 pm.
	WKBG—Chicago, Ill.—(Portable), C. L. Carrell, 36 So. State St	100	215.7	1390		
	WKRC—Cincinnati, Ohio—Kodel Radio Corp., 507 E. Pearl St	1000	325.9 422.3	920 710	Central	Mon., 6 to 7 pm; 8 to 10 pm; 12 pm. to 2 am; Tue., 10 to 12 pm; Wed., same as Mon.; Thu., 10 to 12 pm; Fri., Silent; Sat., 10 to 12 pm. Sun.: 6:45 to 7:30 pm; 10 pm to 1 am.
	WKY—Oklahoma, Okla.—E. C. Hull & H. S. Richards 1911 W. Ash St	100	275	1090	Central	
WL	**WLAL—Tulsa, Okla.**—First Christian Church	100	250	1200	Central	
	WLAP—Louisville, Ky.—W. V. Jordon, 306 West Breckenridge St	20	275	1090	Central	
	WLB—Minneapolis, Minn.—University of Minnesota	500	277.6	1080	Central	
	WLBL—Madison, Wis.—(Transmitter is in Stevens Point, Wis.), Wisconsin Department of Markets	500	278	1080	Central	Mon., 8:45 am; 9:45 am; 10:45 am; 11:45 am; 12:30 pm; 1:45 pm; 6 to 7 pm; Tue., 9:45 am; 10:45 am; 11:45 am; 12:30 pm; 1:45 pm; 8 pm; Wed., 8:45 am; 9:45 am; 10:45 am; 11:45 am; 12:30 pm; 1:45 pm; Thu., same as Wed.; Fri., same as Mon.; Sat., same as Wed.; also 8 pm to 12 pm.
	WLIB—Chicago, Ill.—Liberty Weekly	4000	303	990	Central	Mon., Silent; Tue., 7 pm to 8 pm; 11 pm to 12:30 pm; Wed., 7 pm to 8 pm; 11 pm to 12:30 pm; Thu., 7 pm to 8 pm; 11 pm to 12:30 pm; Fri., 7 pm to 8 pm; 11 pm to 12:30 pm; Sat., 7 pm to 8 pm; 11 pm to 12:30 pm. Sun.: 5 to 6:15 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WL						
WLIT	Philadelphia, Pa.—Lit Bros	500	394.5	760	Eastern	Daily: 12 am to 1 pm; 2 pm to 3 pm; 4:30 to 5:30 pm; 7:30 to 11 pm Mon., Wed. and Fri.; 7:30 to 8 pm; Tue., Thu. and Sat. Sun.: 2 to 4 pm, also from 6:30 to 9:30 pm on alternate Sun.
WLS	Chicago, Ill.—(Transmitter is in Crete, Ill.), Sears Roebuck & Co	5000	345	870	Central	Mon., 9 to 7; Tue., 6:30 to 8:30; Wed., 6:30 to 1 am; Thu., 6:30 to 8:30 pm; Fri., 6:30 am to 1 am; Sat., 7:30 am to 12 pm. Sun.: 6 to 8 pm.
WLSI	Cranston, R. I.—Dutee W. Flint & Lincoln Studios, Inc	500	440.9	680	Eastern	Daily: 5 to 6 pm; 8 to 10 pm; Sat., Silent. Sun.: 9:45 am and 4:45 pm.
WLTS	Chicago, Ill.—Lane Technical High School, Hotel Flanders	100	258.5	1160	Central	Mon., 1 to 2 pm; 6 to 7 pm; Tue., 7 to 8 pm; 10 pm to 2 am; Wed., 1 to 2 pm; 6:30 to 7 pm; 10 pm to 12 pm; Thu., 7 to 8 pm; 10 pm to 2 am; Fri., 1 to 2 pm; 6:30 to 7 pm; 10 pm to 12 pm; Sat., 7 to 8 pm; 10 pm to 12 pm. Sun.: 12 pm to 3 am.
WLW	Cincinnati, Ohio—(Transmitter is in Harrison, Ohio), Crosley Radio Corp., Cincinnati, Ohio	5000	422.3	710	Central	Mon., 7:30 am; 8 am; 10 am; 11 am; 11:55 am; 12:05 pm; 1.30 pm; 1:40 pm; 3 pm; 4 pm; 4:30 pm; 6:50 pm; 7 pm; 7:30 pm; 7:40 pm; 10 pm; Tue., 7:30 am; 8 am; 10 am; 11 am; 11:55 am; 12:10 pm; 1:30 pm; 1:40 pm; 3 pm; 4 pm; 4:10 pm; 4:30 pm; 6 pm; 6:30 pm; 7 pm; 7:20 pm; 7:30 pm; 7:50 pm; 8 pm; 8:50 pm; 9 pm; Wed., 7:30 am; 8 am; 10 am; 11 am; 11:55 am; 12:05 pm; 1:30 pm; 1:40 pm; 3 pm; 3:30 pm; 4 pm; 4:30 pm; 4:45 pm; 6:50 pm; 7 pm; 7:30 pm; 7:40 pm; 10 pm; 11 pm; 11:15 pm; Thu., 7:30 am; 8 am; 10 am; 11 am; 11:55 am; 12:05 pm; 12:30 pm; 1:30 pm; 1:40 pm; 2 pm; 3 pm; 4 pm; 4:30 pm; 5 pm; 6:15 pm; 6:45 pm; 6:50 pm; 7 pm; 7:30 pm; 7:40 pm; 10 pm; 10:03 pm; 10:40 pm; 11 pm; 11:30 pm; 12:15 am; Fri., 7:30 am; 8 am; 10 am; 11 am; 11:55 am; 12:10 pm; Sat., 10 am; 11:55 am; 1:30 pm; 1:30 pm; 6:50 pm; 7 pm; 7:30 pm; 8 pm; 8:30 pm; 9 pm. Sun.: 9:30 am; 10:30 am; 11 am; 5 pm; 7:30 pm; 8:30 pm.
WLWL	New York, N. Y.—Universal Broadcasters Corp., 415 West 59th St	3500	288	1040	Eastern	Mon., 9 to 11 pm; Tue., 9 to 11 pm; Wed., 9 to 11 pm; Thu., 8:30 to 11 pm. Sun.: 8 pm.
WM						
WMAC	Cazenovia, N. Y.—Clive B. Meredith	100	275	1090	Eastern	
WMAF	Dartmouth, Mass.—Round Hills Radio Corp.	1000	440.9	680	Eastern	
WMAK	Lockport, N. Y.—Norton Laboratories	500	266	1130	Eastern	
WMAL	Washington, D. C.—M. A. Leese Co., 720 Eleventh St., N. W	100	212.6	1410	Eastern	Tue., Thu. and Sat.,
WMAN	Columbus, Ohio—W. E. Heskett, 507 North High St	50	286	1050	Eastern	Sun.: 10:30 am; 7:30 pm.
WMAQ	Chicago, Ill.—Chicago Daily News	1000	447.5	670	Central	Mon., 12 am to 3 pm; 4 to 7 pm; Tue., 12 am to 3 pm; 4 to 7 pm; 8 to 10 pm; Wed., 12 am to 3 pm; 4 to 7 pm; 8 to 10 pm; Thu., 12 am to 3 pm; 4 to 7 pm; 8 to 10 pm; Fri., 12 am to 3 pm; 4 to 7 pm; 8 to 10 pm; Sat., 12 am to 3 pm; 4 to 7 pm; 8 to 10 pm.
WMAY	St. Louis, Mo.—Kingshighway Presbyterian Church	100	248	1210	Central	
WMAZ	Macon, Ga.—Mercer University	500	261	1150	Eastern	Mon., 9 to 11 pm; Wed., 10 to 12 pm; Fri., 9 to 11 pm.
WMBB	Chicago, Ill.—American Bond & Mortgage Co., 6201 Cottage Grove Ave	500	250	1200	Central	Daily: 7 to 8 pm and 9 to 11 pm; Mon., Silent. Sun.: 3 to 5 pm; 7:40 to 9 pm; 9 to 11 pm.
WMBC	Detroit, Mich.—Hotel Addison, Mich. Broadcasting Co. (F. G. Siegel)	100	256.4	1170	Eastern	
WMBF	Miami Beach, Fla.—Fleetwood Hotel Corp	500	384.4	780	Eastern	Daily: 7 to 8 pm; 8 to 9 pm; 10 pm to 1 am; Tue., Silent.
WMC	Memphis, Tenn.—The Commercial Appeal	500	499.7	600	Central	Mon., 9:45 am; 11:30 am; 2:30 pm; 7:15 to 8 pm; 8:30 to 10 pm; Tue., same as Mon.; also 11 to 12 pm; Wed., silent; Thu., same as Mon.; Fri., same as Tue.; Sat., same as Mon. Sun.: 11 am to 12:30 pm.
WMCA	New York, N. Y. (Transmitter is in Hoboken, N. J.)—Associated Broadcasters, Inc	500	341	880	Eastern	Daiy: 10:30 to 5 pm; 6 pm to 12:15 am. Sun.: 11 to 12:15 am; 2:50 to 10 pm.
WMSG	New York, N. Y.—Madison Square Garden	500	212.6	1410	Eastern	
WN						
WNAB	Boston, Mass.—The Shepard Stores	100	250	1200	Eastern	Daily: 3 to 4 pm; Special.
WNAC	Boston, Mass.—The Shepard Stores	500	280.2	1070	Eastern	Daily: 10:30 to 11:30 am; 1 to 2 pm; 4 pm; 5 pm; 6 pm; 7:35 pm; 8 to 10 pm or later. Sun.: 11 am; 1:30 to 2:30 pm; 6:45 to 8:30 pm.
WNAD	Norman, Okla.—University of Oklahoma	500	254	1180	Central	Mon., 12:50 to 1:20; 7 to 11 pm; Tue., 12:50 to 1:20; 7 to 8 pm; Wed., 12:50 to 1:20; 7 to 8 pm; Thu., 12:50 to 1:20 pm; Fri., 12:50 to 1:20 pm. Sun.: 9:30 pm.
WNAL	Omaha, Neb.—Omaha Central High School	50	258	1160	Central	Fri., 9 pm; Sat., 9 pm.
WNAT	Philadelphia, Pa.—Lennig Bros. Co., Spring Garden and 9th Sts	100	250	1200	Eastern	Wed., 6:50 pm to mid; Sat., 7:30 pm to mid. Sun.: 4:30 to 7:30 pm.
WNAX	Yankton, S. D.—Dakota Radio Apparatus Co.	100	244	1230	Central	
WNBH	New Bedford, Mass.—New Bedford Hotel (Irving J. Vermilya)	250	248	1210	Eastern	Mon., Wed. and Fri., 6 to 10 pm; Tues., Thu. and Sat., Silent. Sun.: 11 am to 12:15 pm; 2 to 3 pm; 4:30 to 5:30 pm; 7 to 9 pm.
WNJ	Newark, N. J.—Radio Shop of Newark (Herman Lubinsky), 89 Lehigh Ave	150	252	1190	Eastern	

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WN	**WNOX—Knoxville, Tenn.**—People's Telephone and Telegraph Co.	100	268	1120	Central	
	WNRC—Greensboro, N. C.—Wayne M. Nelson	10	224	1340	Eastern	
	WNYC—New York, N. Y.—City of New York, Dept. of Plants and Structures	1000	526	570	Eastern	Daily: 6 to 11 pm. Sun.: Irregular.
WO	**WOAI—San Antonio, Texas**—Southern Equipment Co.	2000	394.5	760	Central	Daily: 10 am; 12:15 pm; 2:30 pm; 3 pm; 6:10 pm; 8:30 pm. Sun. and Holidays: 11 am; 7:35 pm; 9:30 pm.
	WOAN—Lawrenceburg, Tenn.—Jas. D. Vaughn	500	282.8	1060	Central	Daily except Sat.
	WOAW—Omaha, Neb.—Woodmen of the World	1000	526	570	Central	Daily: 6 pm to 7:30 pm; 9 to 11 pm (except Wed.); Sat., 6 to 12 pm. Sun. and Holidays: 9 to 11 am; 1:30 to 4 pm; 6 to 7 pm; 9 to 11 pm.
	WOAX—Trenton, N. J.—Franklyn J. Wolff, Top of the Monument Pottery Co.	500	240	1250	Eastern	Daily: Noon, 12:15 pm; 6 to 7 pm; Tue. and Fri., special 8:30 to 10:30 pm; Sat., 9:30 to 11 pm. Sun.: 9:30 pm to 11 pm.
	WOC—Davenport, Iowa—The Palmer School of Chiropractic	5000	483.6	620	Central	Mon., 12:15; 1:55; 2; 3; 6; Tue., 12:15; 1:55; 2; 3; 6; 6:30; 7; 9; Wed., 12:15; 1:55; 2; 3; 4; 5:45; 6; 6:30; 9; Thu., 12:15; 1:55; 2; 3; 6; 6:30; 7; 11; Fri., 12:15; 1:55; 2; 3; 4; 5:45; 6; 6:30; 8; 9; Sat., 12:15; 1; 5:45; 6; 6:30; 9; 11. Sun.: 1; 6:30; 8:15; 9:45.
	WOCL—Jamestown, N. Y.—A. E. Newton, for the Jamestown Furniture Market Assn.	15	275.2	1090	Eastern	Mon., 9 to 12 pm. Sun.: 10:30 am and 7:30 pm.
	WODA—Paterson, N. J.—O'Dea Temple of Music	250	224	1340	Eastern	
	WOI—Ames, Iowa—Iowa State College	750	270	1110	Central	Daily: 9:30 am; 10:30 am; 12:30 pm; 12:45 pm, Mon. and Thu., 7:30 and 7:50 pm; Tue. and Thu., 10:30 am. Sun.: 10:45 am to 11; 11 am to 12 am.
	WOK—Chicago, Ill. (Transmitter is in Homewood, Ill.) Neutrowound Radio Mfg. Co., 1721 Prairie Ave.	5000	217.3	1380	Central	
	WOKO—New York, N. Y.—Otto Baur (Operated by The Dyckman Radio Shop), 138 Dyckman St.	50	233	1290	Eastern	Daily: 8 to 12 pm.
	WOO—Philadelphia, Pa.—John Wanamaker	500	508.2	590	Eastern	Daily: 11 am; 12 to 1 pm; 4:45 pm; 7:30 pm; Mon., Wed. and Fri., 8 to 11. Sun.: Alternate Sun. Morning and Evening. 10:30 am and 7:30 pm. Every Sun. 6 to 7 pm; every other Sun., 9:15 to 10:15 pm.
	WOOD—Grand Rapids, Mich.—Grand Rapids Radio Co., 211 Diamond Ave., SE.	1000	242	1240	Central	Daily: 10 am; 9 pm to mid.; Thu., Silent.
	WOQ—Kansas City, Mo.—Unity School of Christianity.	1000	278	1080	Central	Mon., 11 am; Tue., 11 am; 8 to 9:30 pm; Thu., 11 am; 7 to 10 pm; Sat., 11 am; 8 pm to 12 pm. Sun.: 11 am to 12:30 pm; 7 to 7:45 pm; 7:45 pm to 9:30 pm.
	WOR—Newark, N. J.—L. Bamberger and Co.	500	405	740	Eastern	Daily: 6:45 am; 2:30 to 4 pm; 6:15 to 7:30 pm; Mon., Wed. and Sat., until 12 pm. Not on Sun. but every holiday.
	WORD—Batavia, Ill.—Peope's Pulpit Assn., 18 Concord St., Brooklyn, N. Y.	5000	275	1090	Central	Tue., 7 to 7:45 pm; 9 to 10 and 11 to 12 pm; Wed., 7 to 8 pm and 9 to 10 pm; Thu., 8 to 10 pm; Fri., 7 to 8; 9 to 10 pm; Sat., 7 to 8; 9 to 10 pm. Sun.: 10 to 11 am; 2:30 to 4 pm; 6 to 7 pm; 9 to 10:30 pm.
	WOS—Jefferson City, Mo.—Missouri State Marketing Bureau	500	440.9	680	Central	
	WOWL—New Orleans La.—Owl Battery Co., 901 Carondelet St.	10	270	1110	Central	Mon., Wed., Thu., Fri., Sat., 11:30 am to 12:30 pm; 2 to 3; 4:30 to 6:30 pm; Tue., 11:30 am to 12:30 pm; 2 to 3; 4:30 to 6:30 pm; 8:30 to 10:30 pm.
	WOWO—Fort Wayne, Ind.—The Main Auto Supply Co., 213 West Main St.	500	227	1320	Central	Mon., 8 to 12 pm; Wed., 8 to 12 pm; Thu., 8 to 12 pm. Every noon except Sat. and Sun.
WP	**WPAK—Fargo, N. D.**—North Dakota Agricultural College	100	275	1090	Central	Mon., 7:30 pm; Wed., 7:30 pm; Fri., 7:30 pm.
	WPCC—Chicago, Ill.—North Shore Congregational Church	500	258	1160	Central	Wed., 7 to 8 pm; Fri., 7 to 8 pm. Sun.: 11 am; 3:30 pm; 8 pm.
	WPDQ—Buffalo, N. Y.—Hiram L. Turner, 121 Norwood Ave.	50	205.4	1460	Eastern	
	WPG—Atlantic City, N. J.—Municipality of Atlantic City	500	299.8	1000	Eastern	Daily: 6:30 to mid. with occasional luncheon and tea music at 1:30 and 4:30 pm. Sun.: 3:15 to 5 pm; 9 to 11 pm.
	WPRC—Harrisburg, Pa.—W. Arthur Wilson, Prop., Wilson Printing and Radio Co., Fifth and Kelker Streets	100	215.6	1390	Eastern	Mon., 9 to 11 pm; Wed., 9 to 11 pm. Sun.: 7:20 to 10:30 pm.
	WPSC—State College, Pa.—Pennsylvania State College, Dept. of Elec. Engineering	500	261	1150	Eastern	Mon., 7:30 to 10:30 pm; Wed., 7:30 to 10:30 pm; Fri., 7:30 to 10:30 pm.
WQ	**WQAA—Parkersburg, Pa.**—Horace A. Beale, Jr.	500	220	1360	Eastern	
	WQAC—Amarillo, Texas—Gish Radio Service	100	234	1280	Central	Mon. to Sat., incl.: Sunrise; Sunset; 10 am; 11 am; noon and 8 pm. Sun.: Sunrise; Sunset; 11 am and 8 pm.
	WQAE—Springfield, Vt.—Moore Radio News Station	50	246	1220	Eastern	
	WQAM—Miami, Fla.—Electrical Equipment Co., 42 Northwest Fourth St.	100	263	1140	Eastern	Daily: 6 to 6:30 pm; 7:30 to 9 pm; 10:30 to 12:30 pm. Sun. and Holidays: 10:30 to 12 am; 7:30 to 9 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WQ	**WQAN—Scranton, Pa.**—Scranton Times	100	250	1200	Eastern	Daily: 12:30 to 1:30; 4:30 to 5:30 pm; except Sun., Fri. and Tue. nights, 8 to 11 pm; Sat. night 11 to 12 pm.
	WQAO—New York, N. Y.—Calvary Baptist Church	100	360	833	Eastern	
	WQJ—Chicago, Ill.—Calumet Baking Powder Co. and Rainbo Gardens	500	447.5	670	Central	Daily: 11 am to 12 am; 3 to 4 pm; 7 to 8 (except Mon.); 10 pm to 2 am (except Sat.); Sat., 10 to 3 am. Sun.: 10 to 12 am; 3 to 4 pm; 8 to 10 pm.
WR	**WRAF—Laport, Ind.**—The Radio Club, Inc	100	223.8	1340	Central	Mon. and Thu., 8 to 10 pm. Sun.: 10:45 am to 12:15 pm; 7:30 pm to 9 pm.
	WRAK—Escanaba, Mich.—Economy Light Co., 1105 Ludington St	100	256.3	1170	Central	
	WRAM—Galesburg, Ill.—Lombard College	100	243.8	1230	Central	Mon., 7 pm; 8 pm; 9 pm.
	WRAV—Yellow Springs, Ohio—Antioch College	100	263	1140	Central	
	WRAW—Reading, Pa.—Avenue Radio and Electric Shop, 460 Schuylkill Ave	10	238	1260	Eastern	Tue., 9 pm; Thu., 10 pm.
	WRAX—Gloucester City, N. J.—Flexon's Garage, 410 Jersey Ave	500	268	1120	Eastern	
	WRBC—Valparaiso, Ind.—Immanuel Lutheran Church	500	278	1080	Central	Mon., 7:30 pm. Sun.: 7:30 pm. During July, Aug. and Sept., 10:30 am.
	WRC—Washington, D. C.—Radio Corporation of America	1000	468.5	640	Eastern	
	WRCO—Raleigh, N. C.—Wynne Radio Co., 226½ Fayetteville St	100	252	1190	Eastern	
	WREC—Coldwater, Miss.—Wooten's Radio and Electric Co	10	254	1180	Central	
	WREO—Lansing, Mich.—Reo Motor Car Co	500	285.5	1050	Eastern	Daily except Sun.: 6 to 7 pm; Tue., 8:15 pm; Thu., 8:15 pm; Sat., 10 to 12 pm. Sun.: 10; 10:30 am; 7:30 pm.
	WRHF—Washington, D. C.—Washington Radio Hospital Fund, 525 Eleventh St., N. W	50	256	1170	Eastern	Tue., Thu. and Sat., 6 to 7 pm.
	WRHM—Minneapolis, Minn.—Rosedale Hospital Co., Inc	50	252	1190	Central	Mon., 1:15 pm; Tue., 11 pm; Wed., 9 pm; Thu., Silent; Fri., 1:15 pm; Sat., Silent. Sun.: 9:30 am; 2 pm; 9 pm.
	WRK—Hamilton, Ohio—Doron Bros. Electrical Co	00	270	1110	Central	
	WRM—Urbana, Ill.—University of Illinois	500	273	1100	Central	
	WRMU—Richmond Hill, N. Y. MU-1 (Yacht)—A. H. Grebe and Co., Inc	100	236	1270		No fixed schedule.
	WRNY—New York, N. Y.—Experimenter Publishing Co., 53 Park Place	500	258.5	1160	Eastern	Mon., 11 am to 1 pm; 6:50 to 11:45 pm; Tue., 11 am to 1 pm; 6:45 to 11:45 pm; Wed., 11 am to 1 pm; 6:15 to 10:45 pm; Thu., 11 am to 1 pm; 6:45 to 12 pm; Fri., 11 am to 1 pm; 5:20 to 12 pm; Sat., 11 am to 1:15 pm; 1 to 2 am. Sun.: 2:30 to 6 pm.
	WRR—Dallas, Tex.—City of Dallas, Police and Fire Signal Department	500	246	1220	Central	
	WRST—Bay Shore, N.Y.—Radiotel Mfg. Co., 5 First Ave.	250	215.7	1390	Eastern	
	WRVA—Richmond, Va.—Larus & Brother Co., Inc., 22nd & Cary Strs	1000	256	1170	Eastern	Mon., 8 to 11 pm; Tue., 11 to 1 am; Wed., 8 to 11 pm; Thu., 8 to 11 pm; Fri., 7 to 11 pm; Sat., Silent. Sun.: Silent.
	WRW—Tarrytown, N. Y.—Tarrytown Radio Research Laboratories (Koenig Bros.)	500	273	1100	Eastern	
WS	**WSAI—Cincinnati, Ohio**—(Transmitter is in Mason, Ohio), United States Playing Card Co., Cincinnati, Ohio	5000	325.9	920	Central	Mon., 8 to 9 pm (alternate months Feb., etc.); 10 to 12 pm; Tue., 5:30 to 10 pm; Wed., 6:45 to 8 pm; 10 to 12 pm; Thu., 7 to 10 pm; Fri., Silent; Sat., 6:40 to 10 pm; 12 pm to 1 am. Sun.: 3 to 4:30 pm and 7:45 to 10:15 pm.
	WSAJ—Grove City, Pa.—Grove City College	250	229	1310	Eastern	Irregular schedule.
	WSAN—Allentown, Pa.—Allentown Call Publishing Co.	100	229	1310	Eastern	
	WSAR—Fall River, Mass.—Doughty & Welch Electric Co., Inc., 46 N. Main St	100	254	1180	Eastern	Daily: 12:05 pm to 1 pm; 5 to 6 pm. Sun.: 10:30 am to 12:15 pm.
	WSAX—Chicago, Ill.—(Portable), Zenith Radio Corp., 332 South Michigan Ave	100	268	1120		
	WSAZ—Pomeroy, Ohio—Chase Electric Shop	50	244	1230	Eastern	
	WSB—Atlanta, Ga.—The Atlanta Journal	1000	428.3	700	Central	Daily: 12 am to 1 pm; 5 pm to 6 pm; 8 to 9 pm; 10:45 pm; 3 pm baseball. Sun.: 9:30 am; 10:45 am; 5 to 6 pm; 7:30 pm.
	WSBC—Chicago, Ill.—World Battery Co., 1219 South Wabash Ave	1000	210	1430	Central	Tue. to Sun., incl., 6:30 pm to 8:30 pm and 10 pm 1 am. Sun.: Special. Own Program, 2 am to 4 am; Mon., 5:30 pm to 7 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
WS	WSBF—St. Louis, Mo.—Stix, Baer & Fuller Dept. Store	250	273	1100	Central	Daily: Noon to 1 pm to 3 to 4 pm; Mon., Wed. and Fri., 7:30 to 9 pm; Wed., 11 pm to 1 am. Sun.: 9 pm to 10:30 pm.
	WSBT—South Bend, Ind.—South Bend Tribune	500	275	1090	Central	Mon., 7 to 10 pm; Wed., 7 to 9; 11:45 to 1 am; Fri., 7 to 10 pm.
	WSDA—New York, N. Y.—The City Temple (Seventh Day Adventist Church, 120th St. Lenox)	250	263	1140	Eastern	
	WSKC—Bay City, Mich.—World's Star Knitting Co.	100	261	1150	Eastern	Mon., 8 to 11 pm; Wed., 9 to 11 pm; Sat., 9 pm to 2 am. Sun.: 10:30 to 12.
	WSM—Nashville, Tenn.—The National Life & Accident Ins. Co.	1000	282.8	1060	Central	Mon., 6:30 to 9; 10 to 11 pm; Tue., 10 to 12 pm; Wed., 6:30 to 9; 10 to 11 pm; Thu., Silent; Fri., 6:30 to 9; 10 to 11 pm; Sat., 6:30 to 12 pm. Sun.: Alternate morning and Evening Church Services.
	WSMB—New Orleans, La.—Saenger Theatres, Inc. & Maison Blanche Co.	500	319	940	Central	Daily: 12:30 to 1:30 pm; 6:30 to 7:30 pm; Mon., Wed., Thu., Sat., 8:30 pm.
	WSMH—Owosso, Mich.—Shattuck Music House, 207 Washington St.	20	240	1250	Eastern	Wed., 8 to 10 pm; Sat., 10 to 12 pm. Sun.: 10 to 11:30 am.
	WSMK—Dayton, Ohio—S. M. K. Radio Corporation, 39 East Third St.	500	275	1090	Central	
	WSOE—Milwaukee, Wis.—School of Engineering of Milwaukee, 415 Marshall St.	500	246	1220	Central	
	WSRO—Hamilton, Ohio—The Radio Co., 409-421 High St.	100	252	1190	Central	Tue., 8 to 10 pm; Fri., 8 to 10 pm. Sun.: 2 to 4 pm.
	WSSH—Boston, Mass.—Tremont Temple Baptist Church	100	261	1150	Eastern	Mon. and Fri., 7:30 to 9 pm. Sun.: 10:30 am to 12 am; 6:30 pm to 9 pm.
	WSUI—Iowa City, Iowa—State University of Iowa	500	484	620	Central	Daily except Sat. and Sun.: 12:30 pm; Mon. of alternate weeks 4 pm; Mon., 7:30 to 8:30 pm; Wed., 9 to 9:30 am; 7:30 to 8:30 pm. Occasional programs are broadcast Sat. at 7:30 pm. Sun.: 9:30 pm to 10 pm. About once a month a Vesper Service program is broadcast at 4 pm.
	WSVS—Buffalo, N. Y.—Seneca Vocational School, Seneca & Hydraulic Sts.	50	219	1370	Eastern	Mon., Wed. and Fri., 9 pm.
	WSWS—Woodale, Ill.—Illinois Broadcasting Corp.	1000	275	1090	Central	
WT	WTAB—Fall River, Mass.—Fall River Daily Herald	100	266	1130	Eastern	
	WTAD—Cartage, Ill.—Robt. E. Compton	50	236	1270	Central	
	WTAG—Worcester, Mass.—Worcester Telegram Pub. Co.	500	268	1120	Eastern	
	WTAL—Toledo, Ohio—Toledo Radio & Electric Co., 316 Jackson St.	10	252	1190	Eastern	Mon., 7:30 to 10:30 pm; Tue., 7:30 to 9 pm; Wed. 7:30 to 10:30 pm; Thu., 7:30 to 9 pm; Fri., 7:30 to 10:30 pm; Sat., 7:30 to 9 pm. Sun.: 4 to 6 pm
	WTAM—Cleveland, Ohio—Willard Storage Battery Co.	1000	389.4	770	Eastern	Mon., 6; 8; 10 pm; Wed., 6; 8; 11 pm; Sat., 6; 8 pm.
	WTAP—Cambridge, Ill.—Cambridge Radio & Electric Co.	50	242	1240	Central	
	WTAQ—Eau Claire, Wis.—C. S. Van Gorden	100	254	1180	Central	
	WTAR—Norfolk, Va.—Reliance Electric Co., 519 West 21st St.	100	261	1150	Eastern	Mon., 6:15 pm; Tue., 8 to 9 pm; Wed., 6:15 pm; Thu., 6:15 pm; Fri., 6:15 pm; Sat., 6:15 pm.
	WTAW—College Station, Tex.—Agricultural & Mechanical College of Texas	500	270	1110	Central	Wed. and Fri., 8 to 9:30 pm. Sun.: 11 to 12 am.
	WTAX—Streator, Ill.—Williams Hardware Co., 115 So. Vermillion St.	50	231	1300	Central	Thu., 8 to 12 pm.
	WTAZ—Lambertville, N. J.—Thos. J. McGuire	15	261	1150	Eastern	
	WTIC—Hartford, Conn.—Travelers Insurance Co.	500	475.9	630	Eastern	Mon., 11 am to 12 am and 5:30 to 11 pm; Tue., Silent; Wed., 5:30 to 9 pm; Thu., 5:30 to 6:30 pm; Fri., 11 am to 12 am and 5:30 to 11 pm; Sat., 5:30 to 10:30 pm.
WW	WWAD—Philadelphia, Pa.—Wright & Wright Inc., 2215 North Broad St.	250	250	1200	Eastern	Mon. and Thu., 7 pm to 12 pm. Sun.: 9 to 12 pm.
	WWAE—Plainfield, Ill.—Lawrence J. Crowley	500	242.2	1240	Central	Mon., Silent; Tue., Wed. and Thu., 9 to 12 pm; Fri., 9 pm to 3 am; Sat., 9 pm to 12 pm. Sun.: 9 pm to 12 pm.
	WWAO—Houghton, Mich.—Michigan College of Mines	250	263	1140	Central	
	WWI—Dearborn, Mich.—Ford Motor Co.	500	266	1130	Central	
	WWJ—Detroit, Mich.—Detroit News	1000	352.7	850	Eastern	Daily: 7:30 to 8:30 am; 9:30 to 9:50 am; 12 to 12:45 pm; 3 to 4 pm; 4 to 5:30 pm; 6 to 7 pm; 8 to 11 pm. Sun.: 11 am to 12:30 pm.
	WWL—New Orleans, La.—Loyola University	100	275	1090	Central	

This list has been corrected up to and including April 30, 1926.

Gladys Johnson, Cellist in daily concerts.

Richard V. Haller, Director-Announcer.

William N. Mahon, Announcer.

Paul R. Heitmeyer, Publicity Director-Announcer.

PORTLAND ORE.

Novak's Vaudette Orchestra, a KGW feature.

CINCINNATI, OHIO

Johanna Grosse, organist of the Crosley WLW staff, broadcasts a novelty number every Wednesday through that Cincinnati station.

Louis John Johnen is the new program director of station WLW.

Mary Louise Wosezcek, known as the "Crosley piano request-lady."

Wm. C. Stoess, former Musical Director, has been promoted to the position of Studio Director.

Irene Downing, player-roll artist.

The Kudisch String Quartette is an ensemble of four first rate musicians who are now playing a series of morning musicales at WRNY.

Alfred W. McCann is the world's foremost authority on foods. Is it any wonder that Friday 7:45 P.M. is a popular time?

June Lee is the miniature toast of the air, the Singing Vagabond of popular songsdom.

James Maresca, is the engineer of WRNY who is bringing it to the highest type of service.

Bill Ferrucci and his orchestra have been a dance feature at WRNY since the beginning.

Kathryn Behnke is the original Lullabye Lady who croons a nation's children to sleep.

Frankie Peeper is a rising young soprano heard frequently at WRNY.

Gordon Hampson who directs an ensemble of light opera miscellaneous concert numbers.

Isabel Austin of Roxy's gang, now has a gang all her own at WRNY.

NEW YORK, N.Y.

H. O. Osgood, associate editor of Musical Courier, translator of Grand Opera texts, tells the world what is happening musically.

The Chevalier De Lancellotti holds the medals of the King of England, the King of Italy, and the President of France. Now WRNY has decorated him for his song ensembles.

Virginia Columbati, (seated) who sang in the greatest opera houses of the world, and Josephine Lusesse coloratura soprano (standing).

Olcott Vail, leader Hotel McAlpin String Ensemble, broadcasts everyevenng, 6 PM.

Snedden Weir, Chief Announcer and Studio Manager.

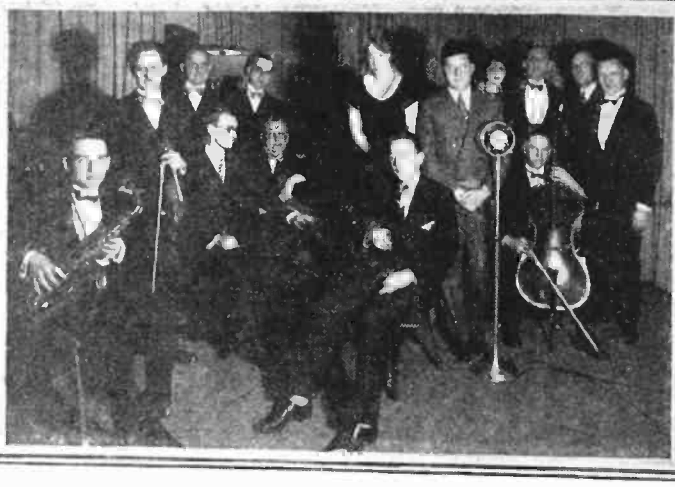
WMCA

NEW YORK, N.Y.

Miss Hedda Comoro, Publicity Director.

Donald Flamm, Dramatic Critic and sponsor of Donald Flamm Frolickers.

Edward French, Studio Accompanist.



Roemer's Homers, broadcast every Sunday 6 to 7 P.M.

Miss Pearl Dyer, Piano and Vocal Artist.

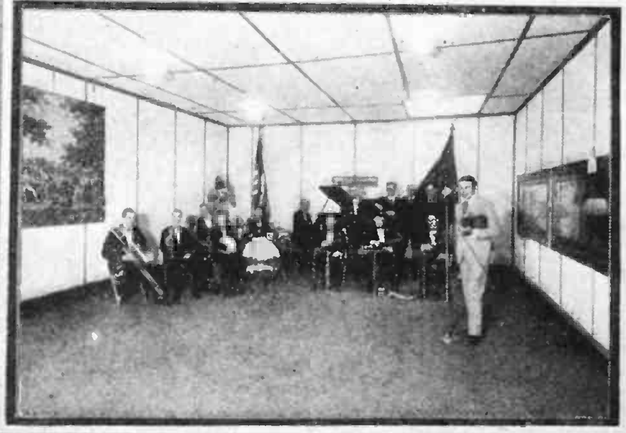
KFJF

OKLAHOMA CITY

OKLAHOMA.

Art. Fowler, Ukelele Entertainer, a staff artist at this station.

Miss Elsie Shaw, Nationally known Dramatic Reader.



Tracy-Brown's Staff Orchestra, a regular feature at Station KFJF.

Robt. C. Graham (Sergeant Bob). Program Director-Announcer, American Legion Radio Post 300.

RADIO BROADCAST STATIONS OF THE UNITED STATES

By Wavelengths and Frequencies

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
202.6	1480	500	KFXB	Big Bear Lake, Cal.
202.6	1480	10	WEHS	Evanston, Ill.
202.6	1480	10	WIBS	Elizabeth, N. J.
204	1470	10	WABB	Harrisburg, Pa.
205.4	1460	50	KFVD	San Pedro, Cal.
205.4	1460	10	KFXD	Logan, Utah
205.4	1460	50	KFXY	Flagstaff, Ariz.
205.4	1460	10	KFYF	Oxnard, Cal.
205.4	1460	100	WFRL	Brooklyn, N. Y.
205.4	1460	150	WIBX	Utica, N. Y.
205.4	1460	50	WPDQ	Buffalo, N. Y.
206.8	1450	50	WABW	Wooster, Ohio
206.8	1450	50	WJBA	Joilet, Ill.
207	1450	500	KFWM	Oakland, Cal.
207	1450	50	KGTT	San Francisco, Cal.
208	1440	250	KNRC	Los Angeles, Cal.
209.7	1430	10	KFYO	Texarkana, Tex.
209.7	1430	100	KSMR	Santa Maria, Cal.
209.7	1430	500	WBNY	New York, N. Y.
209.7	1430	100	WCBR	Providence, R. I.
209.7	1430	100	WCWS	Providence, R. I.
209.7	1430	30	WIBH	New Bedford, Mass.
210	1430	1000	WSBC	Chicago, Ill.
211.1	1420	50	KFWC	San Bernardino, Cal.
211.1	1420	250	KFWO	Avalon, Catalina Island, Cal.
211.1	1420	100	WJBU	Lewisburg, Pa.
212.6	1410	50	KFWV	Portland, Oregon
212.6	1410	100	WMAL	Washington, D. C.
212.6	1410	500	WMSG	New York, N. Y.
214.2	1400	250	KFWF	St. Louis, Mo.
214.2	1400	15	KFXR	Oklahoma Okla.
214.2	1400	150	WCLS	Joliet, Ill.
214.2	1400	100	WKBB	Joliet, Ill.
215.6	1390	100	WPRC	Harrisburg, Pa.
215.7	1390	50	KFBC	San Diego, Cal.
215.7	1390	50	KFQW	North Bend, Wash.
215.7	1390	10	KFXJ	Edgewater, Colo.
215.7	1390	50	WBBZ	Chicago, Ill.
215.7	1390	50	WHBL	Chicago, Ill.
215.7	1390	20	WHBM	Chicago, Ill.
215.7	1390	50	WIBJ	Chicago, Ill.
215.7	1390	10	WIBM	Chicago, Ill.
215.7	1390	100	WKBG	Chicago, Ill.
215.7	1390	250	WRST	Bay Shore, N. Y.
216	1390	100	WHBW	Philadelphia, Pa.
217.3	1380	50	KFAF	San Jose, Cal.
217.3	1380	100	KFQU	Alma, (Holy City) Cal.
217.3	1380	500	WFKB	Chicago, Ill.
217.3	1380	5000	WOK	Chicago, Ill.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
218.8	1370	10	KFJC	Junction City, Kans.
218.8	1370	50	KFRW	Olympia, Wash.
218.8	1370	10	WHBU	Anderson, Ind.
218.8	1370	50	WIBI	Flushing, N. Y.
218.8	1370	250	WJBI	Red Bank, N. J.
219	1370	50	WSVS	Buffalo, N. Y.
220	1360	100	KFUU	Oakland, Cal.
220	1360	5	KJBS	San Francisco, Cal.
220	1360	100	WIBW	Logansport, Ind.
220	1360	500	WQAA	Parkersburg, Pa.
222	1350	50	WBBW	Norfolk, Va.
222	1350	100	WBES	Takoma Park, Md.
222	1350	500	WCOA	Pensacola, Fla.
222	1350	20	WHBD	Bellefontaine, O.
222	1350	100	WHBF	Rock Island, Ill.
222	1350	100	WHBH	Culver, Ind.
222	1350	50	WIBG	Elkins Park, Pa.
222	1350	20	WIBU	Poynette, Wis.
223.7	1340	10	KFQP	Iowa City, Ia.
223.8	1340	100	WRAF	Laport, Ind.
224	1340	100	KFBL	Everett, Wash.
224	1340	50	KFUR	Ogden, Utah
224	1340	50	KFVS	Cape Girardeau, Mo.
224	1340	50	WKAV	Laconia, N. H.
224	1340	10	WNRC	Greensboro, N. C.
224	1340	250	WODA	Paterson, N. J.
225.4	1330	50	WAGM	Royal Oak, Mich.
225.4	1330	1500	WBBM	Chicago, Ill.
225.4	1330	10	WEBQ	Harrisburg, Ill.
226	1330	10	KFGQ	Boone, Iowa
226	1330	10	KFKZ	Kirksville, Mo.
226	1330	50	KFOB	Burlingame, Cal.
226	1330	100	KFOR	David City, Neb.
226	1330	50	KFQZ	Hollywood, Cal.
226	1330	500	KFWI	San Francisco, Calif.
226	1330	150	WDAD	Nashville, Tenn.
226	1330	100	WEBL	U. S. (Portable)
226	1330	10	WFBE	Seymour, Ind.
226	1330	1000	WIBO	Chicago, Ill.
227	1320	50	KFVN	Fairmont, Minn.
227	1320	500	WOWO	Ft. Wayne, Ind.
227.1	1320	50	WJBR	Omro, Wis.
228.9	1310	1000	KMMJ	Clay Center, Nebr.
229	1310	100	KFLV	Rockford, Ill.
229	1310	50	KPPC	Pasadena, Cal.
229	1310	10	WAIT	Taunton, Mass.
229	1310	50	WBBL	Richmond, Va.
229	1310	50	WCBM	Baltimore, Md.
229	1310	50	WDBJ	Roanoke, Va.
229	1310	10	WGBR	Marshfield, Wis.
229	1310	250	WSAJ	Grove City, Pa.
229	1310	100	WSAN	Allentown, Pa.
230.6	1300	500	KFPR	Los Angeles, Cal.
230.6	1300	50	WCLO	Camp Lake, Wis.
230.6	1300	10	WIBZ	Montgomery, Ala.
231	1300	5	KDLR	Devils Lake, N. D.
231	1300	10	KFDZ	Minneapolis, Minn.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
231	1300	50	KFOT	Wichita, Kans.
231	1300	500	KQW	San Jose, Cal.
231	1300	500	KUT	Austin, Tex.
231	1300	100	WBRE	Wilkes-Barre, Pa.
231	1300	100	WKBE	Webster, Mass.
231	1300	50	WTAX	Streator, Ill.
231.6	1300	20	WHBG	Harrisburg, Pa.
233	1290	10	KFEY	Kellogg, Idaho
233	1290	500	KFON	Long Beach, Calif.
233	1290	10	WDBZ	Kingston, N. Y.
233	1290	50	WHBQ	Memphis, Tenn.
233	1290	10	WJBK	Ypsilanti, Mich.
233	1290	50	WOKO	New York, N. Y.
234	1280	50	KFUP	Denver, Colo.
234	1280	50	KMJ	Fresno, Cal.
234	1280	10	WEBE	Cambridge, Ohio
234	1280	5	WFBD	Philadelphia, Pa.
234	1280	100	WFDF	Flint, Mich.
234	1280	30	WGBM	Providence, R. I.
234	1280	100	WQAC	Amarillo, Tex.
234.2	1190	500	WGBX	Orono, Me.
234.2	1280	100	WJBC	La Salle, Ill.
234.4	1280	50	WHBJ	Fort Wayne, Ind.
236	1270	20	KFLU	San Benito, Tex.
236	1270	250	KFOO	Salt Lake City, Utah
236	1270	15	KFVG	Independence, Kans.
236	1270	100	KWKC	Kansas City, Mo.
236	1270	100	WBOQ	Richmond Hill, N. Y.
236	1270	250	WCAM	Camden, N. J.
236	1270	100	WFBJ	Collegeville, Minn.
236	1270	500	WGBF	Evansville, Ind.
236	1270	100	WGMU	Richmond Hill, N. Y.
236	1270	100	WRMU	Richmond Hill, N. Y. (Yacht)
236	1270	50	WTAD	Carthage, Ill.
236.1	1270	100	WIBA	Madison, Wis.
238	1260	15	KFBS	Trinidad, Colo.
238	1260	100	KFCB	Phoenix, Ariz.
238	1260	100	KFWU	Pineville, La.
238	1260	10	KFYJ	Houston, Tex.
238	1260	500	KMTR	Los Angeles, Cal.
238	1260	200	WBBP	Petoskey, Mich.
238	1260	10	WHBN	St. Petersburg, Fla.
238	1260	3500	WHT	Chicago, Ill.
238	1260	10	WRAW	Reading, Pa.
239.9	1250	100	KFUM	Colorado Springs, Colo.
240	1250	10	KFHL	Oskaloosa, Iowa
240	1250	10	KFLX	Galveston, Tex.
240	1250	500	KFVE	St. Louis, Mo.
240	1250	10	KFVI	Houston, Tex.
240	1250	1000	KTAB	Oakland, Cal.
240	1250	100	KZM	Oakland, Cal.
240	1250	100	WABI	Bangor, Me.
240	1250	50	WCAT	Rapid City, S. D.
240	1250	500	WDBO	Winter Park, Fla.
240	1250	10	WGBI	Scranton, Pa.
240	1250	500	WHAP	New York, N. Y.
240	1250	500	WOAX	Trenton, N. J.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
240	1250	20	WSMH	Owosso, Mich.
242	1240	50	KFFP	Moberly, Mo.
242	1240	10	KFPM	Greenville, Tex.
242	1240	50	KFXH	El Paso, Tex.
242	1240	500	KSO	Clarinda, Iowa
242	1240	50	WABY	Philadelphia, Pa.
242	1240	250	WBZA	Boston, Mass.
242	1240	50	WCBH	Oxford, Miss.
242	1240	100	WCBQ	Nashville, Tenn.
242	1240	100	WEBC	Superior, Wis.
242	1240	1000	WOOD	Grand Rapids, Mich.
242	1240	50	WTAP	Cambridge, Ill.
242.2	1240	500	WWAE	Plainfield, Ill.
243.8	1230	1000	WAMD	Minneapolis, Minn.
243.8	1230	100	WATT	Boston, Mass.
243.8	1230	100	WRAM	Galesburg, Ill.
244	1230	500	KUOM	Missoula, Mont.
244	1230	100	WEBR	Buffalo, N. Y.
244	1230	100	WGBB	Freeport, N. Y.
244	1230	100	WNAX	Yankton, S. D.
244	1230	50	WSAZ	Pomeroy, Ohio
246	1220	5000	WBAL	Baltimore, Md.
246	1220	50	KDYL	Salt Lake City, Utah
246	1220	10	KFJI	Astoria, Oregon
246	1220	50	KFJY	Fort Dodge, Ia.
246	1220	500	KFVW	San Diego, Cal.
246	1220	50	KGY	Lacey, Wash.
246	1220	500	WABX	Mount Clemens, Mich.
246	1220	15	WEBD	Anderson, Ind.
246	1220	50	WIBR	Weirton, W. Va.
246	1220	50	WQAE	Springfield, Vt.
246	1220	500	WRR	Dallas, Tex.
246	1220	500	WSOE	Milwaukee, Wis.
247.8	1210	1000	WIOD	Miami Beach, Fla.
248	1210	100	KFBK	Sacramento, Cal.
248	1210	50	KFEC	Portland, Oregon
248	1210	100	KFIF	Portland, Oregon
248	1210	10	KFJB	Marshalltown, Ia.
248	1210	100	KFOX	Omaha, Neb.
248	1210	250	KFRB	Beeville, Tex.
248	1210	10	KFYR	Bismarck, N. D.
248	1210	50	KWG	Stockton, Cal.
248	1210	1000	WAPI	Auburn, Ala.
248	1210	50	WBRC	Birmingham, Ala.
248	1210	100	WCSO	Springfield, O.
248	1210	1000	WEW	St. Louis, Mo.
248	1210	10	WGAL	Lancaster, Pa.
248	1210	100	WMAY	St. Louis, Mo.
248	1210	250	WNBH	New Bedford, Mass.
250	1200	100	KFDX	Shreveport, La.
250	1200	10	KFVY	Albuquerque, N. Mex.
250	1200	500	KFXF	Colorado Springs, Colo.
250	1200	250	KLS	Oakland, Cal.
250	1200	250	KMO	Tacoma, Wash.
250	1200	50	WFBC	Knoxville, Tenn.
250	1200	500	WGES	Oak Park, Ill.
250	1200	10	WHBA	Oil City, Pa

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
250	1200	50	WHBY	West De Pere, Wis.
250	1200	100	WIAD	Philadelphia, Pa.
250	1200	100	WLAL	Tulsa, Okla.
250	1200	500	WMBB	Chicago, Ill.
250	1200	100	WNAB	Boston, Mass.
250	1200	100	WNAT	Philadelphia, Pa.
250	1200	100	WQAN	Scranton, Pa.
250	1200	250	WWAD	Philadelphia, Pa.
252	1190	50	KFHA	Gunnison, Colo.
252	1190	50	KFOY	St. Paul, Minn.
252	1190	15	KFPL	Dublin, Tex.
252	1190	500	KFWB	Holywood, Calif.
252	1190	500	KMA	Shenandoah, Iowa
252	1190	200	KOCW	Chickasha, Okla.
252	1190	50	KWUC	Le Mars, Iowa
252	1190	50	WBBS	New Orleans, La.
252	1200	100	WCAX	Burlington, Vt.
252	1190	100	WFBL	Syracuse, N. Y.
252	1190	500	WGCP	Newark, N. J.
252	1190	150	WNJ	Newark, N. J.
252	1190	100	WRCO	Raleigh, N. C.
252	1190	50	WRHM	Minneapolis, Minn.
252	1190	100	WSRO	Hamilton, Ohio
252	1190	10	WTAL	Toledo, Ohio
254	1180	50	KFEL	Denver, Colo.
254	1180	50	KFJZ	Fort Worth, Tex.
254	1180	100	KFLR	Albuquerque, N. M.
254	1180	100	KFWH	Chico, Calif.
254	1180	20	WABC	Asheville, N. C.
254	1180	500	WCAJ	University Place, Neb.
254	1180	200	WCBA	Allentown, Pa.
254	1180	500	WEAI	Ithaca, N. Y.
254	1180	100	WFBR	Baltimore, Md.
254	1180	20	WFBZ	Galesburg, Ill.
254	1180	10	WHBC	Canton, Ohio
254	1180	100	WIAS	Burlington, Iowa
254	1180	50	WJAK	Kokomo, Ind.
254	1180	10	WJBB	St. Petersburg, Fla.
254	1180	500	WNAD	Norman, Okla.
254	1180	10	WREC	Coldwater, Miss.
254	1180	100	WSAR	Fall River, Mass.
254	1180	100	WTAQ	Eau Claire, Wis.
256	1170	100	KFIQ	Yakima, Wash.
256	1170	50	KFUS	Oakland, Calif.
256	1170	500	KOWW	Walla Walla, Wash.
256	1170	100	KRE	Berkeley, Calif.
256	1170	500	KTNT	Muscatine, Iowa
256	1170	100	WBAX	Wilkes-Barre, Pa.
256	1170	500	WDOD	Chattanooga, Tenn.
256	1170	100	WHBP	Johnstown, Pa.
256	1170	50	WRHF	Washington, D. C.
256	1170	1000	WRVA	Richmond, Va.
256.3	1170	500	WCSH	Portland, Me.
256.3	1170	100	WRAK	Escanaba, Mich.
256.4	1170	500	WBDC	Grand Rapids, Mich.
256.4	1170	100	WMBC	Detroit, Mich.
258	1160	20	KFPW	Carterville, Mo.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
258	1160	50	KFUL	Galveston, Tex.
258	1160	250	KOCH	Omaha, Neb.
258	1160	25	WAAD	Cincinnati, Ohio
258	1080	100	WABO	Rochester, N. Y.
258	1160	500	WADC	Akron, Ohio
258	1160	100	WHEC	Rochester, N. Y.
258	1160	50	WNAL	Omaha, Neb.
258	1160	500	WPCC	Chicago, Ill.
258.5	1160	500	WRNY	New York, N. Y.
258.5	1160	100	WLTS	Chicago, Ill.
261	1150	500	KFJF	Oklahoma, Okla.
261	1150	100	KFMR	Sioux City, Iowa
261	1150	100	KFUT	Salt Lake City, Utah
261	1150	500	KFWA	Ogden, Utah
261	1150	100–1000	WABQ	Haverford, Pa.
261	1150	100	WARC	Medford Hillside, Mass.
261	1150	50	WDAY	Fargo, N. D.
261	1150	250	WEAM	North Plainfield, N. J.
261	1150	500–5000	WKAF	Milwaukee, Wis.
261	1150	500	WMAZ	Macon, Ga.
261	1150	500	WPSC	State College, Pa.
261	1150	100	WSKC	Bay City, Mich.
261	1150	100	WSSH	Boston, Mass.
261	1150	100	WTAR	Norfolk, Va.
261	1150	15	WTAZ	Lambertville, N. J.
263	1140	50	KFJR	Portland, Ore.
263	1140	50	KFMW	Houghton, Mich.
263	1140	1000	KFNF	Shenandoah, Iowa
263	1140	50	KTBR	Portland, Ore.
263	1140	50	WABR	Toledo, Ohio
263	1140	500	WAAM	Newark, N. J.
263	1140	250	WCAD	Canton, N. Y.
263	1140	500	WCAR	San Antonio, Tex.
263	1140	5	WCBE	New Orleans, La.
263	1140	100	WDAG	Amarillo, Tex.
263	1140	50	WEBZ	Savannah, Ga.
263	1140	500	WDGY	Minneapolis, Minn.
263	1140	100	WQAM	Miami, Fla.
263	1140	100	WRAV	Yellow Springs, Ohio
263	1140	250	WSDA	New York, N. Y.
263	1140	250	WWAO	Houghton, Mich.
265.3	1130	100	KFIO	Spokane, Wash.
266	1130	100	KFPY	Spokane, Wash.
266	1130	250	KLZ	Denver, Colo.
266	1130	500	WBCN	Chicago, Ill.
266	1130	1000	WENR	Chicago, Ill.
266	1130	500	WGHB	Clearwater, Fla.
266	1130	50	WHAV	Wilmington, Del.
266	1130	500	WMAK	Lockport, N. Y.
266	1130	100	WTAB	Fall River, Mass.
266	1130	500	WWI	Dearborn, Mich.
267.7	1120	50	KFRC	San Francisco, Cal.
267.7	1120	50	WDAH	El Paso, Tex.
267.9	1120	10	WBBY	Charleston, S. C.
268	1120	500	KFEQ	Oak, Neb.
268	1120	500	KFH	Wichita, Kans.
268	1120	100	WDRC	New Haven, Conn.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
268	1120	500	WEBW	Beloit, Wis.
268	1120	250	WFBM	Indianapolis, Ind.
268	1120	100	WJAM	Cedar Rapids, Iowa
268	1120	100	WJBO	New Orleans, La.
268	1120	100	WNOX	Knoxville, Tenn.
268	1120	500	WRAX	Gloucester City, N. J.
268	1120	100	WSAX	Chicago, Ill.
268	1120	500	WTAG	Worcester, Mass.
270	1110	500	KFBU	Laramie, Wyo.
270	1110	100	WBAO	Decatur, Ill.
270	1110	100	WDBE	Atlanta, Ga.
270	1110	500	WEAN	Providence, R. I.
270	1110	1500	WGHP	Detroit, Mich.
270	1110	500	WGST	Atlanta, Ga.
270	1110	250	WJAG	Norfolk, Nebr.
270	1110	500	WJBL	Decatur, Ill.
270	1110	750	WOI	Ames, Iowa
270	1110	10	WOWL	New Orleans, La.
270	1110	100	WRK	Hamilton, Ohio
270	1110	500	WTAW	College Station, Tex.
272.6	1100	100	KFAD	Phoenix, Ariz.
272.6	1100	500	WBBR	Rossville, N. Y.
272.6	1100	500	WEBJ	New York, N. Y.
272.6	1100	500	WFBH	New York, N. Y.
272.6	1100	1000	WHK	Cleveland, Ohio
273	1100	100	KFDY	Brookings, S. Dak.
273	1100	100	KFIZ	Fondulac, Wis.
273	1100	50	KFKA	Greeley, Colo.
273	1100	100	KFLZ	Anita, Iowa
273	1100	500	KHQ	Spokane, Wash.
273	1100	250	WBAA	West Lafayette, Ind.
273	1100	250	WDAE	Tampa, Fla.
273	1100	10	WFAM	St. Cloud, Minn.
273	1100	250	WIL	St. Louis, Mo.
273	1100	500	WRM	Urbana, Ill.
273	1100	500	WRW	Tarrytown, N. Y.
273	1100	250	WSBF	St. Louis, Mo.
275	1090	50	KFBB	Havre, Mont.
275	1090	500	KFKU	Lawrence, Kans.
275	1090	500	KFSG	Los Angeles, Cal.
275	1090	500	KQV	Pittsburgh, Pa.
275	1090	50	WABZ	New Orleans, La.
275	1090	500	WAFD	Port Huron, Mich.
275	1090	500	WBAK	Harrisburg, Pa.
275	1090	250	WBT	Charlotte, N. C.
275	1090	500	WCAC	Storrs, Conn.
275	1090	100	WCAO	Baltimore, Md.
275	1090	100	WEAU	Sioux City, Iowa
275	1090	500	WFAV	Lincoln, Neb.
275	1090	500	WHAD	Milwaukee, Wis.
275	1090	500	WHAR	Atlantic City, N. J.
275	1090	100	WKY	Oklahoma, Okla.
275	1090	20	WLAP	Louisville, Ky.
275	1090	100	WMAC	Cazenovia, N. Y.
275	1090	5000	WORD	Batavia, Ill.
275	1090	100	WPAK	Fargo, N. D.
275	1090	250	WSBT	South Bend, Ind.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
275	1090	500	WSMK	Dayton, Ohio
275	1090	1000	WSWS	Wooddale, Ill.
275	1090	100	WWL	New Orleans, La.
275.2	1090	15	WOCL	Jamestown, N. Y.
276.6	1080	500	WCAU	Philadelphia, Pa.
277.6	1080	500	WLB	Minneapolis, Minn.
277.8	1080	100	WFBG	Altoona, Pa.
278	1080	100	KFJM	Grand Forks, N. D.
278	1080	500	KOIL	Council Bluffs, Iowa
278	1080	100	KUSD	Vermillion, S. D.
278	1080	500	KWCR	Cedar Rapids, Iowa
278	1080	500	KWWG	Brownsville, Tex.
278	1080	200	WAAF	Chicago, Ill.
278	1080	100	WDZ	Tuscola, Ill.
278	1080	10	WGBC	Memphis, Tenn.
278	1080	500	WGBU	Fulford-by-the-Sea, Fla.
278	1080	100	WHAM	Rochester, N. Y.
278	1080	500	WHDI	Minneapolis, Minn.
278	1080	500	WLBL	Stevens Point, Wis.
278	1080	1000	WOQ	Kansas City, Mo.
278	1080	500	WRBC	Valparaiso, Ind.
278.6	1080	50	KFDD	Boise, Idaho
280.2	1070	750	KFAU	Boise, Idaho
280.2	1070	5000	KFQA	St. Louis, Mo.
280.2	1070	1500	KMOX	St. Louis, Mo.
280.2	1070	500	KOAC	Corvallis, Ore.
280.2	1070	500	WNAC	Boston, Mass.
282.8	1060	500	WOAN	Lawrenceburg, Tenn.
282.8	1060	1000	WSM	Nashville, Tenn.
285.5	1050	1000	WKAR	East Lansing, Mich.
285.5	1050	500	WREO	Lansing, Mich.
286	1050	500	WEMC	Berrien Springs, Mich.
286	1080	50	WMAN	Columbus, Ohio
288	1040	3500	WLWL	New York, N. Y.
288.3	1040	5000	KFKX	Hastings, Neb.
293.9	1020	750	KTBI	Los Angeles, Cal.
293.9	1020	500	WAIU	Columbus, Ohio
293.9	1020	500	WEAO	Columbus, Ohio
296.9	1010	500	KPRC	Houston, Tex.
299.8	1000	1000	KSL	Salt Lake City, Utah
299.8	1000	750	KUOA	Fayetteville, Ark.
299.8	1000	500	WPG	Atlantic City, N. J.
303	990	1000	WGN	Chicago, Ill.
303	990	4000	WLIB	Chicago, Ill.
305.9	980	1000	KTCL	Seattle, Wash.
305.9	980	500	WJAR	Providence, R. I.
309.1	970	Var.	KDKA	Pittsburgh, Pa.
315.6	950	500	KFDM	Beaumont, Tex.
315.6	950	1000	KPSN	Pasadena, Cal.
315.6	950	500	WAHG	Richmond Hill, N. Y.
315.6	950	500	WGBS	New York, N. Y.
319	940	1000	KQP	Portland, Ore.
319	940	750	WGR	Buffalo, N. Y.
319	940	500	WSMB	New Orleans, La.
322.4	930	5000	KOA	Denver, Colo.
322.4	930	1500	WJAZ	Chicago, Ill.
325.9	920	1000	WKRC	Cincinnati, Ohio

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
325.9	920	5000	WSAI	Cincinnati, Ohio
327	1320	50	WDBK	Cleveland, Ohio
329	1150	500	KWKH	Shreveport, La.
331.1	900	2000	WBZ	Springfield, Mass.
336.9	890	500	KFMX	Northfield, Minn.
336.9	890	1000	KNX	Los Angeles, Cal.
336.9	890	500	WCAL	Northfield, Minn.
336.9	1090	500	WJAS	Pittsburgh, Pa.
336.9	890	1000	WJAX	Jacksonville, Fla.
340.7	880	1000	KFAB	Lincoln, Nebr.
340.7	880	500	KSAC	Manhattan, Kans.
341	880	500	WMCA	New York, N. Y.
344.6	870	5000	WCBD	Zion, Ill.
345	870	5000	WLS	Chicago, Ill.
348.6	860	1000	KOB	State College, N. Mex.
348.6	860	500	KWSC	Pullman, Wash.
348.6	860	500	WEEI	Boston, Mass.
352.7	850	500	WJAD	Waco, Tex.
352.7	850	1000	WWJ	Detroit, Mich.
360	833	100	WQAO	New York, N. Y.
360.1	830	500	WHN	New York, N. Y.
361.2	830	4000	KGO	Oakland, Cal.
365.6	820	500	WDAF	Kansas City, Mo.
365.6	820	500	WHB	Kansas City, Mo.
370	810	2000	WEBH	Chicago, Ill.
370.2	810	500	WJJD	Mooseheart, Ill.
374.8	800	750	KTHS	Hot Springs National Park, Ark.
375	800	500	KVOO	Bristow, Okla.
379.5	790	10000	WGY	Schenectady, N. Y.
379.5	790	500	WHAZ	Troy, N. Y.
384.4	780	1000	KJR	Seattle, Wash.
384.4	780	500	WAAW	Omaha, Neb.
384.4	780	500	WMBF	Miami Beach, Fla.
389.4	770	1000	WEAR	Cleveland, Ohio
389.4	770	1000	WTAM	Cleveland, Ohio
394.5	760	500	WFI	Philadelphia, Pa.
394.5	760	500	WLIT	Philadelphia, Pa.
394.5	760	2000	WOAI	San Antonio, Tex.
399.8	750	500	WHAS	Louisville, Ky.
405	740	500	WOR	Newark, N. J.
405.2	740	500	KHJ	Los Angeles, Cal.
405.2	740	1000	WJY	New York, N. Y.
416.4	720	5000	WCCO	St. Paul-Minneapolis, Minn.
422.3	710	1000	WKRC	Cincinnati, Ohio
422.3	710	5000	WLW	Cincinnati, Ohio
428.3	700	1000	KPO	San Francisco, Cal.
428.3	700	1000	WSB	Atlanta, Ga.
434.5	690	1000	NAA	Arlington, Va.
440.9	680	1000	KLDS	Independence, Mo.
440.9	680	500	WDWF—WLSI	Cranston, R. I.
440.9	680	1000	WMAF	Dartmouth, Mass.
440.9	680	500	WOS	Jefferson City, Mo.
447.5	670	1000	WMAQ	Chicago, Ill.
447.5	670	500	WQJ	Chicago, Ill.
454.3	660	1000	KFOA	Seattle, Wash.
454.3	660	1000	KTW	Seattle, Wash.
455	660	50000	WJZ	New York, N. Y.

Wave Length (Meters)	Frequency (Kilocycles)	Power (Watts)	Call Letters	Location
461.3	650	500	WCAE	Pittsburgh, Pa.
467	640	4000	KFI	Los Angeles, Calif.
468.5	640	1000	WRC	Washington, D. C.
469	640	500	WCAP	Washington, D. C.
475.9	630	1500	WBAP	Fort Worth, Tex.
475.9	630	500	WFAA	Dallas, Tex.
475.9	630	500	WTIC	Hartford, Conn.
483.6	620	5000	WOC	Davenport, Iowa
484	620	500	WSUI	Iowa City, Iowa
491.5	610	500	KGW	Portland, Ore.
491.5	610	5000	WEAF	New York, N. Y.
499.7	600	500	KFRU	Columbia, Mo.
499.7	600	500	WMC	Memphis, Tenn.
508	590	500	KLX	Oakland, Cal.
508.2	590	1000	KFQB	Fort Worth, Tex.
508.2	590	500	WIP	Philadelphia, Pa.
508.2	590	500	WOO	Philadelphia, Pa.
516.9	580	5000	WCX	Pontiac, Mich.
516.9	580	5000	WJR	Detroit, Mich.
526	570	5000	WHO	Des Moines, Iowa
526	570	1000	WNYC	New York, N. Y.
526	570	1000	WOAW	Omaha, Neb.
535.4	560	750	WHA	Madison, Wis.
536	560	2000	KYW	Chicago, Ill.
545.1	550	500	KFUO	St. Louis, Mo.
545.1	550	500	KSD	St. Louis, Mo.

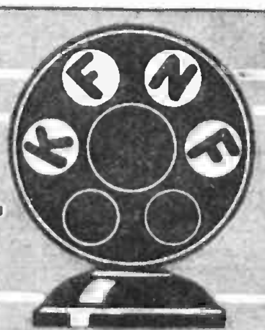
This list has been corrected up to and including April 30, 1926.

One section of 126 Fiddlers who appeared at the station.

The Memorial Pipe Organ—in the station studio of KFNF.

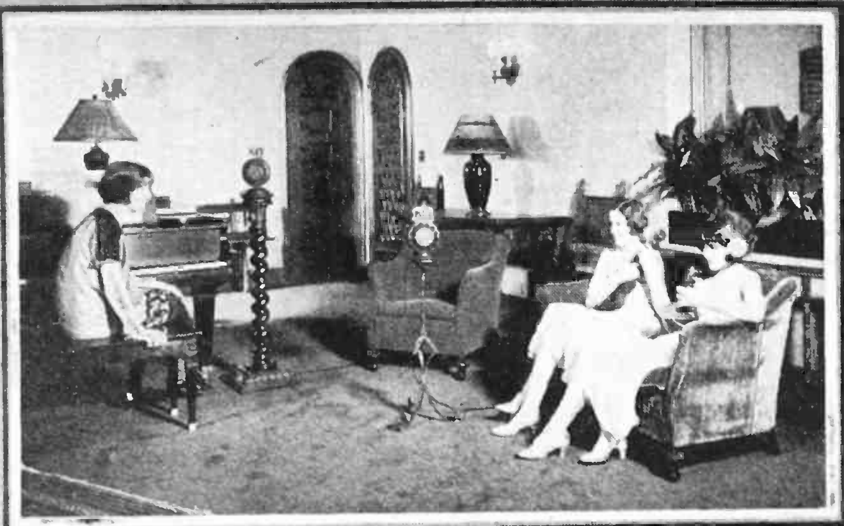
Henry Field, owner of the station and his children.

Henry Field, Announcer of the station.



SHENANDOAH IOWA

A group of contestants who participated in an accordion contest held at this station.



A view of the station studio which shows its artistic arrangement.

Felipe Delgado, Spanish baritone well known in radio and theatres of West.

Virginia Flohn. Famous coloratura soprano. Very popular throughout the country, having sung at many stations as guest artist.

Leslie Adams pianist, a favorite with radio audiences in the West.

The Gunzman Trio. Jean Hayden, Soprano Soloist with Trio.

KFI

LOS ANGELES CAL.

Glen Rice, Chief Announcer of "KFI".

CHICAGO ILL.

Mrs. Pauline Stiffler Atlass, concert violinist.

Miss Corinne Jordan, assistant director and staff ccompanist.

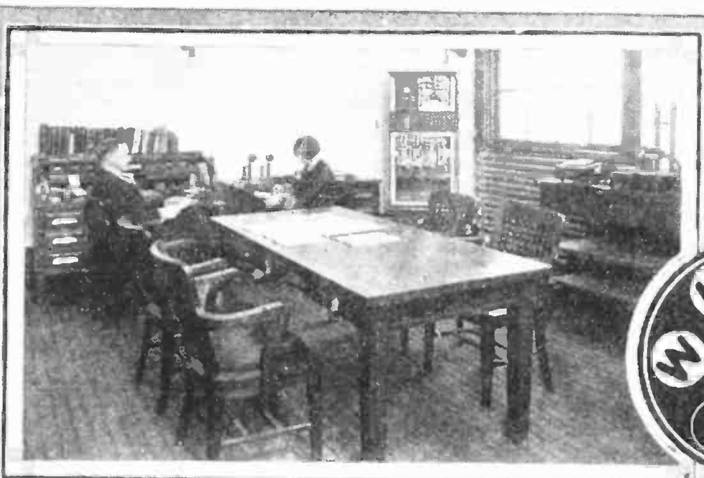
"The Two Jays" is the title by which Fred Jeske and Corinne Jordan are known.

Floyd Falch, announcer.

Miss Vivian Sheaffer, a popular blues singer.

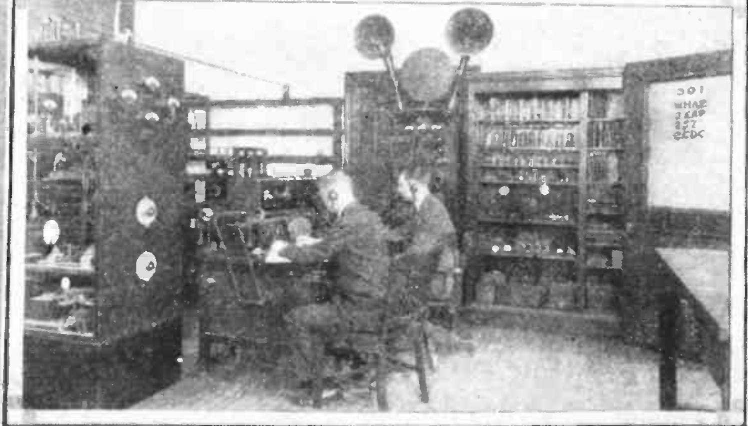
Harold Anderson, a pofessional accordian player.

TROY, N.Y.

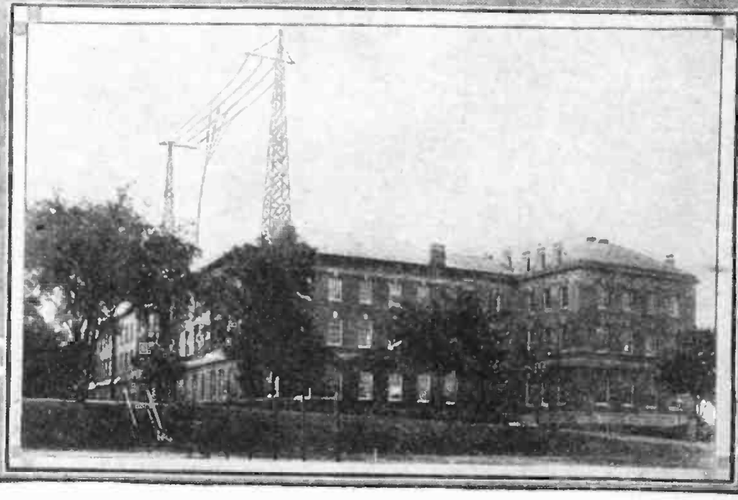


Prof. W. J. Williams, Faculty Manager at Rensselaer Polytechnic Institute Communication Department office.

Students' Symphony Orchestra, Rensselaer Polytechnic Institute, Troy, N. Y.



Broadcast apparatus at Radio Station WHAZ. Chief Operators at the desk during program.



Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., showing antenna of radio station.

RADIO BROADCAST STATIONS OF THE UNITED STATES

By States and Cities

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
ALABAMA	Auburn	WAPI	248	1000
"	Birmingham	WBRC	248	50
"	Montgomery	WIBZ	230.6	10
ARIZONA	Flagstaff	KFXY	205.4	50
"	Phoenix	KFAD	272.6	100
"	Phoenix	KFCB	238	100
ARKANSAS	Fayetteville	KUOA	299.8	750
"	Hot Springs, National Park	KTHS	374.8	750
CALIFORNIA	Alma (Holy City)	KFQU	217.3	100
"	Avalon, Catalina Island	KFWO	211.1	250
"	Berkeley	KRE	256	100
"	Big Bear Lake	KFXB	202.6	500
"	Burlingame	KFOB	226	50
"	Chico	KFWH	254	100
"	Fresno	KMJ	234	50
"	Hollywood	KFQZ	226	50
"	Hollywood	KFWB	252	500
"	Long Beach	KFON	233	500
"	Los Angeles	KFI	467	4000
"	Los Angeles	KFPR	230.6	500
"	Los Angeles	KFSG	275	500
"	Los Angeles	KHJ	405.2	500
"	Los Angeles	KMTR	238	500
"	Los Angeles	KNRC	208	250
"	Los Angeles	KNX	336.9	1000
"	Los Angeles	KTBI	293.9	750
"	Oakland	KFUS	256	50
"	Oakland	KFUU	220	100
"	Oakland	KFWM	207	500
"	Oakland	KGO	361.2	4000
"	Oakland	KLS	250	250
"	Oakland	KLX	508	500
"	Oakland	KTAB	240	1000
"	Oakland	KZM	240	100
"	Oxnard	KFYF	205.4	10
"	Pasadena	KPPC	229	50
"	Pasadena	KPSN	315.6	1000
"	Sacramento	KFBK	248	100
"	San Bernardino	KFWC	211.1	50
"	San Diego	KFBC	215.7	50
"	San Diego	KFVW	246	500
"	San Francisco	KFRC	267.7	50
"	San Francisco	KFWI	226	500
"	San Francisco	KGTT	207	50
"	San Francisco	KJBS	220	5
"	San Francisco	KPO	428.3	1000
"	San Jose	KFAF	217.3	50
"	San Jose	KQW	231	500
"	San Pedro	KFVD	205.4	50
"	Santa Maria	KSMR	209.7	100
"	Stockton	KWG	248	50

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
COLORADO	Colorado Springs	KFUM	239.9	100
"	Colorado Springs	KFXF	250	500
"	Denver	KFEL	254	50
"	Denver	KFUP	234	50
"	Denver	KLZ	266	250
"	Denver	KOA	322.4	5000
"	Edgewater	KFXJ	215.7	10
"	Greeley	KFKA	273	50
"	Gunnison	KFHA	252	50
"	Trinidad	KFBS	238	15
CONNECITCUT	Hartford	WTIC	475.9	500
"	New Haven	WDRC	268	100
"	Storrs	WCAC	275	500
DELAWARE	Wilmington	WHAV	266	50
DIST. OF COLUMBIA	Washington	WCAP	469	500
"	Washington	WMAL	212.6	100
"	Washington	WRC	468.5	1000
"	Washington	WRHF	256	50
FLORIDA	Clearwater	WGHB	266	500
"	Fulford-by-the-Sea	WGBU	278	500
"	Jacksonville	WJAX	336.9	1000
"	Miami	WQAM	263	100
"	Miami Beach	WIOD	247.8	1000
"	Miami Beach	WMBF	384.4	500
"	Pensacola	WCOA	222	500
"	St. Petersburg	WHBN	238	10
"	St. Petersburg	WJBB	254	10
"	Tampa	WDAE	273	250
"	Winter Park	WDBO	240	500
GEORGIA	Atlanta	WDBE	270	100
"	Atlanta	WGST	270	500
"	Atlanta	WSB	428.3	1000
"	Macon	WMAZ	261	500
"	Savannah	WEBZ	263	50
IDAHO	Boise	KFAU	280	750
"	Boise	KFDD	278.6	50
"	Kellogg	KFEY	233	10
ILLINOIS	Batavia	WORD	275	5000
"	Cambridge	WTAP	242	50
"	Carthage	WTAD	236	50
"	Chicago	KYW	536	2000
"	Chicago	WAAF	278	200
"	Chicago	WBBM	225.4	1500
"	Chicago	WBBZ	215.7	50
"	Chicago	WBCN	266	500
"	Chicago	WEBH	370	2000
"	Chicago	WENR	266	1000
"	Chicago	WFKB	217.3	500
"	Chicago	WGES	250	500
"	Chicago	WGN	303	1000
"	Chicago	WHBL	215.7	50
"	Chicago	WHBM	215.7	20
"	Chicago	WHT	238	3500
"	Chicago	WIBJ	215.7	50
"	Chicago	WIBM	215.7	10
"	Chicago	WIBO	226	1000
"	Chicago	WJAZ	322.4	1500

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
ILLINOIS	Chicago	WKBG	215.7	100
"	Chicago	WLIB	303	4000
"	Chicago	WLS	345	5000
"	Chicago	WLTS	258.5	100
"	Chicago	WMAQ	447.5	1000
"	Chicago	WMBB	250	500
"	Chicago	WOK	217.3	5000
"	Chicago	WPCC	258	500
"	Chicago	WQJ	447.5	500
"	Chicago	WSAX	268	100
"	Chicago	WSBC	210	1000
"	Decatur	WBAO	270	100
"	Decatur	WJBL	270	500
"	Evanston	WEHS	202.6	10
"	Galesburg	WFBZ	254	20
"	Galesburg	WRAM	243.8	100
"	Harrisburg	WEBQ	225.4	10
"	Joliet	WCLS	214.2	150
"	Joliet	WJBA	206.8	50
"	Joliet	WKBB	214.2	100
"	La Salle	WJBC	234.2	100
"	Mooseheart	WJJD	370.2	500
"	Plainfield	WWAE	242.2	500
"	Rockford	KFLV	229	100
"	Rock Island	WHBF	222	100
"	Streator	WTAX	231	50
"	Tuscola	WDZ	278	100
"	Urbana	WRM	273	500
"	Wooddale	WSWS	275	1000
"	Zion	WCBD	344.6	5000
INDIANA	Anderson	WEBD	246	15
"	Anderson	WHBU	218.8	10
"	Culver	WHBH	222	100
"	Evansville	WGBF	236	500
"	Fort Wayne	WHBJ	234	50
"	Fort Wayne	WOWO	227	500
"	Indianapolis	WFBM	268	250
"	Kokomo	WJAK	254	50
"	Laport	WRAF	223.8	100
"	Logansport	WIBW	220	100
"	Seymour	WFBE	226	10
"	South Bend	WSBT	275	250
"	Valparaiso	WRBC	278	500
"	West Lafayette	WBAA	273	250
IOWA	Ames	WOI	270	750
"	Anita	KFLZ	273	100
"	Boone	KFGQ	226	10
"	Burlington	WIAS	254	100
"	Cedar Rapids	KWCR	278	500
"	Cedar Rapids	WJAM	268	100
"	Clarinda	KSO	242	500
"	Council Bluffs	KOIL	278	500
"	Davenport	WOC	483.6	5000
"	Des Moines	WHO	526	5000
"	Fort Dodge	KFJY	246	50
"	Iowa City	KFQP	223.7	10
"	Iowa City	WSUI	484	500

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
IOWA	Le Mars	KWUC	252	50
"	Marshalltown	KFJB	248	10
"	Muscatine	KTNT	256	500
"	Oskaloosa	KFHL	240	10
"	Shenandoah	KFNF	263	1000
"	Shenandoah	KMA	252	500
"	Sioux City	KFMR	261	100
"	Sioux City	WEAU	275	100
KANSAS	Independence	KFVG	236	15
"	Junction City	KFJC	218.8	10
"	Lawrence	KFKU	275	500
"	Manhattan	KSAC	340.7	500
"	Wichita	KFH	268	500
"	Wichita	KFOT	231	50
KENTUCKY	Louisville	WHAS	399.8	500
"	Louisville	WLAP	275	20
LOUISIANA	New Orleans	WABZ	275	50
"	New Orleans	WBBS	252	50
"	New Orleans	WCBE	263	5
"	New Orleans	WJBO	268	100
"	New Orleans	WOWL	270	10
"	New Orleans	WSMB	319	500
"	New Orleans	WWL	275	100
"	Pineville	KFWU	238	100
"	Shreveport	KFDX	250	100
"	Shreveport	KWKH	329	1000
MAINE	Bangor	WABI	240	100
"	Orono	WGBX	234.2	500
"	Portland	WCSH	256.3	500
MARYLAND	Baltimore	WBAL	246	5000
"	Baltimore	WCAO	275	100
"	Baltimore	WCBM	229	50
"	Baltimore	WFBR	254	100
"	Tokoma Park	WBES	222	100
MASSACHUSETTS	Boston	WATT	243.8	100
"	Boston	WBZA	242	250
"	Boston	WEEI	348.6	500
"	Boston	WNAB	250	100
"	Boston	WNAC	280.2	500
"	Boston	WSSH	261	100
"	Dartmouth	WMAF	440.9	1000
"	Fall River	WSAR	254	100
"	Fall River	WTAB	266	100
"	Medford Hillside	WARC	261	100
"	New Bedford	WIBH	209.7	30
"	New Bedford	WNBH	248	250
"	Springfield	WBZ	331.1	2000
"	Taunton	WAIT	229	10
"	Webster	WKBE	231	100
"	Worcester	WTAG	268	500
MICHIGAN	Bay City	WSKC	261	100
"	Berrien Springs	WEMC	286	500
"	Dearborn	WWI	266	500
"	Detroit	WGHP	270	1500
"	Detroit	WJR	516.9	5000
"	Detroit	WMBC	256.4	100

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
MICHIGAN	Detroit	WWJ	352.7	1000
"	East Lansing	WKAR	285.5	1000
"	Escanaba	WRAK	256.3	100
"	Flint	WFDF	234	100
"	Grand Rapids	WBDC	256.4	500
"	Grand Rapids	WOOD	242	1000
"	Houghton	KFMW	263	50
"	Houghton	WWAO	263	250
"	Lansing	WREO	285.5	500
"	Mount Clemens	WABX	246	500
"	Owosso	WSMH	240	20
"	Petoskey	WBBP	238	200
"	Pontiac	WCX	516.9	5000
"	Port Huron	WAFD	275	500
"	Royal Oak	WAGM	225.4	50
"	Ypsilanti	WJBK	233	10
MINNESOTA	Collegeville	WFBJ	236	100
"	Fairmont	KFVN	227	50
"	Minneapolis	KFDZ	231	10
"	Minneapolis	WAMD	243.8	1000
"	Minneapolis	WDGY	263	500
"	Minneapolis	WHDI	278	500
"	Minneapolis	WLB	277.6	500
"	Minneapolis	WRHM	252	50
"	Northfield	KFMX	336.9	500
"	Northfield	WCAL	336.9	500
"	St. Cloud	WFAM	273	10
"	St. Paul	KFOY	252	50
"	St. Paul-Minneapolis	WCCO	416.4	5000
MISSISSIPPI	Coldwater	WREC	254	10
"	Oxford (near)	WCBH	242	50
MISSOURI	Cape Girardeau	KFVS	224	50
"	Carterville	KFPW	258	20
"	Columbia	KFRU	499.7	500
"	Independence	KLDS	440.9	1000
"	Jefferson City	WOS	440.9	500
"	Kansas City	KWKC	236	100
"	Kansas City	WDAF	365.6	500
"	Kansas City	WHB	365.6	500
"	Kansas City	WOQ	278	1000
"	Kirksville	KFKZ	226	10
"	Moberly	KFFP	242	50
"	St. Louis	KFQA	280.2	5000
"	St. Louis	KFUO	545.1	500
"	St. Louis	KFVE	240	500
"	St. Louis	KFWF	214.2	250
"	St. Louis	KMOX	280.2	1500
"	St. Louis	KSD	545.1	500
"	St. Louis	WEW	248	1000
"	St. Louis	WIL	273	250
"	St. Louis	WMAY	248	100
"	St. Louis	WSBF	273	250
MONTANA	Havre	KFBB	275	50
"	Missoula	KUOM	244	500
NEBRASKA	Clay Center	KMMJ	229	1000
"	David City	KFOR	226	100
"	Hastings	KFKX	288.3	5000

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
NEBRASKA	Lincoln	KFAB	340.7	1000
"	Lincoln	WFAV	275	500
"	Norfolk	WJAG	270	250
"	Oak	KFEQ	268	500
"	Omaha	KFOX	248	100
"	Omaha	KOCH	258	250
"	Omaha	WAAW	384.4	500
"	Omaha	WNAL	258	50
"	Omaha	WOAW	526	1000
"	University City	WCAJ	254	500
NEW HAMPSHIRE	Laconia	WKAV	224	50
NEW JERSEY	Atlantic City	WHAR	275	500
"	Atlantic City	WPG	299.8	500
"	Camden	WFBI	236	250
"	Elizabeth	WIBS	202.6	10
"	Gloucester City	WRAX	268	500
"	Lambertville	WTAZ	261	15
"	Newark	WGCP	252	500
"	Newark	WNJ	252	150
"	Newark	WOR	405.4	500
"	North Plainfield	WEAM	261	250
"	Paterson	WODA	224	250
"	Red Bank	WJBI	218.8	250
"	Trenton	WOAX	240	500
NEW MEXICO	Albuquerque	KFLR	254	100
"	Albuquerque	KFVY	250	10
"	State College	KOB	348.6	1000
NEW YORK	Bay Shore	WRST	215.7	250
"	Brooklyn	WFRL	205.4	100
"	Buffalo	WEBR	244	100
"	Buffalo	WGR	319	750
"	Buffalo	WPDQ	205.4	50
"	Buffalo	WSVS	219	50
"	Canton	WCAD	263	250
"	Cazenovia	WMAC	275	100
"	Flushing	WIBI	218.8	50
"	Freeport	WGBB	244	100
"	Ithaca	WEAI	254	500
"	Jamestown	WOCL	275.2	15
"	Kingston	WDBZ	233	10
"	Lockport	WMAK	266	500
"	New York	WBNY	209.7	500
"	New York	WEAF	491.5	5000
"	New York	WEBJ	272.6	500
"	New York	WFBH	272.6	500
"	New York	WGBS	315.6	500
"	New York	WHAP	240	500
"	New York	WHN	360.1	500
"	New York	WJY	405.2	1000
"	New York	WJZ	455	50000
"	New York	WLWL	288	3500
"	New York	WMCA	341	500
"	New York	WMSG	212.6	500
"	New York	WNYC	526	1000
"	New York	WOKO	233	50
"	New York	WQAO	360	100
"	New York	WRNY	258.5	500

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
NEW YORK	New York	WSDA	263	250
"	Richmond Hill	WAHG	315.6	500
"	Richmond Hill	WBOQ	236	100
"	Richmond Hill	WGMU	236	100
"	Richmond Hill	WRMU	236	100
"	Rochester	WABO	253	100
"	Rochester	WHAM	278	100
"	Rochester	WHEC	258	100
"	Rossville	WBBR	272.6	500
"	Schenectady	WGY	379.5	10000
"	Syracuse	WFBL	252	100
"	Tarrytown	WRW	273	500
"	Troy	WHAZ	379.5	500
"	Utica	WIBX	205.4	150
NORTH CAROLINA	Asheville	WABC	254	20
"	Charlotte	WBT	225	250
"	Greensboro	WNRC	224	10
"	Raleigh	WRCO	252	100
NORTH DAKOTA	Bismark	KFYR	248	10
"	Devils Lake	KDLR	231	5
"	Fargo	WDAY	261	50
"	Fargo	WPAK	275	100
"	Grand Forks	KFJM	278	100
OHIO	Akron	WADC	258	500
"	Bellefontaine	WHBD	222	20
"	Cambridge	WEBE	234	10
"	Canton	WHBC	254	10
"	Cincinnati	WAAD	258	25
"	Cincinnati	WKRC	325.9–422.3	1000
"	Cincinnati	WLW	422.3	5000
"	Cincinnati	WSAI	325.9	5000
"	Cleveland	WDBK	327	50
"	Cleveland	WEAR	389.4	1000
"	Cleveland	WHK	272.6	1000
"	Cleveland	WTAM	389.4	1000
"	Columbus	WAIU	293.9	500
"	Columbus	WEAO	293.9	500
"	Columbus	WMAN	286	50
"	Dayton	WSMK	275	500
"	Hamilton	WRK	270	100
"	Hamilton	WSRO	252	100
"	Pomeroy	WSAZ	244	50
"	Springfield	WCSO	248	100
"	Toledo	WABR	263	50
"	Toledo	WTAL	252	10
"	Wooster	WABW	20[illegible].8	50
"	Yellow Springs	WRAV	263	100
OKLAHOMA	Bristow	KVOO	375	500
"	Chickasha	KOCW	252	200
"	Norman	WNAD	254	500
"	Oklahoma	KFJF	261	500
"	Oklahoma	KFXR	214.2	15
"	Oklahoma	WKY	275	100
"	Tulsa	WLAL	250	100
OREGON	Astoria	KFJI	246	10
"	Corvallis	KOAC	280.2	500
"	Portland	KFEC	248	50

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
OREGON	Portland	KFIF	248	100
"	Portland	KFJR	263	50
"	Portland	KFWV	212.6	50
"	Portland	KGW	491.5	500
"	Portland	KQP	319	1000
"	Portland	KTBR	263	50
PENNSYLVANIA	Allentown	WCBA	254	200
"	Allentown	WSAN	229	100
"	Altoona	WFBG	277.8	100
"	Elkins Park	WIBG	222	50
"	Grove City	WSAJ	229	250
"	Harrisburg	WABB	204	10
"	Harrisburg	WBAK	275	500
"	Harrisburg	WHBG	231.6	20
"	Harrisburg	WPRC	215.6	100
"	Haverford	WABQ	261	100–1000
"	Johnstown	WHBP	256	100
"	Lancaster	WGAL	248	10
"	Lewisburg	WJBU	211.1	100
"	Oil City	WHBA	250	10
"	Parkersburg	WQAA	220	500
"	Philadelphia	WABY	242	50
"	Phiadelphia	WCAU	276.6	500
"	Philadelphia	WFBD	234	5
"	Philadelphia	WFI	394.5	500
"	Philadelphia	WHBW	216	100
"	Philadelphia	WIAD	250	100
"	Philadelphia	WIP	508.2	500
"	Philadelphia	WLIT	394.5	500
"	Philadelphia	WNAT	250	100
"	Philadelphia	WOO	508.2	500
"	Philadelphia	WWAD	250	250
"	Pittsburgh	KDKA	309.1	Var.
"	Pittsburgh	KQV	275	500
"	Pittsburgh	WCAE	461.3	500
"	Pittsburgh	WJAS	336.9	500
"	Reading	WRAW	238	10
"	Scranton	WGBI	240	10
"	Scranton	WQAN	250	100
"	State College	WPSC	261	500
"	Wilkes-Barre	WBAX	256	100
"	Wilkes-Barre	WBRE	231	100
RHODE ISLAND	Cranston	WDWF	440.9	500
"	Providence	WCBR	209.7	100
"	Providence	WCWS	209.7	100
"	Providence	WEAN	270	500
"	Providence	WGBM	234	30
"	Providence	WJAR	305.9	500
SOUTH CAROLINA	Charleston	WBBY	267.9	10
SOUTH DAKOTA	Brookings	KFDY	273	100
"	Rapid City	WCAT	240	50
"	Vermillion	KUSD	278	100
"	Yankton	WNAX	244	100
TENNESSEE	Chattanooga	WDOD	256	500
"	Knoxville	WFBC	250	50
"	Knoxville	WNOX	268	100
"	Lawrenceburg	WOAN	282.8	500

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
TENNESSEE	Memphis	WGBC	278	10
"	Memphis	WHBQ	233	50
"	Memphis	WMC	499.7	500
"	Nashville	WCBQ	242	100
"	Nashville	WDAD	226	150
"	Nashville	WSM	282.8	1000
TEXAS	Amarillo	WDAG	263	100
"	Amarillo	WQAC	234	100
"	Austin	KUT	231	500
"	Beaumont	KFDM	315.6	500
"	Beeville	KFRB	248	250
"	Brownsville	KWWG	278	500
"	College Station	WTAW	270	500
"	Dallas	WFAA	475.9	500
"	Dallas	WRR	246	500
"	Dublin	KFPL	252	15
"	El Paso	KFXH	242	50
"	El Paso	WDAH	267.7	50
"	Fort Worth	KFJZ	254	50
"	Fort Worth	KFQB	508.2	1000
"	Fort Worth	WBAP	475.9	1500
"	Galveston	KFLX	240	10
"	Galveston	KFUL	258	50
"	Greenville	KFPM	242	10
"	Houston	KFVI	240	10
"	Houston	KFYJ	238	10
"	Houston	KPRC	296.9	500
"	San Antonio	WCAR	263	500
"	San Antonio	WOAI	394.5	2000
"	San Benito	KFLU	236	20
"	Texarkana	KFYO	209.7	10
"	Waco	WJAD	352.7	500
UTAH	Logan	KFXD	205.4	10
"	Ogden	KFUR	224	50
"	Ogden	KFWA	261	500
"	Salt Lake City	KDYL	246	50
"	Salt Lake City	KFOO	236	250
"	Salt Lake City	KFUT	261	100
"	Salt Lake City	KSL	299.8	1000
U. S.	Portable	WEBL	226	100
VERMONT	Burlington	WCAX	252	100
"	Springfield	WQAE	246	50
VIRGINIA	Arlington	NAA	434.5	1000
"	Norfolk	WBBW	222	50
"	Norfolk	WTAR	261	100
"	Richmond	WBBL	229	50
"	Richmond	WRVA	256	1000
"	Roanoke	WDBJ	229	50
WASHINGTON	Everett	KFBL	224	100
"	Lacey	KGY	246	50
"	North Bend	KFQW	215.7	50
"	Olympia	KFRW	218.8	50
"	Pullman	KWSC	348.6	500
"	Seattle	KFOA	454.3	1000
"	Seattle	KJR	384.4	1000
"	Seattle	KTCL	305.9	1000
"	Seattle	KTW	454.3	1000

States	Cities	Call Letters	Wave Length (Meters)	Power Watts
WASHINGTON	Spokane	KFIO	265.3	100
"	Spokane	KFPY	266	100
"	Spokane	KHQ	273	500
"	Tacoma	KMO	250	250
"	Walla Walla	KOWW	256	500
"	Yakima	KFIQ	256	100
WEST VIRGINIA	Weirton	WIBR	246	50
WISCONSIN	Beloit	WEBW	268	500
"	Camp Lake	WCLO	230.6	50
"	Eau Claire	WTAQ	254	100
"	Fondulac	KFIZ	273	100
"	Madison	WHA	535.4	750
"	Madison	WIBA	236.1	100
"	Marshfield	WGBR	229	10
"	Milwaukee	WHAD	275	500
"	Milwaukee	WKAF	261	500 - 5000
"	Milwaukee	WSOE	246	500
"	Omro	WJBR	227.1	50
"	Poynette	WIBU	222	20
"	Stevens Point	WLBL	278	500
"	Superior	WEBC	242	100
"	West De Pere	WHBY	250	50
WYOMING	Laramie	KFBU	270	500

This list has been corrected up to and including April 30, 1926.

Loftis Quartette, one of the finest mixed quartettes in the city of Chicago.

WHT CHICAGO, ILL.

"Tiger" Bowles head of Bowles Live Stock Commission broadcasting up-to-the-minute reports on live stock from the stockyards—WHT.

Paul Rader, official chaplain of WHT, he is one of the first in the field of radio evangelism.

U. S. L. Quartette. Although they have not teamed together a year, they have reached national fame for their classical program which they present Thursday evenings.

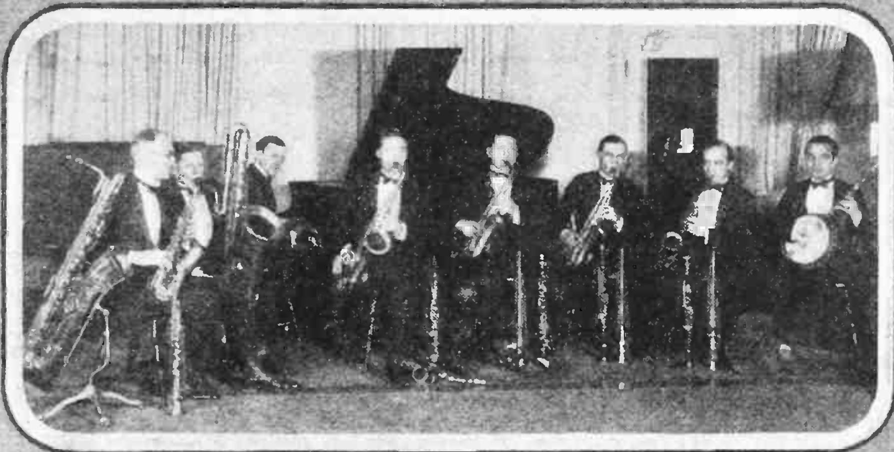
Jean Sargent, who conducts the women's program every morning from 10 to 1 o'clock.

"Silver Masked Tenor" who is heard with the "Silvertown Cord Orchestra" every Thursday evening from 10 to 11.

Guiseppe di Benedetto, tenor of the WEAF Grand Opera Company heard, every Monday evening from 10 to 11.

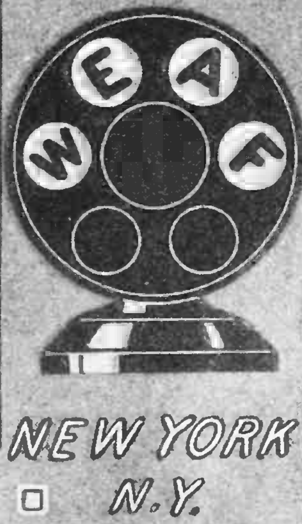
"Clicquot Club Eskimos," under the direction of Harry Reser, heard every Thursday evening from 9 to 10.

"Davis Saxophone Octette," under the direction of Clyde Doerr, heard every Wednesday evening from 8:30 to 9.



Gena Zielinska, coloratura soprano of the WEAF Grand Opera Company.

"The Larkinites" who are heard in a musical program through WEAF and chain of stations every Thursday evening from 8 to 8:30.

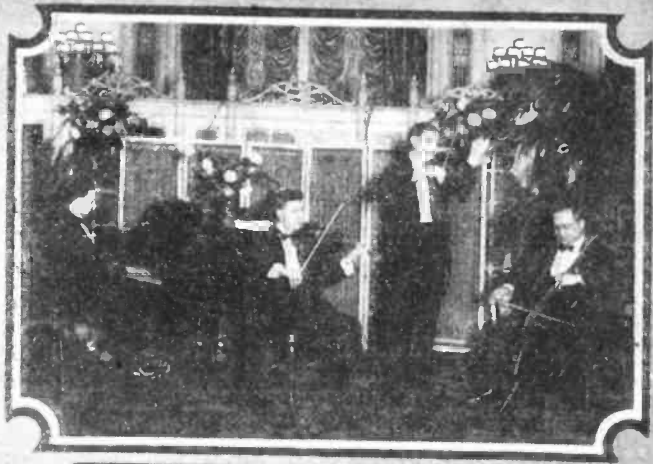


"The Happiness Candy Boys," Billy Jones and Ernest Hare, who entertain every Friday evening from 8 to 8:30.

"Goldy and Dusty," popular artists of WEAF, also known as the Gold Dust Twins. Goldy is the tenor half of the Gold Dust Twins and Dusty the baritone.

"Silvertown Cord Orchestra," under the musical direction of Joseph Knecht, broadcasts every Thursday evening from 10 to 11.

Miss Eulalie Kober Stade, accompanist and pianist.



Joska DeBabary and his Continental Orchestra.

Mrs. Anna J. Peterson broadcasts daily TABLE TALKS.

Miss Florence Pauley, soprano; Miss Eulalie Kober Stade, Accompanist; Harold H. Isbell, Announcer.

Rev. Claude J. Pernin, S. J., broadcasts every Thursday at 8 P.M.

KYW

CHICAGO, ILL.

Miss Vivette Gorman, assists Mrs. A. J. Peterson in her daily TABLE TALKS.

Candace Holmes, popular soprano.

WBZ

SPRINGFIELD, MASS.

Mrs. Thornton W. Burgess who, in the absence of her husband, conducts the WBZ Radio Nature League.

John D. Kuhns, Announcer.

Anne Louise Lawless, the station hostess.

Bill Boyle and his Copley Plaza Orchestra.

Samuel Seiniger, Boston Symphony Orchestra violinist

Capt. Donald MacMillan, Arctic Explorer, at Microphone of WGY.

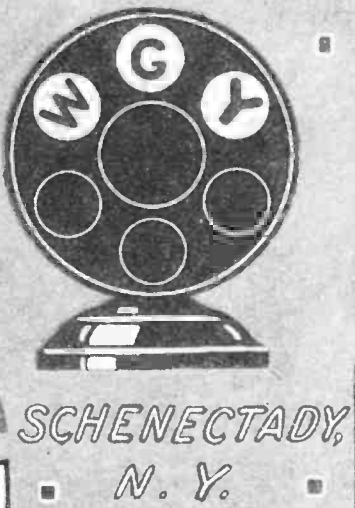
Eugene Goossens, conductor of the Rochester Philharmonic Symphony Orchestra.

Jessie B. Lane, who gives home economic talks on afternoon programs.

William L. Widdemer who is giving series of "Literary Appreciations" talks.

Prof. Martha Van Rensselaer, director of the N. Y. State College of Home Economics, Cornell University.

C. W. Woodall, the radio doctor, who gives weekly health talks.



Caryl Marshall, Soprano soloist.

Rose Mountain, contralto soloist.

Leon A. Huguemont, native of France, gives weekly lesson in French.

Edward A. Rice, Violin soloist.

Peter E. Potts Orchestra heard weekly from WGY.

The control room and transmitter of the station.

WGHB

CLEARWATER FLORIDA

Miss Caroline Lee "The Virginia Girl" and her Spanish guitar.

The Station studio with Miss Caroline Lee at the piano and Walter Tison chief announcer at the microphone.

Mr. John D. Thomas, Baritone, Program Director and Conductor of the Zion Choir.

Mrs. John D. Thomas, Soprano.

WCBD

ZION CITY, ILL

Miss Florence Farrar, Contralto.

Mr. J. H. DePew, Chief Announcer and Manager.

Mr. Richard F. Hire, Violinist and Pianist.

Mr. Glen R. Sparrow, Tenor.

Canadian Radio Broadcast Stations

Indexed Alphabetically by Call Letters

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
CF	CFAC—**Calgary, Alberta**—The Calgary Herald	500	435	690	Mountain	Mon., 1 pm to 9 pm; Tue., 1 pm to 8 pm; Wed., 1 pm; 5 pm to 8 pm; Thu., 1 pm; 7 pm to 9 pm (under call CNRC); Fri., 1 pm to 7 pm; Sat., 12 am to 1 pm; Silent; Sun.: 11 am to 7:30 pm alternating.
	CFCA—**Toronto, Ont.**—Star Publishing & Printing Co., 18 King St. W.	500	356.9	840	Eastern	Daily except Sun.: 12 am to 1 pm; 5 to 6:30 pm; Mon., 6:30 to 8 pm; Wed., 6:30 pm to 2 am; alternate Thu. and Sat., 8 pm to 2 am; alternate Thu., 7 to 9 pm; alternate Sat., 8 to 9 pm. Sun.: 10 am to 1 pm; 6 to 9 pm.
	CFCF—**Montreal, Que.**—Canadian Marconi Co. (Ltd.), Canada Cement Bldg.	1650	410.7	730	Eastern	Daily except Sun.: 12:40 to 1 pm; Tue. and Sat., 4:45 to 5:45 pm (except in June. July and August); Mon. and Fri., 7 to 11:30 pm.
	CFCH—**Iroquois Falls, Ont.**—Abitibi Power & Paper Co., Ltd.	250	499.7	600	Eastern	Mon., Thu. and Sat., 6:30 to 7 pm; Tue., Fri., 7 to 8 pm; Wed., 7:15 to 7:45 pm; Thu., 7 to 7:30 pm; Sat., 12 pm to 1 am.
	CFCK—**Edmonton, Alberta**—Radio Supply Co., Ltd., 10,229 101st St.	100	516.9	5[illegible]0	Mountain	Daily except Sun.: 4 to 5 pm; 9 to 11:30 pm.
	CFCN—**Calgary, Alberta**—W. W. Grant Radio (Ltd.), 708 Crescent Rd., N. W.	1800	434.5	690	Mountain	Daily except Sun.: 8:45 to 9 pm; Tue. and Wed., 9 to 10 pm; Thu., 8 to 9; Tue., 11:30 to 1 pm to am; Fri., 10 to 1 pm to am.
	CFCQ—**Vancouver, B. C.**—Sprott-Shaw Radio Co., 153 Pender St., W.	5	410.7	730	Pacific	Daily except Sun.: 7:30 to 8:30 pm.
	CFCT—**Victoria, B. C.**—G. W. Deaville	500	329.5	910	Pacific	Mon., Silent; Tue., Silent; Wed., 8 pm; Thu., 10:30 pm alternating; Fri., 8 pm; Sat., 10 pm; Sun.: 11 am and 7:30 pm; 9 pm.
	CFCU—**Hamilton, Ont.**—Jack V. Elliott (Ltd.), 123 King St., W.	500	340.7	880	Eastern	
	CFCY—**Charlottetown, P. E. Island**—Island Radio Co.	50-100	312.4	960	Atlantic	Wed. and Thu., 7:30 to 9:30 pm; Sun.: 11 am and 7 pm.
	CFDC—**Vancouver, B. C.**—Arthur Holstead & Wm. Hanlon	10	410.7	730	Pacific	Daily except Sun.: 6 to 7 pm; Mon. and Wed., 9:30 to 11:30 pm; Thu., 10:30 to 11:30 pm. Sun.: 10 to 12 pm.
	CFGC—**Brantford, Ont.**—White Bros., Bakery, Colborne St.	50	296.9	1010	Eastern	
	CFKC—**Thorold, Ont.**—D. J. Fendell, Patricia Theatre Bldg.	75	247.8	1210	Eastern	Mon., 3 to 4 pm; 5:30 to 6 pm; Tue., Thu., 5 to 6 pm; Wed., Fri. and Sat., 5:30 to 6:30 pm; Tue., 8:30 to 10 pm; Sat., 8:30 to 10:30 pm. Sun.: 11 am to 12:30 pm; 7 to 8:30 pm; 1:30 to 3 pm; 9 pm to 10 pm.
	CFMC—**Kingston, Ont.**—Monarch Battery Co., 290-2 Princess St.	20	267.7	1120	Eastern	
	CFQC—**Saskatoon, Sask.**—The Electric Shop, Ltd., 144 2nd Ave. N.	500	329.5	910	Mountain	Daily: 9 to 10; 1 to 2; Wed., 8 to 10 pm; Fri., 9 to 12 pm; Sun.: 11 to 12; 7 to 8:30.
	CFRC—**Kingston, Ont.**—Queens University, Dept. of Electrical Engineering	500	267.7	1120	Eastern	
	CFXC—**New Westminster, B. C.**—Westminster Trust Co., Columbia & Begbie Sts.	20	291.1	1030	Pacific	Mon., Wed. and Fri., 7:30 to 8:30 pm.
	CFYC—**Vancouver, B. C.**—Commercial Radio Ltd., Royal Oak Ave., Municipality of Burnaby	500	410.7	730	Pacific	Daily except Sun.: 12 to 1:30 pm; 2:30 to 3:30 pm. Daily except Sun. and Wed.: 4:30 to 5:30 pm. Daily except Sun. and Mon.: 6:30 to 7:30; Mon., 6:30 to 8:30; 9:30 to 11:30; Thu., Sat., 7:30 to 8:30; Sat., 10:30 to 11:30. Sun.: 7 to 7:30 pm; 9 to 10 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
CH	**CHCS**—**Hamilton, Ont.**—The Hamilton Spectator	10	340.7	880	Eastern	
	CHIC—**Toronto, Ontario**—Northern Electric Co., Ltd. (Uses station CHNC.)	500	356.9	840	Eastern	Mon., 8 to 9 pm; Sat., 10:30 to 11:30 am; 10:00 to 12 pm; Sun.: 5 to 6 pm.
	CHNC—**Toronto, Ont.**—Toronto Radio Research Soc., 46 Lauder Ave	500	356.9	840	Eastern	No regular schedule.
	CHSC—**Unity, Sask.**—Horace N. Stovin, Main St	250	356.9	840	Mountain	Daily except Sun.: 5 to 6:30; Mon., Thu. and Fri., 4:30 to 5 pm; Tue., 10:45 to 11 am; 8:30 to 10 pm; Thu., 9 to 12. Sun.: 7:30 to 8:45 pm; 4:30 to 5 pm; 9 to 10:30 pm.
	CHUC—**Saskatoon, Sask.**—The International Bible Students Assoc., Cor. Main and 2nd Sts	50	329.5	910	Mountain	Tue. and Thu., 8 to 9:30 pm. Sun.: 1 to 2 pm; 7 to 9:30 pm.
	CHWC—**Regina, Sask.**—R. H. Williams & Sons, Ltd.	15	296.9	1010	Mountain	
	CHXC—**Ottawa, Ont.**—J. R. Booth, Jr., 28 Range Rd	250	434.5	690	Eastern	Fri., 8:30 to 10 pm. Sun.: 2 to 3 pm.
	CHYC—**Montreal, Que.**—Northern Electric Co., Ltd., 121 Shearer St	850	410.7	730	Eastern	Wed., 7 to 12:30 pm; Sun.: 11 to 12 am; 7 to 11 pm.
CJ	**CJBC**—**Toronto, Ont.**—Jarvis St. Baptist Church (Uses one or other of stations in Toronto and district.)	—	356.9	840	Eastern	
	CJCA—**Edmonton, Alberta**—The Edmonton Journal, Ltd., Journal Bldg	500	516.9	580	Mountain	Daily except Sun.: 12:30 pm; Mon., 7:30 to 8 pm; 8:30 to 10 pm; Tue., 7:30 to 8 pm; Wed., 8:45 to 9 pm; 9 to 12 pm; mid to 1; Thu., 6 to 8 pm; Fri., 7:30 to 8 pm; 8:30 to 10:30 pm; Sat., 7:30 to 8 pm; 10 to 12 pm; mid. to 1; Sun.: 7:30 to 9 pm.
	CJCD—**Toronto, Ont.**—The T. Eaton Co., Ltd., Queen St. W., Broadcasting Temporarily Suspended.	50	356.9	840	Eastern	
	CJCF—**Kitchener, Ont.**—News Record, Ltd. (Operation suspended for an indefinite period)	50	—	—	Eastern	
	CJCL—**Montreal, Que.**—A. Couture, 4472 St. Denis St.	35	270.5	—	Eastern	Tue., 5 to 6:55 pm; Thu., 5 to 6:55 pm; Sat., 1:30 to 6:55 pm; 11:30 pm to 1:30 am; Sun.: 1:30 to 4:25 pm.
	CJGC—**London, Ont.**—London Free Press Printing Co., 440 Richmond St	50	329.5	910	Eastern	Daily except Sun. and Mon.: 1 to 2 pm; 7 to 9 pm. Sun.: 11 am and 7 pm. Alternate Sun.: 2:30 to 3:30 pm.
	CJKC—**Vancouver, B. C.**—Pyramid Temple Society (Uses station CFYC Vancouver, B. C.)	500	410.7	730	Pacific	Alternate Sun.: 2:45 to 4:15 pm; 7:30 to 9 pm.
	CJSC—**Toronto, Ont.**—The Evening Telegram. (Uses station CKCL, the Dominion Battery Co., 20 Trinity St., Toronto, Ont.)	500	356.9	840	Eastern	No regular program schedule.
	CJWC—**Saskatoon, Sask.**—The Wheaton Electric Co., Ltd., 236 2nd Ave. S	250	329.5	910	Mountain	Mon., 12 to 1; 8 to 10 pm; Tue. and Thu., 12 to 1; 5 to 6; 6 to 7 pm; Sun.: 3:45 to 5 pm.
	CJYC—**Scarboro Station, Ont.**—Universal Radio of Canada, Ltd	500	291.1	1030	Eastern	
CK	**CKAC**—**Montreal, Que.**—La Presse Publishing Co., Ltd., Cor. St. James St. & St. Lawrence Blvd.	1200	410.7	730	Eastern	Daily except Sat.: 4 pm 4:30 pm; Mon., Wed. and Fri., 1:45; 4:30 pm; Tue., Thu. and Sat., 7; 7:30; 8:30; 10:30 pm. Midnight Frolics, first and third Thu. of each month, at 11:30 pm; Sun., 2:45 pm.
	CKCD—**Vancouver, B. C.**—Vancouver Daily Province, 142 Hastings St. W	1000	410.7	730	Pacific	Wed. and Sat., 8:30 to 9:30 pm; Tues. and Fri., 8:30 to 8:50 pm; Mon., 8 to 9 pm; Thu., 8:30 to 10:30 pm.
	CKCK—**Regina, Sask.**—Leader Publishing Co., Ltd. (Operating temporarily on 475.9 meters 630 K/C)	500	312.3	960	Mountain	Daily except Sun.: 9:45 to 10:30 am; 1 to 2 pm; Tue., 7:30 to 8:15 pm. Sun.: 9 to 10 pm.

Radio Call Letters	BROADCAST STATIONS Location and Owner	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Sending Hours
CK						
CKCL	**Toronto, Ont.**—Dominion Battery Co., Ltd., Toronto & Wireless Dry Cells Co.	500	356.9	840	Eastern	Daily except Sat.: 10:30 to 11:30 am; 3 to 4:30 pm; Mon., Wed. and Fri., 7 to 8 am; Tue., 7 to 12 pm; alternate Thu., 7 to 8; Sat., 7 to 8 pm; Sun.: 3 to 4:55 pm.
CKCO	**Ottawa, Ont.**—Dr. G. M. Geldert, 282 Somerset St. W.	100	434.5	690	Eastern	Tue., 7 to 10 pm. Sun.: 7 to 10 pm.
CKCW	**Burlington Jct., Durham Co., Ont.**—Canadian Broadcasting Corp.	5000	329.5	910	Eastern	
CKFC	**Vancouver, B. C.**—First Congregational Church	50	410.7	730	Pacific	Sun.: 11 am to 1 pm; 3 pm to 5:30 pm; Alternate Sun.: 7:30 to 9 pm.
CKNC	**Toronto, Ont.**—Canadian National Carbon Co.	750	357	840	Eastern	Mon., 8; 9 to 11 pm (alternate); Sat., 4; 8 pm.
CKOC	**Hamilton, Ont.**—H. Slack, Wentworth Radio Supply Co., Ltd., 31 John St. N.	50	341.1	880	Eastern	Mon., 6:15 to 7:15 pm; Thu., 5 to 6 pm; Fri., 6 to 7 pm; Sat., 2:30 to 6:30 pm; Sun.: 11 am to 12:30 pm; 6:30 to 8:30 pm.
CKY	**Winnipeg, Manitoba**—Manitoba Telephone System, Sherbrooke St.	500	384.4	780	Central	Mon., 10:50; 11 am; 12:30; 12:40 to 12:45; 1:15; 1:30; 2:15; 2:35; 4; 4:25; 4:45; 4:50; 5; 8; 8:30; 10:30; 11; 12 pm; Tue., 10:50; 11 am; 12:30; 12:40; 12:45; 1:15; 1:30; 2:15; 2:35; 4; 4:25; 4:45; 4:50; 5 pm (evening usually silent); Wed., 10:50; 11 am; 12:30; 12:40; 12:45; 1:15; 1:30; 2:15; 2:35; 4; 4:25; 4:45; 4:50; 5; 7:3 ; 11 pm; Thu., 10:50; 11 am; 12:30; 12:40; 12:45; 1:15; 1:30; 2:15; 2:35; 4; 4:25; 4:45; 4:50; 5; 8:30; 10; 11 pm; Fri., 10:50; 11 am; 12:30; 12:40; 12:45; 1:15; 1:30; 2:15; 2:35; 4; 4:25; 5 pm (evening usually silent); Sat., 10:50; 11 am; 12:30; 12:40; 12:45; 1; 1:15; 1:30; 8; 8:30; 11 pm; Sun., 7; 9; 10 pm.
CN						
CNRA	**Moncton, N. B.**—Canadian National Railways. (Operating temporarily on 291.1 meters 1030 K/C)	500	312.4	960	Atlantic	Daily: 2:45 to 3:45; Tue., 7:30 to 12; Fri., 9 to 12 pm.
CNRC	**Calgary, Alberta**—Canadian National Railways (Uses station CFAC, Calgary Herald, Calgary, or station CFCN, W. W. Grant, Lt., Calgary).	500-750	434.5	690	Mountain	Wed. and Thu., 9 to 11 pm.
CNRE	**Edmonton, Alberta**—Canadian National Railways. (Uses station CJCA, Edmonton Journal Ltd., Edmonton, Alberta)	500	516.9	580	Mountain	Fri., 7:30 to 8 pm; 8:30 to 10:30 pm.
CNRM	**Montreal, Que.**—Canadian National Railways. (Uses station CHYC, Northern Elec. Co., Ltd., Montreal; CKAC, LaPresse Pub. Co., Ltd., Montreal; CFCF, Canadian Marconi Co., Montreal, P. Q.)	1000-1650	410.7	730	Eastern	4th Wed. of each month, 8:30 to 10:30 pm; 1st, 2nd and 3rd Thu. of each month, 8:30 to 10:30 pm; 5th Fri. of each month (when any), 8:30 to 10:30 pm.
CNRO	**Ottawa, Ont.**—Canadian National Railways	500	434.5	690	Eastern	Wed., 7 to 7:30 pm; 7:30 to 8; 8 to 8:30; 8:57 to 10:15; 11 to 12:30 pm; Sat., 7:30 to 8; 8 to 8:30; 8:57 to 10:15; 11 to 12:30 pm.
CNRR	**Regina, Sask.**—Canadian National Railways. (Uses station CKCK, Leader Pub. Co., Ltd., Regina, Sask. Operating temporarily on 475.9 meters, 630 K/C)	500	312.3	960	Mountain	Tue., 8 to 10 pm.
CNRS	**Saskatoon, Sask.**—Canadian National Railways. (Uses station CFQC, Elec. Shop, Ltd., Saskatoon, Sask.)	500	329.5	910	Mountain	Daily: 2:30 to 3:30 pm.
CNRT	**Toronto, Ont.**—Canadian National Railways. (Uses station CFCA, Star Printing & Pub. Co., Toronto, Ont.)	500	356.9	840	Eastern	Fri., 6:30 pm to 2 am.
CNRV	**Vancouver, B. C.**—Canadian National Railways, (Transmitter is on Lulu Island, B. C.)	500	291.1	1030	Pacific	Tue., 3:30 to 11:30 pm; Fri., 3:30 to 11:30 pm.
CNRW	**Winnipeg, Manitoba**—Canadian National Railways. (Uses station CKY, Manitoba Tel. System, Winnipeg, Manitoba.)	500	384.4	780	Central	Wed., 8:30 to 11 pm.

Valeska Barl, in charge of the YWCA radio educational activities over Station KGO, Oakland, Calif.

Irene Miller, pianist, is heard regularly over KGO, Oakland, Calif.

Little Miss Virginia Sturm is a familiar song singer, very popular in the City of Buffalo, N. Y., despite her tender years, a WGR artist.

Miss Margaret Blakeslee, solo violinist of the Clef Trio, a very popular organization in Buffalo, N. Y., a WGR artist.

Richard Smith, Announcer at WBDC, Grand Rapids, Mich.

Premier Male Quartette, Broadcasts from WLWL, New York, N. Y., Tuesdays at 9.30 P.M.

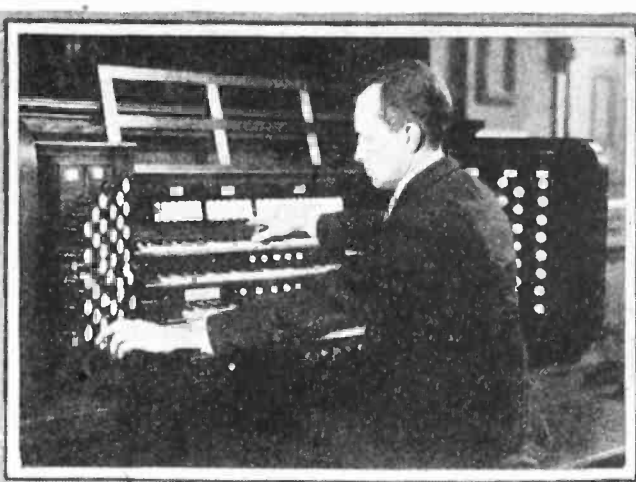
R. B. Meader, Studio Manager, Station WSSH, Boston, Mass.

Richmond Hotel Winter Garden Orchestra, Richmond, Va.—WRVA.

The WBAL trio which has recently become a regular musical feature of WBAL, Baltimore's super power station.

W B A L

BALTIMORE MD.



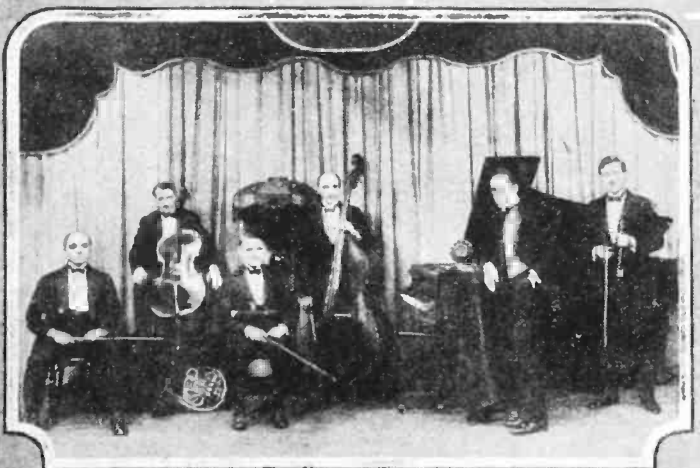
Frederick D. Weaver, WBAL staff organist, at the console of the 4 Manual James Wilson Leakin memorial organ.

John Wilbourn (standing), tenor and WBAL assistant studio manager, and Gustav Klemm, program supervisor and director of WBAL concert orchestra.

Geo. M. Castelle, opera supervisor of WBAL.

Hazel Knox, who broadcasts a children's program.

The WBAL Male Quartet that gives a concert over WBAL every Tuesday and Friday from 7.30 to 8 o'clock.



Carl Rupp's Hotel Hollenden Orchestra. While this orchestra plays semi-classical music for the most part, they also play modern popular music in an individual style all their own.

W T A M

CLEVELAND, OHIO.

Austin Wylie's Vocalion Recording Orchestra is one of Cleveland's best known popular music makers.

Ev Jones and his Gang broadcast each Saturday night at 9.00 P.M., and have come to be a unique radio feature in Cleveland and vicinity.

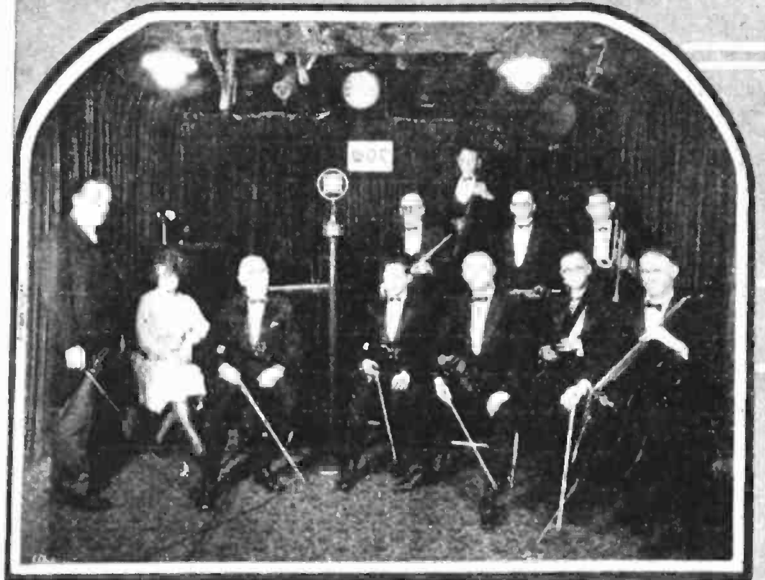
Guy Lombardo's Royal Canadians are known to hundreds of thousands of radio fans through broadcasting for almost a year from this station.


E. H. Twamley, Studio Director.


"Aunt Jane" who conducts the Woman's Home Management

DAVENPORT IOWA


Bernie Schultz's "Crescent Orchestra," which broadcasts from 4 to 5 o'clock each Friday.


The well-known Palmer Little Symphony Orchestra, famous for its Sunday afternoon (1 to 2 o'clock) programs and for its Sunday evening concerts.


Erwin F. Swindell, Musical Director.


Peter MacArthur, Announcer at Station WOC.


V. A. L. Jones, Program Director and Announcer.

ST. LOUIS MO.


Post Despatch Concert Orchestra. Max Steindel, Conductor.


Esmeralda Berry Mayes, Violinist-Pianist.


Miss Olga Christensen, Mezzo-soprano.

MILWAUKEE WIS.


Miss Iva Bigelow Weaver, Dramatic soprano.


Miss Estelle Fielding, Dramatic reader.


Robert F. (Bob) Hall, Announcer and Studio Director. Mrs. Anita DeWitte Hall, Hostess and Accompanist.

Canadian Radio Broadcast Stations

By Provinces and Cities

Provinces	Cities	Call Letters	Wave Length (Meters)	Power (Watts)
ALBERTA	Calgary	CFAC	434.5	500
"	Calgary	CFCN	434.5	1800
"	Calgary	CNRC	434.5	500-750
"	Edmonton	CFCK	516.9	100
"	Edmonton	CJCA	516.9	500
"	Edmonton	CNRE	516.9	500
BRITISH COLUMBIA	New Westminster	CFXC	291.1	20
"	Vancouver	CFCQ	410.7	5
"	Vancouver	CFDC	410.7	10
"	Burnaby	CFYC	410.7	500
"	Burnaby	CJKC	410.7	500
"	Vancouver	CKCD	410.7	1000
"	Vancouver	CKFC	410.7	50
"	Vancouver	CNRV	291.1	500
"	Victoria	CFCT	329.5	500
MANITOBA	Winnipeg	CKY	384.4	500
"	Winnipeg	CNRW	384.4	500
NEW BRUNSWICK	Moncton	CNRA	312.4	500
ONTARIO	Brantford	CFGC	296.9	50
"	Burlington Jct., Durham Co.	CKCW	329.5	5000
"	Hamilton	CFCU	340.7	500
"	Hamilton	CHCS	340.7	10
"	Hamilton	CKOC	341.1	50
"	Iroquois Falls	CFCH	499.7	250
"	Kingston	CFRC	267.7	500
"	Kingston	CFMC	267.7	20
"	Kitchener	CJCF	—	50
"	London	CJGC	329.5	50
"	Ottawa	CHXC	434.5	250
"	Ottawa	CKCO	434.5	100
"	Ottawa	CNRO	434.5	500
"	Scarboro Station	CJYC	291.1	500
"	Thorold	CFKC	247.8	75
"	Toronto	CFCA	356.9	500
"	Toronto	CHIC	356.9	500
"	Toronto	CHNC	356.9	50
"	Toronto	CJBC	356.9	—
"	Toronto	CJCD	356.9	50
"	Toronto	CKCL	356.9	500
"	Toronto	CKNC	357	750
"	Toronto	CNRT	356.9	500
P. E. ISLAND	Charlottetown	CFCY	312.4	50-100
QUEBEC	Montreal	CFCF	410.7	1650
"	Montreal	CFUC	400	—
"	Montreal	CHYC	410.7	850
"	Montreal	CKAC	410.7	1200
"	Montreal	CNRM	410.7	1000-1650

Provinces	Cities	Call Letters	Wave Length (Meters)	Power (Watts)
SASKATCHEWAN	Regina	CHWC	296.9	15
"	Regina	CKCK	312.3	500
"	Regina	CNRR	312.3	500
"	Saskatoon	CFQC	329.5	500
"	Saskatoon	CHUC	329.5	50
"	Saskatoon	CJWC	329.5	250
"	Saskatoon	CNRS	329.5	500
"	Unity	CHSC	356.9	250

Licenses Required for Both Transmitters and Receivers in Canada

All radio stations, whether used for transmitting or receiving purposes are required to be licensed in Canada. The penalty on summary conviction for operating an unlicensed radio station is a fine not exceeding $50.00, and on conviction or indictment a fine not exceeding $500.00, with imprisonment for a term not exceeding 12 months, in addition to forfeiture of all unlicensed apparatus. The different classes of stations for which licenses are issued and their license fees vary from $1.00 for a private receiving set to $50.00 for a public commercial station.

The issue of licenses for transmitting stations is limited to British subjects or to companies incorporated under the laws of the Dominion of Canada or its provinces. Licenses for private receiving sets are issued to any person irrespective of nationality. Licenses for receiving sets are obtained from the Postmaster of the larger towns and cities in the Dominion, radio dealers, Royal Canadian Mounted Police, Department of Radio Inspectors, Departmental Agencies or from the Department of Marine and Fisheries. Licenses for all other classes of stations are obtained from the Department of Marine and Fisheries at Ottawa.

Another view of the All-American Pioneers, a quartette of Jazz musicians.

E. N. Rauland, president of the All-American Corp. (left) introducing Senator Wm. B. McKinley of Illinois.

Rauland-Lyric Trio.

The triangular towers and antenna system of the station.

The All-American Pioneers, whose specialty is radio dance music.

Hal Laige of the All-American Pioneers, with his "sarrusaphone."

Bob Buster Duffy, popular song artist.

Miss Rosalind Wallach, violinist.

CHICAGO, ILL.

Miss Vella Cook, contralto.

Miss Genevieve Barry Burnham, soprano.

Mr. Graves, musical director of the station.

Jack Keefe, Announcer and popular entertainer.

NASHVILLE, TENN.

Martha Rowland Brown, studio accompanist and Bedtime Story Lady.

Geo. D. Hay, "The Solemn Old Judge."

Thos. L. Parkes, Resident Engineer of the station.

MILWAUKEE WIS.

The Atlas Quartette is a regular feature at WHAD.

Andy Hertel, Radio Editor of the Milwaukee Journal

Miss Lucille Meinhardt, a member of the Milwaukee Journal Staff.

Bill Benning, director of the Milwaukee Athletic Club Orchestra.

Mary Liner Lambert, who gives a cooking talk each week.

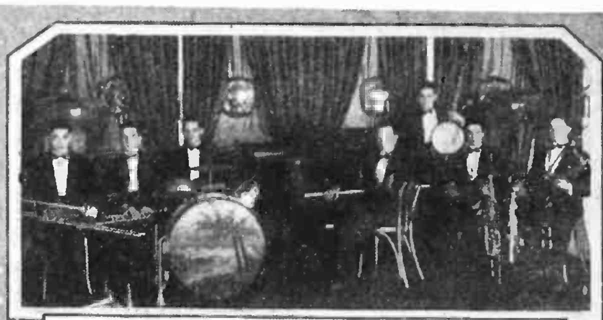
Mary Mac, Movie Editor-Critic, the Milwaukee Journal, who broadcasts movie talks from this station.

Clementine Malek, staff soprano of WHAD.

ST. LOUIS, MO.

Bonita Frede, blues singer.

Hausman Bros.



The Oriental Gardens Orchestra appear every Wednesday.

The Four Aces of Harmony entertain every Thursday.

The Georgia Melody Makers appear every Friday at 9 to 11.

Billy Knight (The Little Ole Professor), program director and announcer.

Miss. Eleanor Zell, soprano.

Paul Small broadcasts from Coronado Hotel nightly.

Foreign Radio Broadcast Stations

Including U. S. Possessions

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
ALASKA				
Anchorage	Chovin Supply Co.	KFQD	227.1	100
ARGENTINE				
Buenos Aires	Sociedad Radio Argentina	LOO	250	1000
" "	Tomas Torres	LOQ	260	500
" "	Diario "Oritica"	LOR	400	500
" "	Santiago Sanchez	LOS	287	2500
" "	Francisco J. Brusa	LOV	352	1000
" "	Grand Splendid	LOW	327	1000
" "	Radio Cultura	LOX	375	500
" "	Sociedad Radio Nacional	LOY	315	1000
" "	"La Nacion" Soc. A. B. C.	LOZ	425	1000
" "	Gino Bocci Hnos.	B2	275	100
" "	Gino Bocci Hnos.	A11		
" "	Sociedad Radiotelefonica	A1		
" "	Francisco J. Brusa	B1		1000
" "	Facultad de Ciencias Medicas	C1		
" "	Departmento Nacional de Higiene	C2		
" "	Departmento Nacional de Higiene	C3		
Cordoba	Antonio Vanelli	H4	275	20
"	Sociedad Radio Comercial de Cordoba		381	100
"	Diario "Los Principios"	HD6	250	20
Hurlingham, FCP.	Felix Gunther	DA-1		
Monte Grande, FCS.	Argentine Broadcasting Assn.			
Ovivos, FCCA.	Eugenio A. Vautier	LOT	272.7	1200
Rio Cuarto	Arturo Rodriguez	H5	279	100
Rosario	Jose Roca Soler	F1	275	20
"	Sociedad Rural de Cerealistas	F2	270	100
"	Manuel Fugardo	F4	260	100
San Fernando, FCCA.	Americo Liberti	D3		
AUSTRALIA				
Adelaide	Central Broadcasting Co.	5-CL	395	5000
"	F. J. Hume	5-DN	313	1500
"	Marshall & Co.	5-MC	273	500
Brisbane	Queensland Government Bureau of Agriculture	4-QG	385	500 (tem'ry)
Hobart	Associated Radio Co.	7-ZL	390	400
Melbourne	Associated Radio Co.	3-AR	484	1600
"	Broadcasting Co. of Australia	3-LO	371	5000
"	Wangaratta Sports Depot	3-HW	300	100
"		3-UZ	319	
Mildura	R. J. Egge	3-EO	520	100
Newcastle	H. A. Douglas	2-HD	333	50
Perth	Westralian Farmers (Ltd.)	6-WF	1250	5000
Sydney	The Electrical Utilities Supply Co.	2-UE	293	250
"	Burgin Electric Co.	2-BE	316	100
"	A. W. A.	2-WA	462	500
"	Farmer & Co. (Ltd.)	2-FO	1100	5000
"		2-FC	1100	5000
"	Broadcastings Sydney Ltd.	2-BL	353	1500

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
AUSTRIA				
Graz	Oesterreichische Radioverkehrs Gesellschaft		339	500
Vienna	Oesterreichische Radioverkehrs Gesellschaft	ORV	530	1500
BELGIUM				
Brussels	Radio Belgique Co	9BR	262	2500
Haeren		BAV	1100	150
BRAZIL				
Bahia	Radio Sociedade de Bahia		250–450	500
Bello Horizonte	Radio Sociedade Mina Geraes		370	500
Ceare	Radio Club Cearense			50
Curytiba	Livio Moreira			
Goyanna	Benedicto Rabello			
Matto Grosso	Radio Club de Campo Grande			
Parana				300
Penedo	A. G. Oliveira			
Pernambuco	Radio Club de Pernambuco		370	300
"	Cia Radiotelegrafica Brazileira		250–380	
"	Radio Sociedade Jader de Andrada			
"	Radio Sociedade de Garanfaus			
Petropolis	Radio Club de Petropolis			
Porto Alegre	Radio Sociedade Riograndense	RSR	381	80
Rio de Janeiro	Praia Vermelha, Nat. Telegraph Service		300–600	500
"	Radio Sociedad de Rio de Janeiro		450	
"	Radio Club do Brazil	SPE	312	500
Ribeiro Preto	Radio Club de Ribeiro Preto			
Rio Grande do Sul	Radio Sociedade de Parahyba			
Sao Paulo	Sociedade Radio Educadora		310	1000
" "	Radio Educadora Paulista		350	1000
" "	Radio Club de Sao Paulo		350	10
" "	Radio Bandeirantes			
Recife	Sociedad Algodeira			
CANARY ISLANDS				
Teneriffe			120	100
CHILE				
Santiago	Radio Corporation of Chile	CBC	400–600	250
"		CMAG		250
"	Sociedad Broadcasting de Chile	CRC	385	350
"		RC	350	30
"	"Mercurio"		360	1200
"	Radio Comercial	CMAE	280	
"		ORC	430	
Tacna		CMAT	500	
Valparaiso	Cia Radio Transandino	CMAI		
Vilna del Mar	Antonio Cornish Besa	ACB	400	50
CHINA				
Kowloon	Radio Communication Co.			50
Peking	Government			500
Shanghai	The Evening News			
Tientsin	Gesho Elec. Road			500
Victoria	Radio Communication Co.			10
"	Honkong Hotel Co.			100
"	Government			1500
COSTA RICA				
San Jose	Government			
CUBA				
Caibarien	Maria J. Alvarez	6EV	250	50
Camaguey	Pedro Nogueros	7AZ	225	10
"	Salvador Rionda	7SR	350	500

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
CUBA				
Camajuani	Diego Iborra	6YR	200	20
Central Tuinicu	Frank H. Jones	6KW	340	100
" "	Frank H. Jones	6JK	275	100
Cienfuegos	Eligio Cobelo Ramirez	6JQ	275	10
"	Jose Ganduxe	6BY	300	100
Diego de Avila	Eduardo V. Figueroa	7BY	235	20
Havana	Credito y Construcciones Co.	2HP	295	100
"	Julio Power	2JP	270	20
"	Frederick W. Borton	2CX	320	10
"	Alberto S. Bustamente	2AB	235	10
"	Cuba Telephone Co.	PWX	400	500
"	Jose Leiro	2JL	275	5
"	"El Pais"	2EP	355	400
"	Humberto Giquel	2CG	350	15
"	Bernardo Barrie	2BB	255	15
"	Manuel Guillermo Salas	2MG	280	20
"	Maria Garcia Velez	20K	360	100
"	Oscar Collar Orta	20L	300	100
"	Roberto E. Ramirez	2TW	230	20
"	Roberto E. Ramirez	2UF	265	10
"	Manuel Karman	2RK	310	20
Matanzas	Leopoldo T. Figueroa	5EV	360	10
Nueva Gerona	Isle of Pines Telephone Co.	8JQ	225	20
Puerto del Rio	Antonio Sarasola	1AZ	275	5
Sagua la Grande	Santiago Ventura	6HS	200	10
Santiago	Andres Vinent	8FU	225	15
"	Alberto Ravelo	8BY	250	100
"	Guillermo Polanco	8HS	200	20
CZECHO-SLOVAKIA				
Prague (Strasnice)			368	5000
" **(Kbely)**		OKP	1160	1000
"	Radio Journal		650	1000
DENMARK				
Copenhagen			337	700
Lyngby	Danish State Telegraph System	OXE	2400	1500
"	Danish Government		775	500
Rybang	Ministry of War		1160	1000
EQUADOR				
Guayaquil	J. Puig Arosemena			
FINLAND				
Helsingfors	Civil Guards of Finland		318	
"	Youths' Society		520	1500
Jyvaskyla			560	200
Skatudden	Military Station Radio Div.		420	1000
Tammerfors	Nuoren Voiman Liiton Radiohydistys	3NB	300	250
Uleaborg			233	2000
FRANCE				
Agen			318	250
Bordeaux	Lafayette Station		410	
Dijon		FND	900	
Issy-sur-Moulineaux	Ministry of Posts		1600	
Lille	Coupleux Freres			
Lyon	Ministry of Posts	YN	480	500
"	Radio Lyon		280	2000
Marseilles			351	
Montpellier	Societe Languedocienne de T. S. F.		186	100

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
FRANCE				
Nice	Ministry of Posts		362–460	
Paris	Ecole Superieure de P. T. T.	**FPTT**	458	500
"	Eiffel Tower, Army	**FL**	2650–2740	5000
"	Radio Electrique	**CFR**	1750	4000
"		**8AJ**	1780	
"	Petit Parisien		345	500
"			1780	15000
Pic du Midi			350	
Toulouse	Aerodrome	**MRD**	280	
"	Radiophonie du Midi		441	2000
Tours	Ministry of Posts	**YG**	2500	500
GERMANY				
Berlin	Wolff Agency		2595	1500
"	Koenigswusterhausen	**AFP**	1300	10000
"	Koenigswusterhausen	**AFT**	1300	10000
"	Telefunken Co.		290–750	2000
"	Vox Haus	**AB**	505–576	2000–4500
Bremen			279	700
Breslau	Schlessischer Rundfunk	**GPU**	418	1000
Cassel			2733	1500
Dortmund			283	1500
Dresden			294	1500
Elberfeld			259	1500
Frankfort	Sudwest Deutscher Rundfunk Dienst	**LP**	470	1500
Gleiwitz			251	1500
Hamburg	Nordischer Rundfunk	**EG**	395	1500
Hamburg		**HA**	392 5	10000
Hanover			297	1500
Koenigsberg	Ostmarken Rundfunk	**LP**	463	1500
Leipzig	Mitteldeutscher Rundfunk	**MR**	452	1500
Munster			410	1500
Munich	Deutsche Stunde in Bayern	**WM**	493	1500
Norddeich		**KAV**	1800	
Stuttgart	Suddeutscher Rundfunk	**OKP**	446	1500
Waldenburg				1500
HAWAII				
Honolulu	Marion A. Mulrony	**KGU**	270	500
HUNGARY				
Budapest	Post Office	**MTI**	950	250
"	Post Office	**HV**	950	1100
ITALY				
Milan	Union Radiofonica Italiana	**IMT**	320	1200
Rome	Union Radiofonica Italiana	**IRO**	425	1500
"	Radioraldo		470	
INDIA				
Bombay	Bombay Presidency Radio Club	**2-FV**	400	1500
Calcutta	Radio Club of Bengal	**2-BZ**	800	500
"		**5-AF**	425	
JAPAN				
Nagoya	Nagoya Radio Broadcasting Co.	**JOCK**	360	
Osaka	Osaka Radio Broadcasting Co.		385	500
"	Osaka Radio Broadcasting Co.		385	1500
Tokyo			375	1000
LATVIA				
Rega				2000

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
MEXICO				
Chihuahua		**CZF**	325	250
"	Telefonos Del Gobierno del Estado de Chihuahua	**ZCF**	310	250
"	Compania Telefonica	**XICE**	500	500
Guadelajara	Radio Club—Degollardo Theatre		280	10
Mazatlan	Rosster & Cia	**CYR**	475	250
Merida	Partido Socialista del Surestan	**CYY**	549	100
Mexico City	Partido Liberal Avanzado	**CYA**	300	500
" "	Jose J. Reynosa (El Buen Tono)	**CYB**	275	500
" "	Miguel S. Castro (La High Life)	**CYH**	375	100
" "	El Universal	**CYL**	400	500
" "	F. C. Stephenex	**IR**	250	
" "	Excelsior Parker	**CYX**	325	500
" "	Fabrica Nacional de Vestuario	**IJ**		
" "	Departmento de Educacion	**CZE**	350	500
" "	La Liga del Radio	**CYZ**	400	100
" "		**CZI**	450	
Monterrey	Constantino Jarnova	**CYO**	425	100
"	Roberto Reyes	**CYM**	275	100
Oaxaca	Federico Zonilla	**CYF**	265	100
Puebla	Agustin del P. Saenz	**CYU**	312	100
Saltillo	Colegio Ateneo Fuente		450	135
Tampico		**CYE**	360	
Tampico	Cipriano Sagaon	**CYQ**	322	100
Vera Cruz	Ministerio de Comunicaciones	**CYC**	300	
Vera Cruz		**CYD**	250	
MOROCCO				
Casablanca	Radio Club de Moroc	**CNO**	250	500
NEW ZEALAND				
Auckland	Newcomb (Ltd.)	**1-YL**	260	500
"	Auckland Radio Service	**1-YA**	260	200
"	LaGloria Gramophone Co.	**1-YB**	260	50
Christchurch				500
Dunedin	Otago University	**4-XO**	140	
"	British Electrical and Engineering Co.	**4-YA**	310–370	500
"	Radio Supply Co.	**4-YO**	370	500
Gisborne	Gisborne Radio Co.	**2-YM**	335	500
Wellington	Broadcastings Ltd.	**2-YB**	275	15
"	Dominion Radio Co.	**2-YA**	275	500
NETHERLANDS				
Amsterdam	W. Bosman	**PX9**	1050	60
"	Vas Dias Press Office	**PCFF**	2125	2000
Bloemendaal	Church		315	400
Debilt			1100	
Hilversum	Nederlandische Seintoellen Fabriek	**HDO**	1050	5000
NORWAY				
Bergen			350	500
Oslo		**OSLO**	382	1000
PERU				
Lima	Peruvian Broadcasting Co.	**OAX**	380	1500
"	German Gallo	**5-0A**	250	20
"	Enrique Perez Palacio	**4-0A**	250	20
"	Augusto Gilardi	**3-0A**	250	20
PHILIPPINE ISLANDS				
Manilla	I. Beck, Inc.	**KZIB**	249.9	20
Manilla	Electrical Supply Co.	**KZKZ**	270	100
Manilla	Far Eastern Radio, Inc.	**KZRQ**	222	500

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
PHILIPPINE ISLANDS				
Baguio	F. Johnson Elser	KZUY	360	500
POLAND				
Warsaw	Government	PTR	380	700
PORTO RICO				
San Juan	Radio Corp. of Porto Rico	WKAQ	340.7	500
PORTUGAL				
Lisboa	Grandes Armazems de Chiado	PIAA	320	
"			400	1500
Montesanto	Government Wireless Station	CTV	2450	1500
RUSSIA				
Riga			1500	2000
Moscow	Sokolniki		1010	2000
"	Trade Union		450	2000
"	Lubovitch		365	
"	Union of Soviet Workers		675	
"	Comintern	RDW	1450	12000
"	Radio-Peredatcha		400	2000
Leningrad			310–240	2000
Niji-Novgorod			253	1000
Kiev			1000	2500
SAN SALVADOR				
San Salvador		EQM	442	
SPAIN				
Asturias		EAJ-12	345	1000
Barcelona	Radio Barcelona (Hotel Solon)	EAJ-1	325	1000
"	Radio Catalana	EAJ-13	360–460	1000
Bilbao	Radio Club Vizcaina	EAJ-9	315–418	1000–2000
"	Radio Vizcaya	EAJ-11	383	2000
Cadiz	Radio Cadiz	EAJ-3	360	1000
"	Lehera	EAJ-10	330	1000
Cartagena		EAJ-16	335	1000
"		EBX	1200	
Madrid	Radio Espana	EAJ-2	310	3000
"	Escuola Superior	PTT	458	1000
"	Lamparas Castilla	EAJ-4	304	1000
"	Radio Iberica	EAJ-6	392	1000
"	Unione Radio	EAJ-7	408	6000
"	Radio Espanola	EAJ-15	490	1000
"		EGC	1650–2200	2000
Malaga		EAJ-25	325	1000
Oviedo (Cima)		EAJ-19	400	1000
Salamanca		EAJ-22	290	1000
San Sebastian		EAJ-8	346	3000
Sevilla		EAJ-17	300	1000
"		EAJ-21	300	1000
"	Radio Club Sevillano	EAJ-5	350	1500
Valencia		EAJ-24	360	1000
"	Reina Victoria Hotel	EAJ-14	400	1000
Zaragoza		EAJ-23	325	1000
STRAIGHTS SETTLEMENTS				
Singapore				100
SWEDEN				
Boden	Radiotjanst	SASE	1200	1500
Falun	Radiotjanst	SMZK	370	250
Gaevle		SMXE	325	250
Goteborg	Radiotjanst	SASB	288	1000

Countries and Cities	Owner	Call Letters	Wave Length (Meters)	Power (Watts)
SWEDEN				
Jonkopings	Radiotjanst Rundradiostation	SMZD	265	500
Karlsborg			1350	2000
Karlstad	Karlstad Rundradiostation	SMXG	221	250
Linkoeping			467	250
Malmo	Radiotjanst	SASC	270	1500
Norrkoeping		SMVV	260	250
Orebro			280	
Stockholm	Radiotjanst	SASA	428	1500
Sundsvall	Radiotjanst	SASD	545	500
Trollhattan	Trollhattans Rundradiostation	SMXQ	322	120
SWITZERLAND				
Berne			315	1500
Geneva	Cointrin	HBI	775	1500
Hoengg	Swiss Radio Assn.		515–650	500
Kloten		HBK	1100	
Lausanne	Champ de l'Air	HV-2	850	600
Zurich	Zurich University	RGZ	515	500
UNION OF SO. AFRICA				
Cape Town	Cape Publicity Assn.	WAMG	400	500
Durban	Town Council		350	500
Grahamstown			400	
Johannesburg	Associated Scientific and Technical Societies	JB	450	500
UNITED KINGDOM				
Aberdeen	British Broadcasting Co.	2-BD	495	
Birmingham	British Broadcasting Co.	5-IT	479	1500
Belfast	British Broadcasting Co.	2-BE	440	
Bournemouth	British Broadcasting Co.	6-BM	386	5000
Cardiff	British Broadcasting Co.	5-WA	353	1000
Dundee	British Broadcasting Co.	2-DE	315	
Edinburgh	British Broadcasting Co.	2-EH	328	
Glasgow	British Broadcasting Co.	5-SC	422	
Daventry	British Broadcasting Co.	5-XX	1600	16000
Hull	British Broadcasting Co.	6-KH	335	150
Leeds-Bradford	British Broadcasting Co.	2-LS	310–321	150
Liverpool	British Broadcasting Co.	6-LV	331	150
London	British Broadcasting Co.	2-LO	365	2000
Manchester	British Broadcasting Co.	2-ZY	378	1000
Newcastle	British Broadcasting Co.	5-NO	404	1000
Nottingham	British Broadcasting Co.	5-NG	326	150
Plymouth	British Broadcasting Co.	5-PY	338	150
Sheffield	British Broadcasting Co.	6-FL	301	150
Swansea	British Broadcasting Co.	5-SX	482	
Stoke-on-Trent	British Broadcasting Co.	6-ST	306	150
URUGUAY				
Montevideo	Radio Sudamericano			500
"	Diario "El Dia"			
"	Casa Paradizabal			1000
VENEZUELA				
Caracas	Coronel Arturo Santana			400
YUGOSLAVIA				
Belgrade	Cie. Generalle De T. S. F.	HFF	1650	2000
Rakovitza			1650	

Slogans of Broadcast Stations in U. S. and Canada

KDLR—DEVILS LAKE, N. D.
North Dakota's Own Station. Voice of the Lake Region.
KFAB—LINCOLN, NEBR.
Home Sweet Home Station.
KFAD—PHOENIX, ARIZ.
The Voice of Phoenix—The Gold Spot of America.
KFAU—BOISE, IDAHO.
KFA U and Voice of Idaho.
KFBK—SACRAMENTO, CALIF.
Sacramento, The Heart of California.
KFBL—EVERETT, WASH.
The Spark Plug of the North West.
KFBU—LARAMIE, WYO.
The Top of the World.
KFEL—DENVER, COLO.
Come Live in Colorado
KFEY—KELLOGG, IDAHO.
Voice of the Coeur D'Alenes.
KFFP—MOBERLY, MO.
The Gospel Messenger of the Air.
KFGQ—BOONE, IOWA.
Daniel Boone Station.
KFH—WICHITA, KANSAS.
Kansas' Finest Hotel.
KFHA—GUNNISON, COLORADO.
Where the Sun Shines Every Day.
KFHL—OSKALOOSA, IOWA.
Keen For Higher Learning.
KFI—LOS ANGELES, CALIF.
The Radio Central Super-Station. A National Institution.
KFJY—FT. DODGE, IOWA.
Where the Tall Corn Grows.
KFKA—GREELEY, COLO.
We Are The Bears.
KFKX—HASTINGS, NEBR.
Pioneer Repeating Station of the World.
KFMR—SIOUX CITY, IOWA.
The College by the Sioux.
KFMW—HOUGHTON, MICH.
Copper Country Station.
KFNF—SHENANDOAH, IOWA.
Known for Neighborly Folks. Keep Friendly, Never Frown.
KFOB—BURLINGAME, CALIF.
Kind Fellows of Burlingame.
KFON—LONG BEACH, CALIF.
Where Your Ship Comes In.
KFOR—DAVID CITY, NEBR.
The Voice of David City.
KFPM—GREENVILLE, TEXAS.
The Biggest Little Ten Watts on the Air.
KFPW—CARTERVILLE, MO.
Keeping Pace With Christ Means Progress.
KFQB—FORT WORTH, TEXAS.
Keep Folks Quoting Bible.
KFRC—SAN FRANCISCO, CALIF.
Keep Forever Radiating Cheer.
KFRU—COLUMBIA, MO.
Where Friendliness is Broadcast Daily.
KFUC—LEMARS, IOWA.
The Best 50 Watt Station on the Air.
KFUM—COLORADO SPRINGS, COLO.
Known for Unsurpassed Mountain Scenery.
KFUO—ST. LOUIS, MO.
Gospel Voice.
KFVN—FAIRMONT, MINN.
The Voice of Martin County.
KFVR—DENVER, COLO.
Denver's Mighty Little Fifty Watt Broadcasting Station
KFVS—CAPE GIRARDEAU, MO.
The City of Opportunity.
KFWC—SAN BERNARDINO, CALIF.
The Gate City.
KFWF—ST. LOUIS, MO.
The Voice of Truth.
KFWM—OAKLAND, CALIF.
The Golden West Station KFWM.
KFWO—AVALON, CALIF.
Katalina for Wonderful Outings.
KFXB—BIG BEAR LAKE, CALIF.
Rim of the World Station.
KFXJ—EDGEWATER, COLO.
America's Scenic Center, and Edgewater, Not Chicago, Colorado.
KFYF—OXNARD, CALIF.
The Voice from the Radio Den.
KGTT—SAN FRANCISCO, CALIF.
Glad Tidings.
KGW—PORTLAND, ORE.
Keep Growing Wiser.
KGY—LACEY, WASH.
Out Where the Cedars meet the Sea.
KJR—SEATTLE, WASH.
Radio Headquarters.
KLDS—INDEPENDENCE, MO.
The Station Dedicated to Knowledge, Liberty, Divinity and Service.
KLS—OAKLAND, CALIF.
The City of Golden Opportunity.
KLX—OAKLAND, CALIF.
Oakland, Where Rail and Water Meet.
KLZ—DENVER, COLO.
Way Out West in Denver.
KMA—SHENANDOAH, IOWA.
Keeps Millions Advised.
KNRC—LOS ANGELES, CALIF.
The Friendly Station.
KOA—DENVER, COLO.
Rocky Mountain Broadcasting Station.
KOAC—CORVALLIS, ORE.
Science for Service.
KOB—STATE COLLEGE, N. MEX.
Sunshine State of America.
KOCH—OMAHA, NEBR.
Voice of 2,000 Students.
KPO—SAN FRANCISCO, CALIF.
The Voice of San Francisco, the City by the Golden Gate.
KPRC—HOUSTON, TEX.
Where Seventeen Railroads Meet the Sea.
KQP—PORTLAND, ORE.
KQP and the Portland News.
KQW—SAN JOSE, CALIF.
King's Quickening Word. Pioneer Broadcasting Station of the World.
KSL—SALT LAKE CITY, UTAH.
Salt Lake City, The Center of Scenic America.
KSMR—SANTA MARIA, CALIF.
The Valley of Gardens.
KSO—CLARINDA, IOWA.
Keep Serving Others.
KTAB—OAKLAND, CALIF.
Knowledge Truth and Beauty.
KTHS—HOT SPRINGS NAT'L PARK, ARK.
Kum to Hot Springs.
KTNT—MUSCATINE, IOWA.
The Home of the Calliaphone, the first new tone in 40 Years.
KTW—SEATTLE, WASH.
Serve the Lord, Preach the Gospel, Evangelize the World.
KUOA—FAYETTEVILLE, ARK.
The Voice of the Ozarks.
KUSD—VERMILLION, S. D.
South Dakota U for South Dakotans.
KUT—AUSTIN, TEX.
Kum to the University of Texas.
KWKC—KANSAS CITY, MO.
Keep Watching Kansas City.
KWUC—LEMARS, IOWA.
The Best 50 Watt Station on the Air.
KWWG—BROWNSVILLE, TEX.
Kum to the World's Winter Garden.
WAAM—NEWARK, N. J.
The Sunshine Station.
WAAW—OMAHA, NEBR.
Where Agriculture Accumulates Wealth.
WABI—BANGOR, ME.
The Community Voice.
WABZ—NEW ORLEANS, LA.
The Station with a Message.
WAFD—PORT HURON, MICH.
Gateway to Great Lakes.
WAIT—TAUNTON, MASS.
We Are in Taunton.

WAMD—MINNEAPOLIS, MINN.
The Call of the North.
WBBL—RICHMOND, VA.
The Gateway North and South.
WBBM—CHICAGO, ILL.
WBBM, The Stewart-Warner Station.
WBBP—PETOSKEY, MICH.
There's only one Petoskey.
WBBS—NEW ORLEANS, LA.
The Gospel Wave.
WBBY—CHARLESTON, S. C.
Seaport of the Southeast.
WBDC—GRAND RAPIDS, MICH.
Your Friendly Station.
WBNY—NEW YORK, N. Y.
The Voice of the Heart of New York.
WBRC—BIRMINGHAM, ALA.
The Biggest Little Radio Station in the World.
WBT—CHARLOTTE, N. C.
Queen City of the South.
WBZ—SPRINGFIELD, MASS.
The Broadcasting Station of New England.
WCAC—STORRS, CONN.
From the Nutmeg State.
WCAD—CANTON, N. Y.
The Voice of the North Country.
WCAL—NORTHFIELD, MINN.
At St. Olaf, the College on the Hill
WCAU—PHILADELPHIA, PA.
Where Cheer Awaits U.
WCAX—BURLINGTON, VT.
The Voice of the Green Mountains.
WCBD—ZION, ILL.
Where God Rules Man Prospers.
WCBE—NEW ORLEANS, LA.
2nd Port U. S. A.
WCBQ—NASHVILLE, TENN.
We Can't Be Quiet.
WCBR—PROVIDENCE, R. I.
New One in Every City Where I Am.
WCCO—ST. PAUL-MINNEAPOLIS, MINN.
Gold Medal Station WCCO.
WCOA—PENSACOLA, FLA.
Wonderful City of Advantages.
WCSH—PORTLAND, ME.
The Voice from Sunrise Land.
WCWS—PROVIDENCE, R. I.
The Birthplace of the American Cotton Industry.
WDAD—NASHVILLE, TENN.
The Athens of the South. Where Dollars are Doubled.
WDAF—KANSAS CITY, MO.
The Nighthawks, the Enemies of Sleep.
WDBE—ATLANTA, GA.
We Distribute Better Equipment.
WDBK—CLEVELAND, OHIO.
Broz-Casting from Cleveland.
WDGY—MINNEAPOLIS, MINN.
See Young Again.
WDOD—CHATTANOOGA, TENN.
Wonderful Dynamo of Dixie.
WEAN—PROVIDENCE, R. I.
We Entertain a Nation.
WEBC—SUPERIOR, WIS.
Head of the Great Water Way.
WEBH—CHICAGO, ILL.
Voice of the Great Lakes.
WEBQ—HARRISBURG, ILL.
Blue Bird Station.
WEBR—BUFFALO, N. Y.
We Extend Buffalo's Regards.
WEBZ—SAVANNAH, GA.
Savannah, Georgia's Port.
WEEI—BOSTON, MASS.
The Friendly Voice.
WEMC—BERRIEN SPRINGS, MICH.
The Radio Lighthouse.
WENR—CHICAGO, ILL.
Makers of Radio for Years to Come.
WFAM—ST. CLOUD, MINN.
Granite City of the World.
WFBG—ALTOONA, PA.
Original Gateway to the West and Wish You All the Very Best.
WFBH—NEW YORK, N. Y.
Voice of Central Park.
WFBJ—COLLEGEVILLE, MINN.
In the Heart of a Landscape Paradise.
WFBM—INDIANAPOLIS, INDIANA.
Good Will Station.
WFBR—BALTIMORE, MD.
Home of the Star Spangled Banner.
WFDF—FLINT, MICH.
The Vehicle City.
WFRL—BROOKLYN, N. Y.
The Voice of Brooklyn.
WGBB—FREEPORT, N. Y.
The Voice of the Sunrise Trail.
WGBF—EVANSVILLE, IND.
Gateway to the South.
WGES—CHICAGO, ILL.
World's Greatest Electrical School.
WGHB—CLEARWATER, FLA.
The Springtime City Uniting the World.
WGR—BUFFALO, N. Y.
Key City of Industry.
WHAR—ATLANTIC CITY, N. J.
Pioneer Broadcasting Station of Atlantic City.
WHAS—LOUISVILLE, KY.
My Old Kentucky Home.
WHAV—WILMINGTON, DEL.
Wilmington—First City of First State.
WHAZ—TROY, N. Y.
The Oldest College of Science and Engineering in America.
WHB—KANSAS CITY, MO.
The Heart of America.
WHBF—ROCK ISLAND, ILL.
Where Historic Blackhawk Fought.
WHBG—HARRISBURG, PA.
Where Harrisburg Broadcasts Gladness.
WHBP—JOHNSTOWN, PA.
The Voice of the Friendly City.
WHBJ—FT. WAYNE, IND.
In the Middle of the Middle West.
WHBU—ANDERSON, IND.
The Home of Chief Anderson.
WHN—NEW YORK, N. Y.
The Station of the Great White Way.
WIAD—PHILADELPHIA, PA.
The Voice from the Birthplace of Liberty.
WIAS—BURLINGTON, IOWA.
On the Mississippi.
WIBA—MADISON, WIS.
Four Lakes City.
WIBM—CHICAGO, ILL.
The Gypsy Station.
WIBW—LOGANSPORT, IND.
On the Banks of the Wabash.
WIBX—UTICA, N. Y.
The Hub of New York State.
WIL—ST. LOUIS, MO.
Watch It Lead.
WIOD—MIAMI BEACH, FLA.
Wonderful Isle of Dreams.
WIP—PHILADELPHIA, PA.
Watch Its Progress.
WJAG—NORFOLK, NEBR.
The Home of the Printer's Devil.
WJAR—PROVIDENCE, R. I.
The Southern Gateway to New England.
WJBB—ST. PETERSBURG, FLA.
Land of Perpetual Sunshine.
WJBC—LA SALLE, ILL.
Better Homes Station.
WLBL—MADISON, WIS.
Wisconsin Land of Beautiful Lakes
WJBR—OMRO, WIS.
Omro, the Center of the State of Lakes.
WJJD—MOOSEHEART, ILL.
Call of the Moose.
WKAV—LACONIA, N. H.
The Voice from the Winjipesaukee Lake Region.
WLIT—PHILADELPHIA, PA.
The Quaker City Siren.
WLSI—PROVIDENCE, R. I.
The New England Station.
WLW—CINCINNATI, OHIO.
The Station With a Soul.
WMBB—CHICAGO, ILL.
Station on the Trianon Ballroom.
WMBF—MIAMI BEACH, FLA.
Down in the Land of Palms and Sunshine—Down Where It's Always June.
WMC—MEMPHIS, TENN.
Memphis, Down in Dixie.
WMCA—NEW YORK, N. Y.
Where the White Way Begins.
WNAD—NORMAN, OKLA.
Voice of Soonerland.
WNAL—OMAHA, NEB.
Pioneer Broadcast Station of Omaha.

WNAT—PHILADELPHIA, PA.
We Never Are Tired in Philadelphia.

WNBH—NEW BEDFORD, MASS.
The Gateway to Cape Cod.

WOAN—LAWRENCEBURG, TENN.
Watch Our Annual Normal.

WOAW—OMAHA, NEB.
WOAW, the Omaha Sation.

WOAX—TRENTON, N. J.
Trenton Makes, The World Takes.

WOC—DAVENPORT, IOWA.
Where the West Begins and the State Where the Tall Corn Grows.

WOCL—JAMESTOWN, N. Y.
WOCL—We're on Chatauqua Lake and "Jamestown" the Pioneer Furniture City.

WOKO—NEW YORK, N. Y.
The Pioneer Radio Service Station.

WOLO—CAMP LAKE, WIS.
The Play Ground of the Lake Region.

WOOD—GRAND RAPIDS, MICH.
The Furniture Capital of America.

WOWL—NEW ORLEANS, LA.
Where Owl Batteries Are Made.

WOWO—FT. WAYNE, IND.
Wayne Offers Wonderful Opportunities.

WPCC—CHICAGO, ILL.
We Preach Christ Crucified.

WPG—ATLANTIC CITY, N. J.
WPG—World's Play Ground Atlantic City.

WPRC—HARRISBURG, PA.
The Capital City of the Keystone State.

WPSC—STATE COLLEGE, PA.
The Voice of the Nittany Lion.

WQAC—AMARILLO, TEX.
Where Quality Alone Counts.

WQAM—MIAMI, FLA.
Most Southern Broadcasting Station in the United States.

WQAN—SCRANTON, PA.
The Voice of the Anthracite.

WRAF—LAPORTE, IND.
The Voice of the Maple City.

WRAW—READING, PA.
The Schuylkill Valley Echo.

WRBC—VALPARAISO, IND.
World Redeemed By Christ.

WREO—LANSING, MICH.
Watch—Reo.

WRNY—NEW YORK, N. Y.
The Radio News Station.

WSAR—FALL RIVER, MASS.
Fall River Looms Up.

WSBC—CHICAGO, ILL.
It Won't Be Long Now.

WSBT—SOUTH BEND, IND.
Voice of the Hoosier State.

WSKC—BAY CITY, MICH.
Where the Summer Trails Begin.

WSM—NASHVILLE, TENN.
We Shield Millions.

WSMH—OWOSSO, MICH.
Watch Shattuck Music House.

WSRO—HAMILTON, OHIO.
We Sell Radio Only. (The Oldest Exclusive Radio Store in the West.)

WSSH—BOSTON, MASS.
Strangers Sunday Home.

WSVS—BUFFALO, N. Y.
Watch Seneca Vocational School.

WTAD—CARTHAGE, ILL.
We Travel All Directions.

WTAL—TOLEDO, OHIO.
The Gateway to the Sea.

WTAR—NORFOLK, VA.
Down in Old Virginia.

WTAX—STREATOR, ILL.
Tappa Keg O' Nails.

WTIC—HARTFORD, CONN.
The Insurance City.

WWAD—PHILADELPHIA, PA.
Penn City Station.

CFCT—VICTORIA, B. C.
The Mecca of the Tourists.

CFCY—CHARLOTTETOWN, P. E. ISLAND.
The End of the Black Fox Trail.

CJWC—SASKATOON, SASK.
The Voice of Saskatoon. The University City.

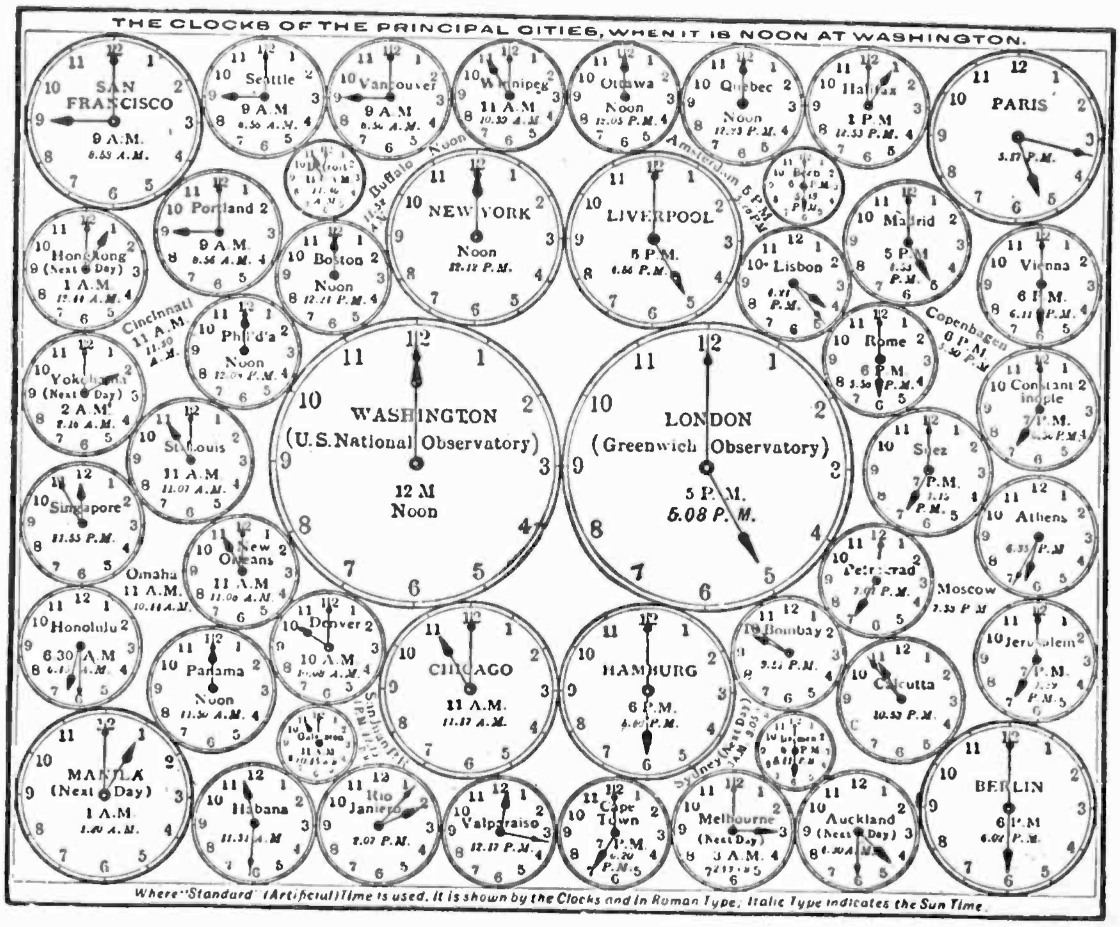
CKNC—TORONTO, ONT.
In the Land of the Sky Blue Water.

CKY—WINNIPEG, MANITOBA.
Manitoba's Own Station.

CNRA—MONCTON, N. B.
The Voice of the Maritimes.

CNRV—VANCOUVER, B. C.
Voice of the Pacific.

TIME IN ALL PARTS OF THE WORLD



All About Standard Time

The United States adopted standard time in 1883, on the initiative of the American Railway Association, and at noon of November 18th, 1883, the telegraphic time signals sent out daily from the Naval Observatory at Washington were changed to the new system, according to which the meridians of 75°, 90°, 105°, and 120° west from Greenwich became the time meridians of Eastern, Central, Mountain, and Pacific standard time respectively.

United States standard Eastern time is used from the Atlantic Ocean to a line through Toledo, Monroeville, Mansfield and Newark, O.; thence through Huntington, W. Va.; Norton, Va.; Johnson City, Tenn.; Asheville, N. C. Atlanta and Macon, Ga.; and Apalachicola, Fla. U. S. standard Central time is used from this first line to a line through Mandan, N. D.; Pierre, S. D.; Pierre, S. D.; McCook, Neb.; Dodge City, Kans., and along west line of Okla., and Tex.; standard Mountain time is used from the second line to a line that forms the western boundary of Mont., thence follows the Salmon River westward, the western boundary of Idaho southward, the southern boundary of Idaho eastward, and thence passes southward through Ogden and Salt Lake City, Utah; Parker and Yuma, Ariz. U. S. standard Pacific time is used from the third line to the Pacific Ocean.

Almost all countries throughout the world use standard time that differs from Greenwich time by a whole number of hours or half-hours; a few countries, however, use standard time based on the longitude of their national observatories.

TIME CHART

Hawaii	San Francisco P. C. T.	Denver M. S. T.	Chicago C. S. T.-D.	Havana Cuba	New York-Washington E. S. T.	New York-Washington Daylight Saving	Halifax Buenos Aires	Rio de Janeiro Brazil	London Paris Madrid	G. M. T.	Sweden Germany Switzerland Italy	Petrograd Constantinople Capetown Jerusalem	Bagdad Persia	Calcutta Bombay India	Borneo Java Dutch E. I.	Manila P. I. China Western Australia	Tokio Central Australia	Sidney Melbourne Eastern Australia	Auckland New Zealand	Samoa
1.30P.M.	4.00P.M.	5.00P.M.	6.00P.M.	6.30P.M.	7.00P.M.	8.00P.M.	8.00P.M.	9.00P.M.	Midnight	0000	1.00A.M.	2.00A.M.	3.00A.M.	5.00A.M.	6.00A.M.	8.00A.M.	9.00A.M.	10.00A.M.	11.30A.M.	Noon
2.30	5.00	6.00	7.00	7.30	8.00	9.00	9.00	10.00	1.00A.M.	0100	2.00	3.00	4.00	6.00	7.00	9.00	10.00	11.00	12.30P.M.	1.00P.M.
3.30	6.00	7.00	8.00	8.30	9.00	10.00	10.00	11.00	2.00	0200	3.00	4.00	5.00	7.00	8.00	10.00	11.00	Noon	1.30	2.00
4.30	7.00	8.00	9.00	9.30	10.00	11.00	11.00	Midnight	3.00	0300	4.00	5.00	6.00	8.00	9.00	11.00	Noon	1.00P.M.	2.30	3.00
5.30	8.00	9.00	10.00	10.30	11.00	12.00	Midnight	1.00A.M.	4.00	0400	5.00	6.00	7.00	9.00	10.00	Noon	1.00P.M.	2.00	3.30	4.00
6.30	9.00	10.00	11.00	11.30	Midnight	1.00A.M.	1.00A.M.	2.00	5.00	0500	6.00	7.00	8.00	10.00	11.00	1.00P.M.	2.00	3.00	4.30	5.00
7.30	10.00	11.00	Midnight	12.30A.M.	1.00A.M.	2.00	2.00	3.00	6.00	0600	7.00	8.00	9.00	11.00	Noon	2.00	3.00	4.00	5.30	6.00
8.30	11.00	Midnight	1.00A.M.	1.30	2.00	3.00	3.00	4.00	7.00	0700	8.00	9.00	10.00	Noon	1.00P.M.	3.00	4.00	5.00	6.30	7.00
9.30	Midnight	1.00A.M.	2.00	2.30	3.00	4.00	4.00	5.00	8.00	0800	9.00	10.00	11.00	1.00P.M.	2.00	4.00	5.00	6.00	7.30	8.00
10.30	1.00A.M.	2.00	3.00	3.30	4.00	5.00	5.00	6.00	9.00	0900	10.00	11.00	Noon	2.00	3.00	5.00	6.00	7.00	8.30	9.00
11.30	2.00	3.00	4.00	4.30	5.00	6.00	6.00	7.00	10.00	1000	11.00	Noon	1.00P.M.	3.00	4.00	6.00	7.00	8.00	9.30	10.00
12.30A.M.	3.00	4.00	5.00	5.30	6.00	7.00	7.00	8.00	11.00	1100	Noon	1.00P.M.	2.00	4.00	5.00	7.00	8.00	9.00	10.30	11.00
1.30	4.00	5.00	6.00	6.30	7.00	8.00	8.00	9.00	Noon	1200	1.00P.M.	2.00	3.00	5.00	6.00	8.00	9.00	10.00	11.30	Midnight
2.30	5.00	6.00	7.00	7.30	8.00	9.00	9.00	10.00	1.00P.M.	1300	2.00	3.00	4.00	6.00	7.00	9.00	10.00	11.00	12.30A.M.	1.00A.M.
3.30	6.00	7.00	8.00	8.30	9.00	10.00	10.00	11.00	2.00	1400	3.00	4.00	5.00	7.00	8.00	10.00	11.00	Midnight	1.30	2.00
4.30	7.00	8.00	9.00	9.30	10.00	11.00	11.00	Noon	3.00	1500	4.00	5.00	6.00	8.00	9.00	11.00	Midnight	1.00A.M.	2.30	3.00
5.30	8.00	9.00	10.00	10.30	11.00	12.00	Noon	1.00P.M.	4.00	1600	5.00	6.00	7.00	9.00	10.00	Midnight	1.00A.M.	2.00	3.30	4.00
5.30	9.00	10.00	11.00	11.30	Noon	1.00P.M.	1.00P.M.	2.00	5.00	1700	6.00	7.00	8.00	10.00	11.00	1.00A.M.	2.00	3.00	4.30	5.00
7.30	10.00	11.00	Noon	12.30P.M.	1.00P.M.	2.00	2.00	3.00	6.00	1800	7.00	8.00	9.00	11.00	Midnight	2.00	3.00	4.00	5.30	6.00
8.30	11.00	Noon	1.00P.M.	1.30	2.00	3.00	3.00	4.00	7.00	1900	8.00	9.00	10.00	Midnight	1.00A.M.	3.00	4.00	5.00	6.30	7.00
9.30	Noon	1.00P.M.	2.00	2.30	3.00	4.00	4.00	5.00	8.00	2000	9.00	10.00	11.00	1.00A.M.	2.00	4.00	5.00	6.00	7.30	8.00
10.30	1.00P.M.	2.00	3.00	3.30	4.00	5.00	5.00	6.00	9.00	2100	10.00	11.00	Midnight	2.00	3.00	5.00	6.00	7.00	8.30	9.00
11.30	2.00	3.00	4.00	4.30	5.00	6.00	6.00	7.00	10.00	2200	11.00	Midnight	1.00A.M.	3.00	4.00	6.00	7.00	8.00	9.30	10.00
12.30P.M.	3.00	4.00	5.00	5.30	6.00	7.00	7.00	8.00	11.00	2300	Midnight	1.00A.M.	2.00	4.00	5.00	7.00	8.00	9.00	10.30	11.00

Note—The heavy lines denote a change of date. Passing the heavy line, going to the right, denotes the following day. Passing the heavy line to the left, denotes the previous day. All figures on the same horizontal line indicate standard time in the various Time Zones at the same instance.

Table For Making Time Transitions

Eastern Standard Time	1	2	3	4	5	6	7	8	9	10	11	12
Central Standard Time	12	1	2	3	4	5	6	7	8	9	10	11
Mountain Standard Time	11	12	1	2	3	4	5	6	7	8	9	10
Pacific Standard Time	10	11	12	1	2	3	4	5	6	7	8	9

HOW TO USE TIME TRANSITION TABLE

If a station is giving a program at 8 o'clock Mountain time and you wish to find what this is equivalent to in Central time, find 8 o'clock in the third or Mountain time row. Then immediately above it in the same vertical column will be found the figure 9 in the Central time row. This indicates that the program would be heard at 9 o'clock Central time.

Log for Additional Broadcast Stations

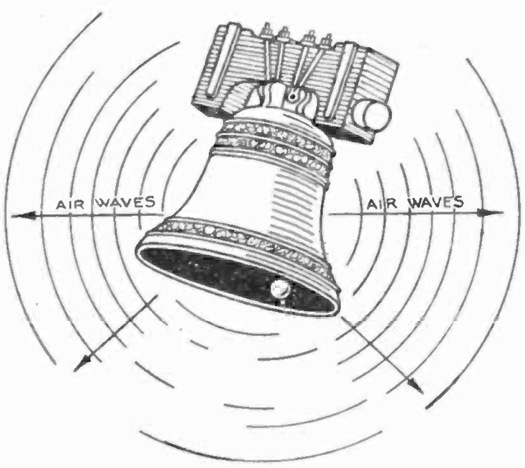
Radio Call Letters	BROADCAST STATIONS Location and Name	Power Watts	Wave Length (Meters)	Frequency (Kilocycles)	Time at Station	Date	Time Received	Dial 1	Dial 2	Dial 3

Some Fundamental Facts About Radio

POWEL CROSLEY, Jr.

THE simple fundamental facts of science are so involved in a mass of complex details today that the tendency is to concentrate one's attentions on the details, and to give up the task of understanding the how and why of scientific matters as impossible. But nevertheless it is true that the fundamentals are just as simple as ever, and that even the least scientifically-minded of us can picture the ground work upon which modern scientific achievements are based if a few fundamental principles and their applications are presented to us in the proper light. Radio vision, broadcasting, and even the celebrated Einstein theory are capable of being understood (not in the most exact mathematical manner perhaps, but in a broader and less accurate sense) by the layman.

Let us consider first the nature of sound. It is a wave motion, comparable to water waves, transmitted primarily through the air. Wood, metal, and other substances placed in the path of the waves take up their vibratory motion and help to transmit them, but generally they are damped out much more quickly, and become unintelligible at a much shorter distance from their origin in all substances other than air. As one goes farther and farther from a sounding body, the sound becomes weaker and weaker. That is because the spreading out of the sound waves in all directions makes them grow smaller as they progress on their journey, and because some of the sound energy is absorbed by the vibrating air and converted into heat.

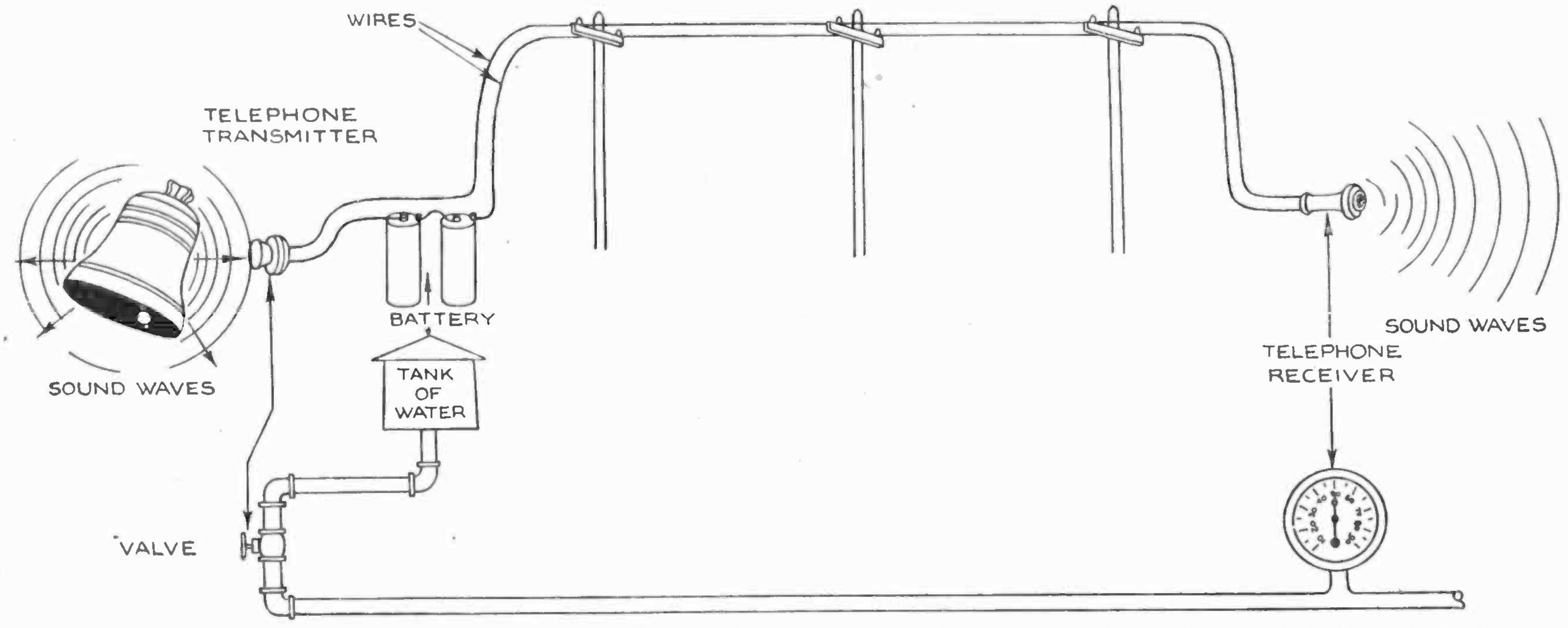


The vibrating bell sends out sound waves through the air.

Water waves behave in a similar way—becoming smaller in size as they travel out in the form of an ever-widening circle, from their source.

Now within distances of from a few feet to often several thousand feet (depending upon the loudness of the sound), sound waves themselves have sufficient energy to carry voices and music to listeners. When it is desired to transmit speech or music over greater distances, some sort of auxiliary apparatus must be resorted to. One of two methods may be used: First, a permanent record of the sound may be made upon a piece of matter and this record transported from place to place and used with a machine which will reconvert the groovings on the record into sound. This system has been developed into the modern phonograph. Second, for rapid transmission of the sounds, the sounds may be used to control some form of energy which is easily and quickly transmitted from one place to another, and the corresponding fluctuations of the energy may be reconverted into sound at the receiver end of the line.

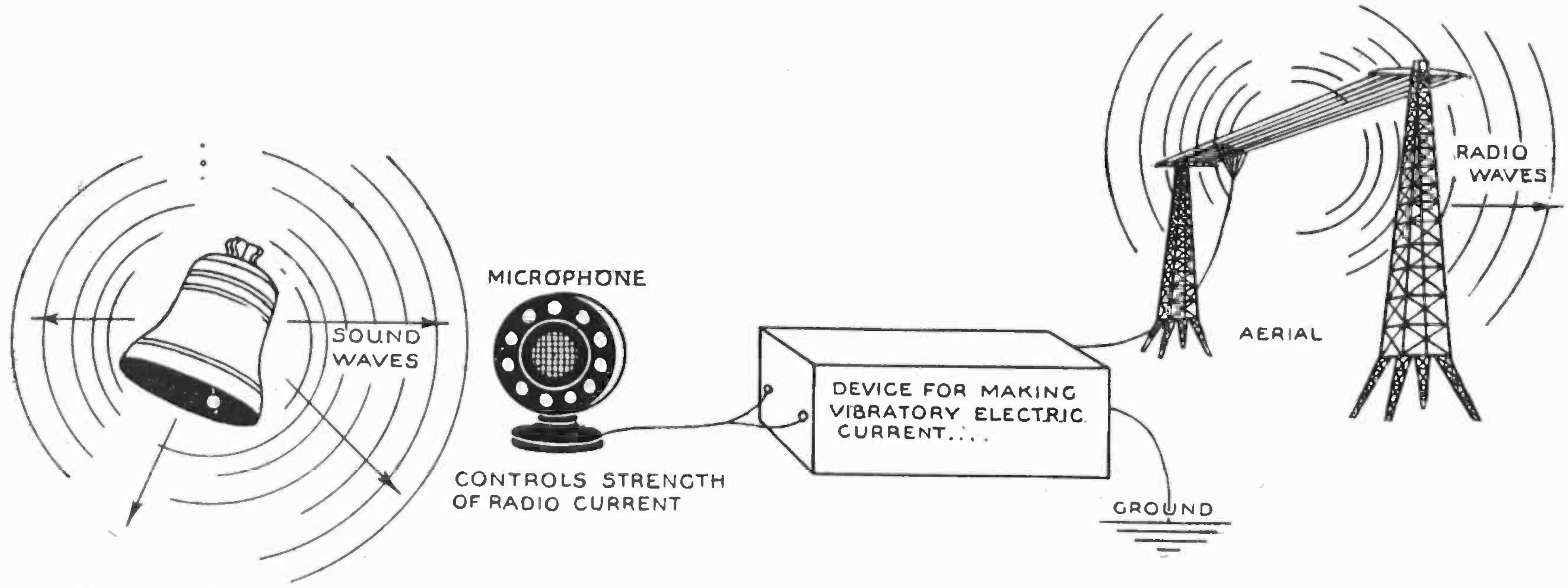
The earliest device to make use of this latter method was the telephone. In the telephone system wires are run from the speaking post to the listening post. Through them is sent an electric current. The current can be transmitted economically, and any change in the strength of current effected by devices at one end of the line can be noticed almost instantaneously at the other end of the line. At the speaking post a device called a "microphone" is connected in the line. It has in it a diaphragm which vibrates when struck by sound waves. The diaphragm is so arranged, together with other parts of the microphone, that when it vibrates, the resistance of the electric line at that point is changed, and consequently the strength of the flowing electric current is varied. The action of the microphone is very similar to that of a valve in a water pipe—it allows more or less of the electric current to flow, according to the vibrations of the



Sound waves are produced at the receiver, which correspond to the sound waves striking the transmitter. The valve in the lower figure is analogous to the transmitter; the pressure gauge at the lower right is analogous to the telephone receiver.

sound waves influencing the diaphragm.

The fluctuations of current caused by the microphone at the speaking post are almost instantly noticed at the receiving station. There a device known as a "receiver" is in- and Heinrich Hertz, led to the establishment as a fact that a vibratory electric current produced just such kind of a space-propagated energy as was wanted. It was shown experimentally that electrical apparatus employing vibratory electric currents of could therefore be sent out in accordance with the dots and dashes of the telegraphic code. He erected another conductor at some distance from the transmitting apparatus, and, of course, every time a dash or dot of energy was sent out from the trans-



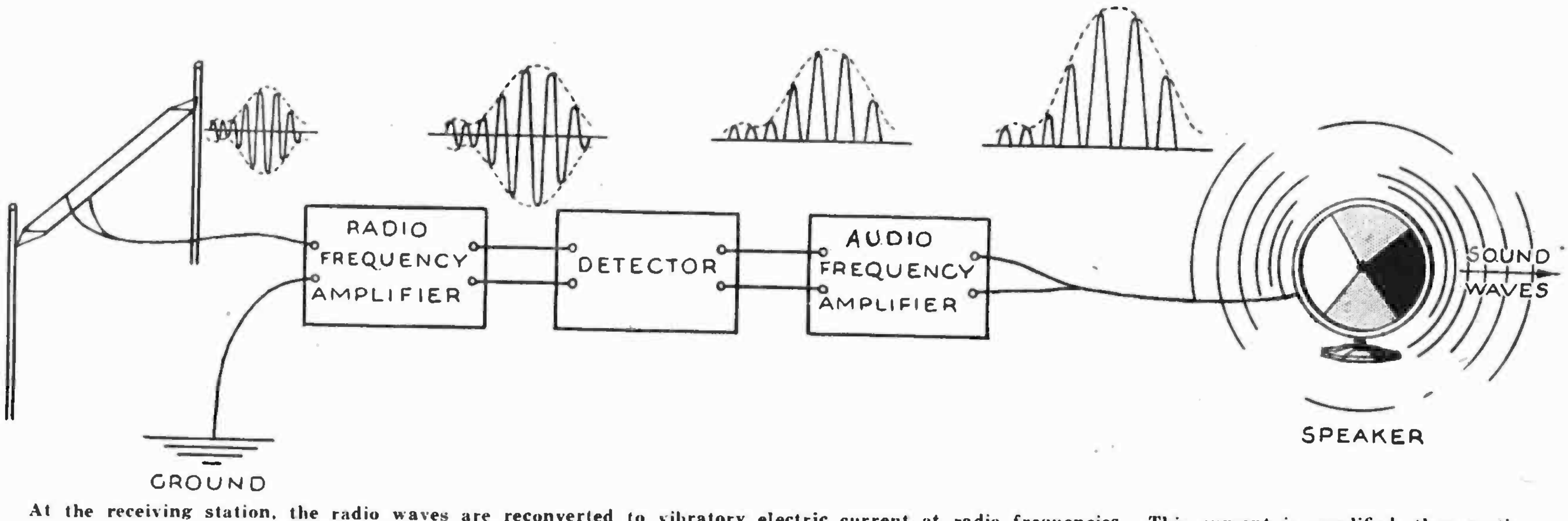
At the transmitting station, the sound waves actuate the microphone which in turn varies the strength of the vibratory electric current used to send out electric waves from the aerial.

serted in the line. It converts the electric current fluctuations into sound. In construction, the receiver is quite simple, consisting merely of an electromagnet so placed as to attract an iron diaphragm when a current flows through it. The fluctuations of the current cause the diaphragm to be attracted more or less, and therefore to vibrate in the same manner as the diaphragm of the microphone at the speaking post.

high frequencies, radiated energy into space, and that this energy, furthermore, would cause a vibratory electric current to be set up in any conducting medium located within its influence.

It remained only to harness this energy, propagated through space, in such a way that it could be used for practical telegraphy and telephony. Marconi, early in the nineties, set his hand to the task, and early suc- mitter, a vibratory electric current of high frequency would be set up in this conductor.

Now this high-frequency vibrating electric current was much above audible frequencies. It was of too great frequency to operate a headphone receiver, and even if it would have been capable of operating a receiver, this fact would have been of no avail, inasmuch as the vibrations of the receiver diaphragm would have been



At the receiving station, the radio waves are reconverted to vibratory electric current at radio frequencies. This current is amplified, then rectified by the detector, further amplified and finally changed back to sound waves at the loud speaker.

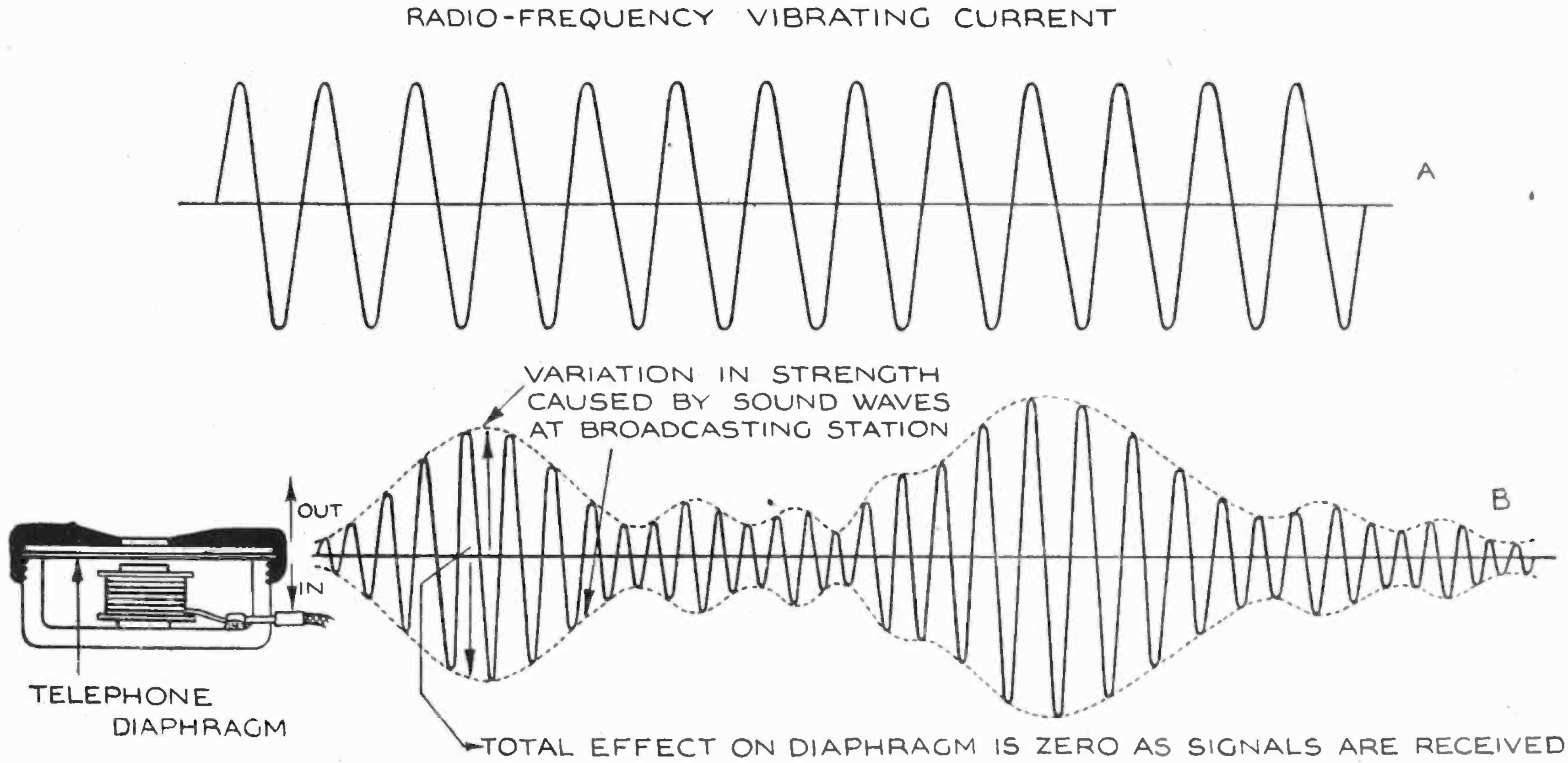
Thus the transmission of speech over wires is fundamentally simple. To accomplish the same results without the use of wires requires some kind of easily controllable, fast moving energy, that will travel through space. Until recent years, no such form of energy was known. During the nineteenth century, however, the brilliant researches and theoretical deductions of certain scientists, among whom were James Clerk Maxwell, Joseph Henry, Herman Helmholtz, ceeded in his endeavors. He demonstrated that the radiation of energy from the transmitting apparatus depended to a large extent on the length and height of the conductors from which the energy was radiated, and that the radiation was greatly improved by connecting one terminal of the apparatus to the ground. In the transmitting apparatus he connected a telegraph key, so that energy was radiated only when the key was depressed, and so that spurts of energy beyond the audible range. But it had been found that a certain device, called a "coherer," could be made to act like a relay under the influence of this high-frequency current, allowing current from a local battery to flow whenever the vibratory current acted upon it. A coherer was therefore attached to the conductor used for receiving purposes, and a headphone receiver placed in the circuit of the local battery attached to the coherer. The headphones would then click whenever the vibrations were started or stopped, and the telegraphic signals sent out by the transmitter could be received.

This was all very well for telegraphic purposes. When the task was undertaken of adapting the use of this radiated, or "radio" energy, for telephonic purposes, difficulties were, however, encountered. It was quite simple, of course, to connect a microphone in one end of an electric line and a telephone receiver in the other, to cause fluctuations in the electric current flowing through this line by impressing sound vibrations on the microphone, and to reconvert the electrical fluctuations into sound by means of a telephone receiver. In radio, however, a problem presented itself from the start—the radio current was not a steady flow of direct current like telephonic current, but was of a vibratory nature. Furthermore, the kinds of devices used in the early history of radio to produce the required energy, gave out a vibratory current which was continually fluctuating in strength, instead of remaining steady. Because the vibrations of the radio current were so far more rapid than those of sound, it would have been easy to have regulated their strength in accordance with the sound waves, just as was done in the telephone, had it not been for their continual fluctuations in strength. These fluctuations were at frequencies well within the audible range, and therefore caused a continual buzzing or grinding noise which drowned out all attempts to regulate the vibrations by means of sound waves.

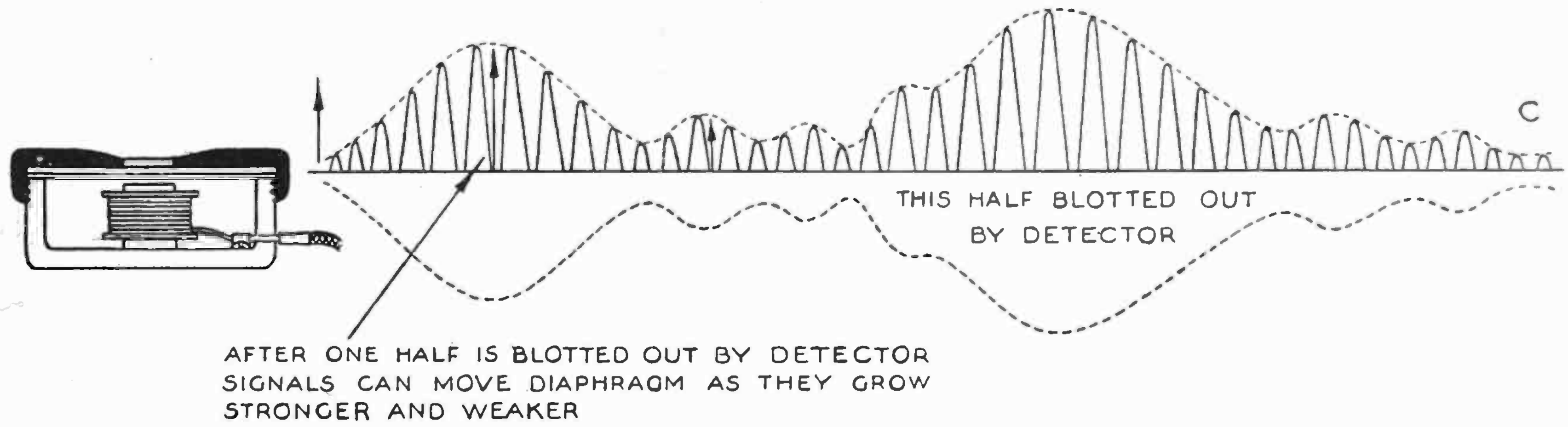
The first step that was necessary in order to make radio-telephony practical was, therefore, to develop a generator of sustained radio currents, that is, of radio currents which did not fluctuate. Several devices for accomplishing this purpose were developed, but the one that has been found most practical for broadcasting is the three-electrode thermionic valve, or, in more common words, the "radio tube." The broadcasting of speech and music as now done by means of modern radio equipment is, then, very similar to the transmission of speech and music, as done in the ordinary telephone, the fundamental difference being that a vibratory radio-frequency electric current is substituted for the direct current of simple telephone equipment.

The use of this vibratory current does introduce one complication, and that is that one half of the high-frequency vibrations must be blotted out in order for a telephone receiver to respond to the received current. This will be made clear by an examination of the diagrams. "A" shows the steady radio-frequency current as it is before being controlled or modulated by the sound waves. "B" shows the radio frequency current which has been made stronger and weaker, or modulated, in accordance with the sound waves at the studio. Now the rapid vibrations of the radio

(*Continued on page* 91)



Radio frequency current, whether unmodulated, as shown in upper figure, or modulated, as indicated below, are incapable of actuating a telephone receiver.

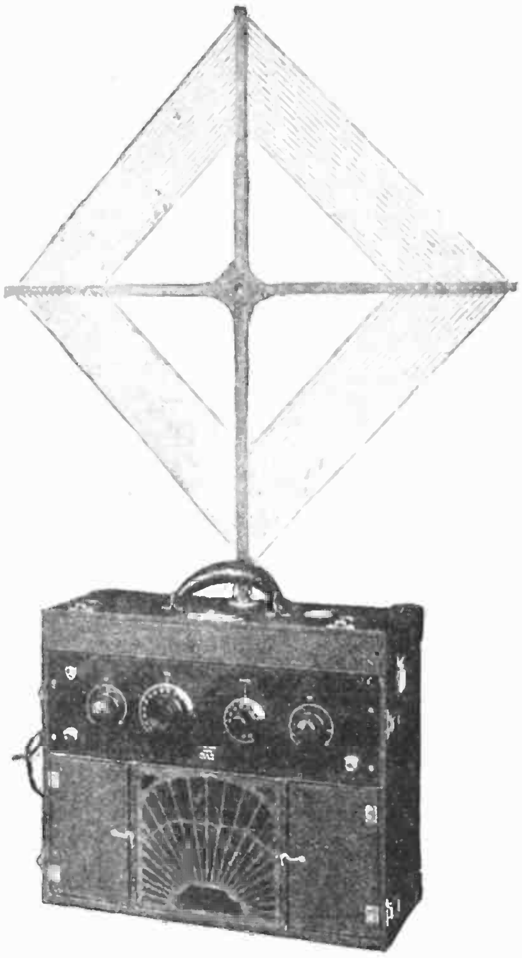


The modulated and *rectified* current can move the diaphragm of the telephone receiver.

The Antenna and Loop

By LEON L. ADELMAN

A QUESTION that is often heard and generally answered by "yes" or "no" is one that leaves much doubt in mind. One such question asked in radio is: "Can I use a loop antenna with this set or must I erect an outdoor antenna?" With this question for our consideration, we are going to go down to the rockbottom truth of the matter and find out for ourselves just what conditions stipulate a comprehensive answer, whether positive or negative in response.



Portable radio receivers employing small loop antennae have been developed to a highly perfected stage.

By definition, an antenna is "a system of suspended wires of any form, kept free from surrounding objects and carefully insulated therefrom, used for the reception or transmission of radio waves." Thus, among the most popular types we have the "T," inverted "L," vertical "I" and pyramid antennae. By far, the most efficient antenna in general use is the single wire inverted "L" type and this statement is made without reservation. It is most efficient when its fundamental wave-length corresponds to that of the wave-length of the signals desired to be received as will be explained later. In practice, of course, this condition is only approximated, since for the most part, receiving antenna systems are of the untuned type—aperiodic in nature.

In Fig. 1 is depicted a "T" type antenna (we will consider, for the sake of brevity, a single wire antenna throughout) and how its fundamental wave-length can be readily calculated. By the definition of "T" type, it is meant that the lead-in from the horizontal is connected exactly at the center. If it is not connected at the center, the antenna is then to be considered as of the inverted "L" type. Since wave-length is measured in meters (a meter being the equivalent of 39.37 inches), the fundamental wave-length of such an antenna can be measured by adding the length of one-half the horizontal portion to the length of the lead-in and ground wires. To this sum is added the equivalent length of the few turns of wire which constitute the primary coil in the receiving set.

The inverted "L" type is shown in Fig. 2. Its wave-length is calculated in precisely the same manner as above, except that the entire length of the horizontal portion is measured. The lead-in should be taken off at the very end.

In Fig. 3 can be seen the vertical "I" antenna and the method of finding out its fundamental wave-length.

"But why bother about all this?" one may ask. For no other reason than to insure against making the antenna too long or too short and thus prevent either a condition of non-selectivity or else poor volume in reproduction.

"What type, then, shall I choose?" is the next question. And the answer to this depends upon your locality, the environment about your dwelling. In some measure to be explained later, it also depends upon the type of receiver one is using. (A so-called "more powerful" set needs less *pickup* energy for fair results.

Together with the question of "what type shall I use?' we might add, "How long shall I make it?"

If one is located in an area congested with a multiplicity of broadcast stations, a reasonably short antenna will afford him a happy medium. On the other hand, if one is situated several miles away from a station, a long antenna will bring in distance and allow of maximum volume.

Where space is limited for the installation of a horizontal type aerial, the vertical antenna will function well provided that it can be made long

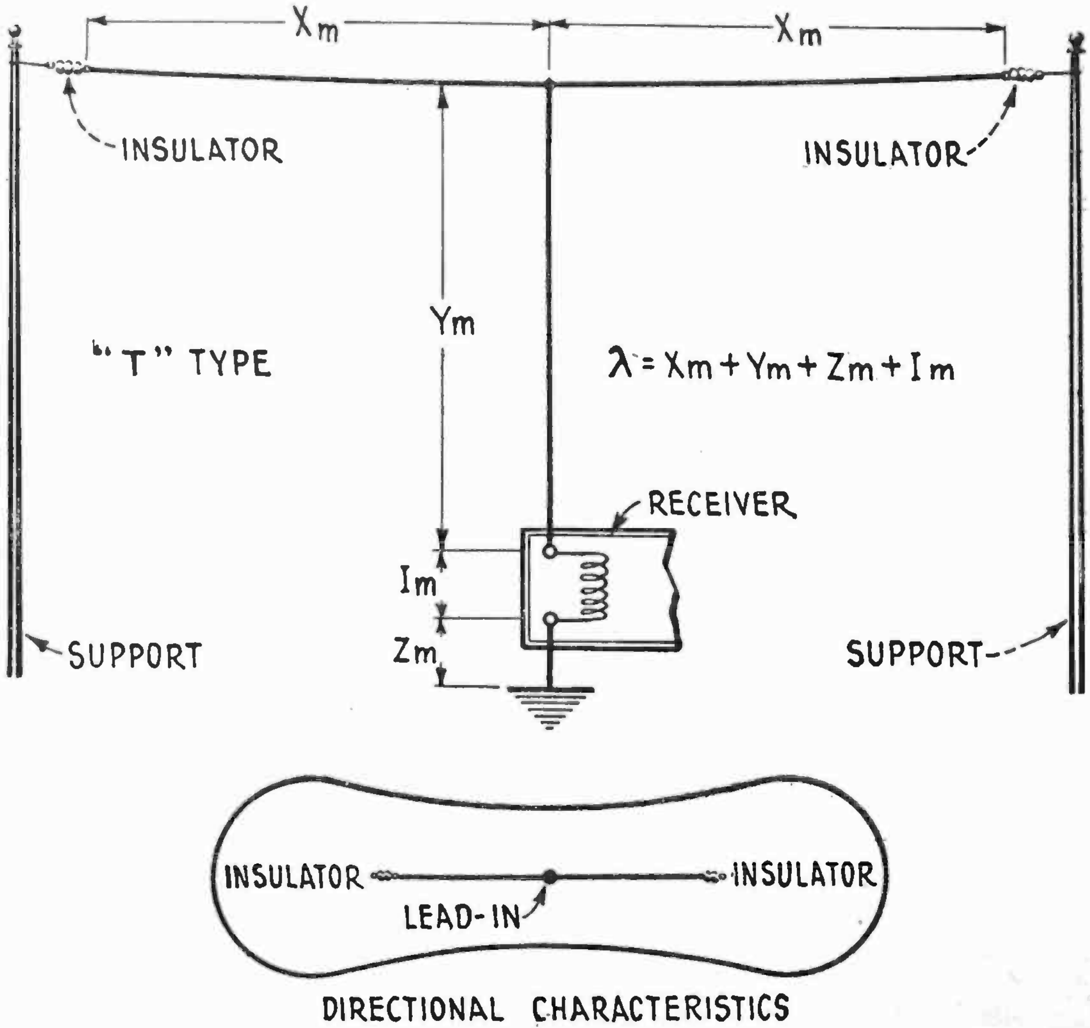


Fig. 1. The "T" type of antenna and its directional characteristics. The diagram shows how to calculate the wave-length. The valve Im averages about 10 meters.

enough. The following is the answer to this question:

At the present time, with the broadcast channel including the wave-lengths between 200 and 550 meters, we have more stations on the air than the ether can possibly afford to have without interference from each other.

Between the limits of the broadcast range, there are 350 channels corresponding to wave-lengths one meter apart. In order to receive the full energy from each of these separate bands, it is necessary to tune the antenna to what is known as resonance—a condition in which the wave-length of the signal is equal to that of the antenna. In former days, the antenna

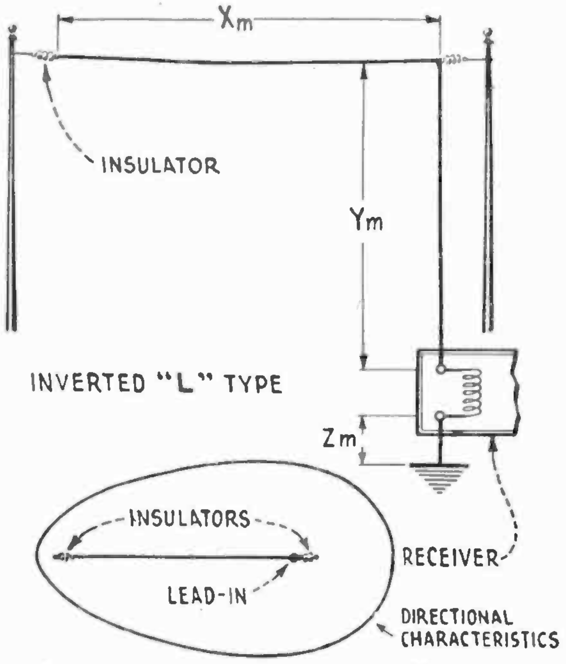
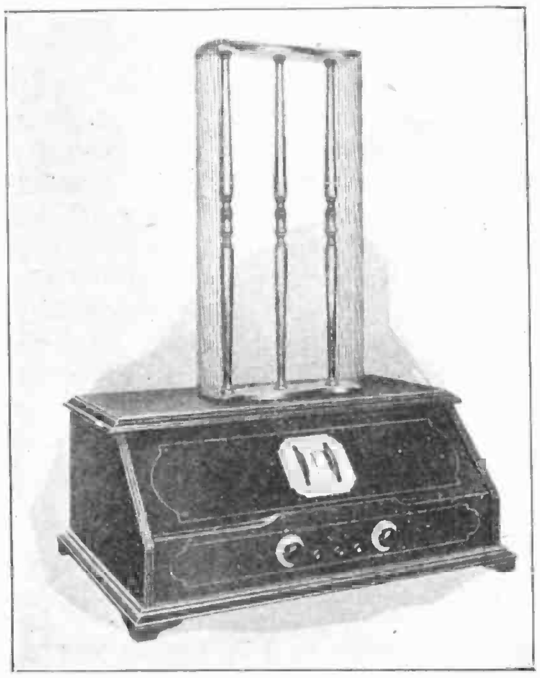


Fig. 2. One type of antenna which has gained wide popularity is the inverted "L." It is the best all-around antenna.

system was tuned to the incoming signal, but as progress went along in the development of more efficient receivers and since the tuning process involved an additional control, the tuned antenna was superseded by the aperiodic type which has been found to be quite effective for all purposes.

Keeping in mind that amplification at the higher wave-lengths is presumably known to be greater than that at the lower wave-lengths and that with the same amount of power input a signal on 200 meters will travel further than the same signal on 600, it may seem perplexing to decide whether or not we want an antenna having a fundamental wave-length nearer 200 meters than one nearer 600.

However, the wave-length of the average antenna installation should be in the neighborhood of 175 meters. And it has been found that this average installation is quite capable of all that may be required. Actual measurements have shown that the energy picked up by a receiving antenna varies more or less in accordance with the graph shown in Fig. 5 curve (a). This curve takes into consideration the antenna alone. The effect of coupling a tuned circuit to it, such as for instance the grid circuit of a radio frequency amplifier or detector tube creates the condition shown in curve (b). The antenna is no longer aperiodic, but semi-aperiodic, the coupling between the coils serving to tune the antenna to a measureable degree. This then accounts for the fact that the ordinary short antenna having about 60 feet in its horizontal portion, 40 feet in the lead-in and 15 feet for the ground connection, is capable of receiving over the broadcast range from 200 to 550 meters, with such excellent results.



Showing another form of loop antenna operating with a radio frequency receiver.

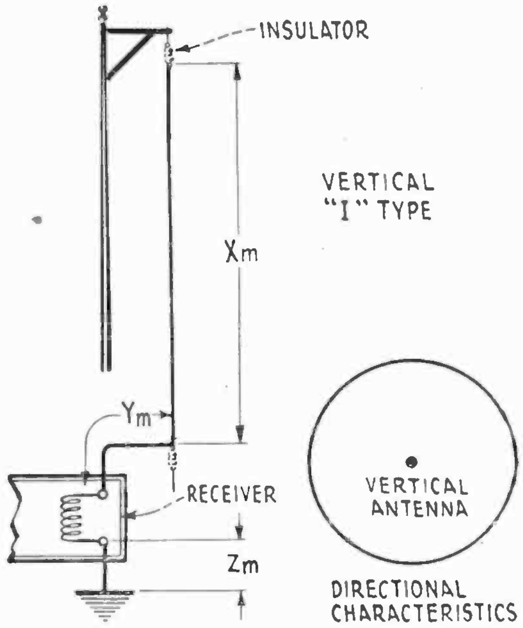


Fig. 3. Where space does not allow the erection of a long antenna, the vertical type will afford good results.

An interesting series of curves is shown in Fig. 4. It represents the three different types of antennae, together with the conditions under which each may operate. Thus, the "T" type can be made "full-wave," "half-wave" or "quarter-wave" in length. The others can also be made similarly. Of course, when we speak of a "full-wave" antenna, we have particular reference to one certain wave-length, as for example, 300 meters.

Within definite limits, the longer the antenna, the more the energy that will be picked up. Thus, the energy may assume such proportion as to necessitate loose coupling between antenna and receiver. Otherwise, broad tuning may manifest itself and several stations may come in, on or near the same dial setting. If the antenna is made as described, it will be found very effective.

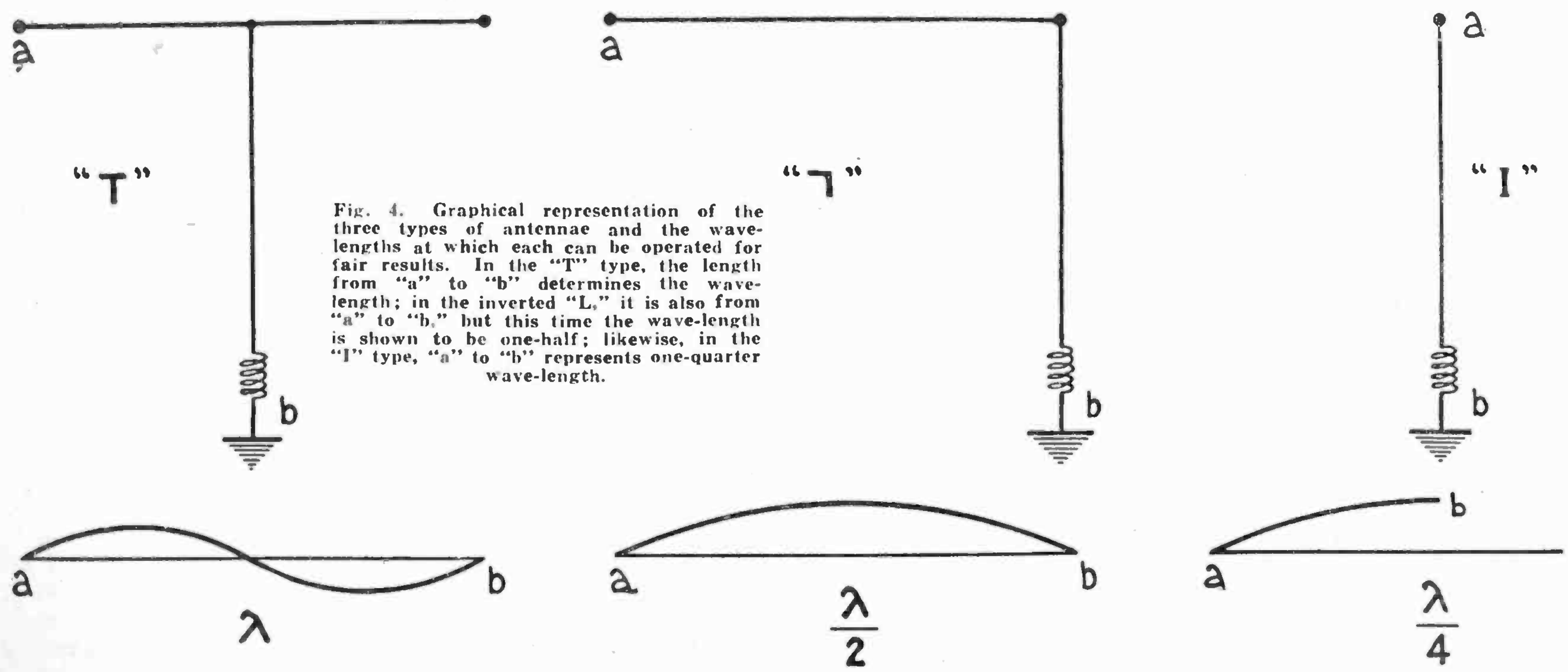
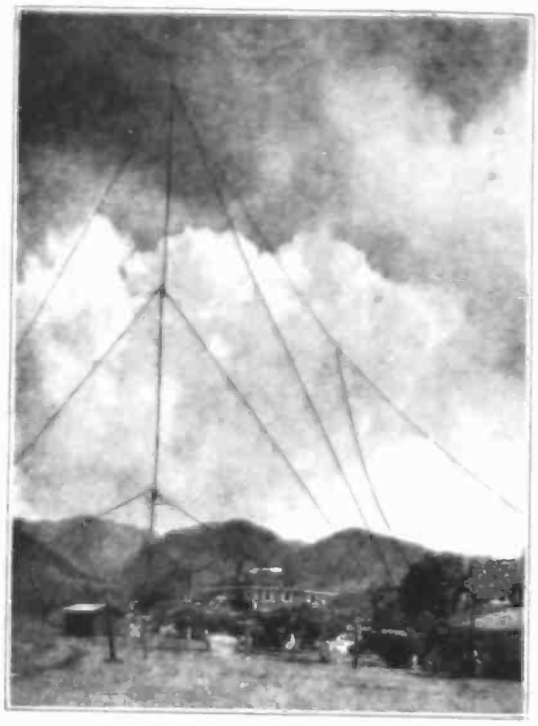


Fig. 4. Graphical representation of the three types of antennae and the wave-lengths at which each can be operated for fair results. In the "T" type, the length from "a" to "b" determines the wave-length; in the inverted "L," it is also from "a" to "b," but this time the wave-length is shown to be one-half; likewise, in the "I" type, "a" to "b" represents one-quarter wave-length.

The Loop

The loop antenna is merely an inductance on a large scale, so designed that when tuned by a suitable condenser, it will cover the wave-lengths of the broadcast stations. The larger



A beautiful type of installation showing the "T" type antenna and the rigidly guyed antenna mast.

the loop, the more the energy that will be picked up. This is in a degree necessary, for the loop is an inefficient collector and the very best loops will pick up no more than 3% to 5% of the total available energy. However, as we increase the size of the loop, we also increase the inductance, so that we must be careful not to exceed the limits allowable, to receive broadcasting. Thus, in order to use as much inductance in the greatest area as possible, we must employ as small a variable capacity or tuning condenser as possible. A .00025 mfd. will serve our purpose admirably, as this is the smallest variable condenser that will allow covering the entire broadcast range, satisfactorily.

The loop itself can be made from two to four feet square, the larger size, as said before, being best. In fact, if the loop could be made with its sides separated by one-half wave-length, it would correspond in effectiveness to an antenna one wave-length long.

The following information is given for various sizes of loops and for various sizes of condensers:

Frame	.00025	.00035	.0005
	Number of turns		
2 ft. square	20	14	10
3 ft. square	16	12	8
4 ft. square	12	8	6

The use of too small or too large a wire for winding the loop is to be avoided, for no other apparent reason than that, if a small size wire is used, it is liable to break easily, and on the other hand, if a heavy wire is used, it is difficult to wind. The average size wire is No. 22 and this will give as good results as any. The insulation can be anything from enamel to double silk covered.

The question of the type of loop to use often comes to mind. There are two distinct types—the spiral or pancake type and the solenoid or box type. Both have more or less the same characteristics and the problem as to selection should depend only upon one's taste. It is true that the pancake loop has a slightly higher resistance due to the fact that the turns decrease in diameter as the winding approaches the center and that in order to compensate for the loss of inductance value, a few more turns must be added. See Fig. 6.

Of course, the shape as well as the size of the loop determines its characteristics. Thus, we often see circular loops; hexagonal and octagonal ones; two rotary loops, one within the other and a variety of other types, some pleasing to the eye, others, freak-looking. However, no matter what particular style or shape that is used, a certain amount of inductance must be had and this is where the larger-size loops win. It is nevertheless true that with some receivers, hardly any difference can be noted when using different types of loops. This will be explained carefully in the following paragraphs.

"Can I use a loop with my set?"—a question that is often asked and more or less carelessly answered. To answer it properly, it is necessary to consider that there are five fundamental types of receivers and that each has its own peculiar capabilities. We have at the present date, the non-regenerative set, including all types of crystal sets (not reflexes) and those circuits which use no tickler feedback, or capacity feedback, or radio frequency amplification preceding a non-regenerative detector. Next come the regenerative receivers which constitute a great portion of the receivers in use. This type includes reflex circuits, inductive and capacitative feedback circuits and all those types of sets which employ no radio frequency amplification before the detector tube.

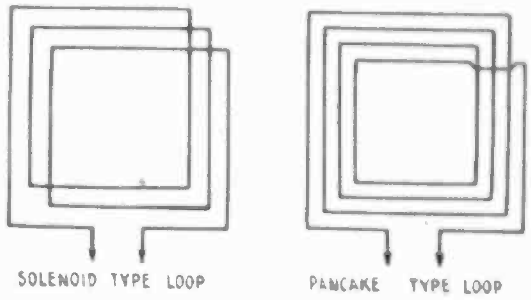


Fig. 6. There are two distinct types of loop antenna—the spiral and the solenoid.

The radio frequency classification, has without doubt, the greatest number of different combinations and these receivers are predominant in the broadcast field. In this class can be found, the neutralized, stabilized, reversed feedback, reflexed and regenerative radio frequency circuit, practically all of which are popular with radio fans. In the next class we have the super-regenerative set. This type of receiver has as yet not been developed to the point where it has achieved any marked degree of success and, as a rule, is not used for broadcast reception. The last type of set, the superheterodyne, stands among the best distance getters and the most selective types of receiver built.

Loops cannot be used with every type of set, for the reasons outlined herewith. In the non-regenerative classification, a loop cannot be used, regardless of whether tubes or crystals are used, unless the set is in the immediate vicinity of a broadcast station. Any distance over an eighth of a mile from a station will necessitate the use of an antenna (indoor or outdoor). At best, it is a poor policy to attempt the use of a loop on a non-regenerative set, volume and selectivity being lacking.

Good results can be obtained with a loop on a regenerative set, but even when employing this type of

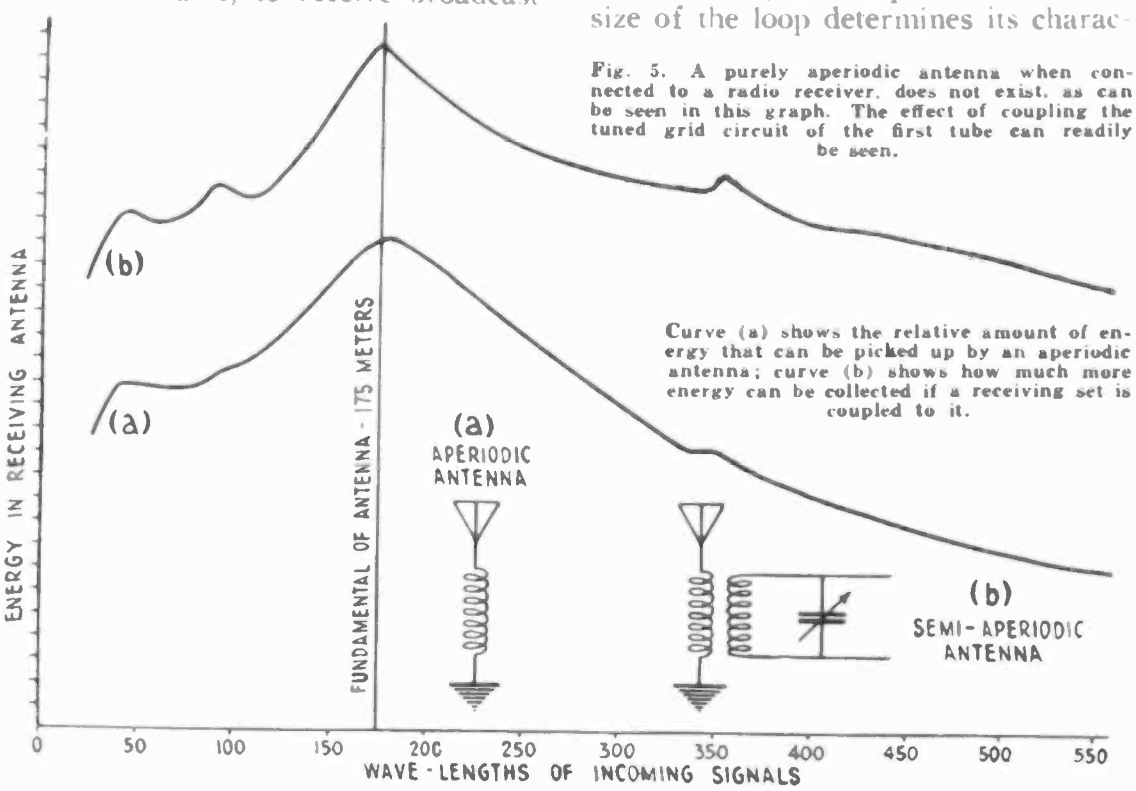


Fig. 5. A purely aperiodic antenna when connected to a radio receiver, does not exist, as can be seen in this graph. The effect of coupling the tuned grid circuit of the first tube can readily be seen.

Curve (a) shows the relative amount of energy that can be picked up by an aperiodic antenna; curve (b) shows how much more energy can be collected if a receiving set is coupled to it.

receiver it is best to use an antenna. The reflexed regenerative sets offer excellent results with a loop. There is one thing that must be kept in mind when using this type of receiver with a loop. That is, not to allow the loop to be placed too close to the set, as excessive feedback takes place and the field of the tuning coil interacts with that of the loop and uncontrollable oscillation may result.

If one has a tuned radio frequency receiver of any of the various modifications described previously, he can successfully supplant the antenna with a loop. See Fig. 7. It can be clearly understood from that sketch how to incorporate a double circuit jack so as to permit of the use of a loop or of an antenna. In the radio frequency circuits as well as the regenerative circuits, care must be exercised to prevent the loop's field from interacting with that of the radio frequency transformers. Keep the loop at a respectable distance from the set.

As regards the superheterodyne and the use of a loop, nothing more need be said than the fact that it is the best combination for distance. A superheterodyne will work on an antenna as well as a loop, but it is necessary to keep the length of the antenna short.

Having pointed out the types of receivers which will work on loop antennae, the next question which arises is "How can we account for the fact that such good results are being had with loops, when they are so inefficient, picking up, as stated before, only 3% to 5% of the energy that a good antenna can?"

This is an important question the answer to which will also answer the question "Is it worth while incorporating a loop antenna, although I get good results on my antenna?"

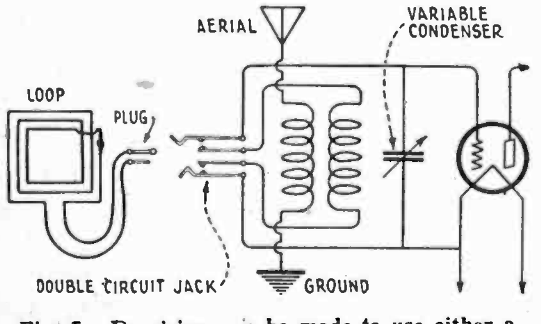
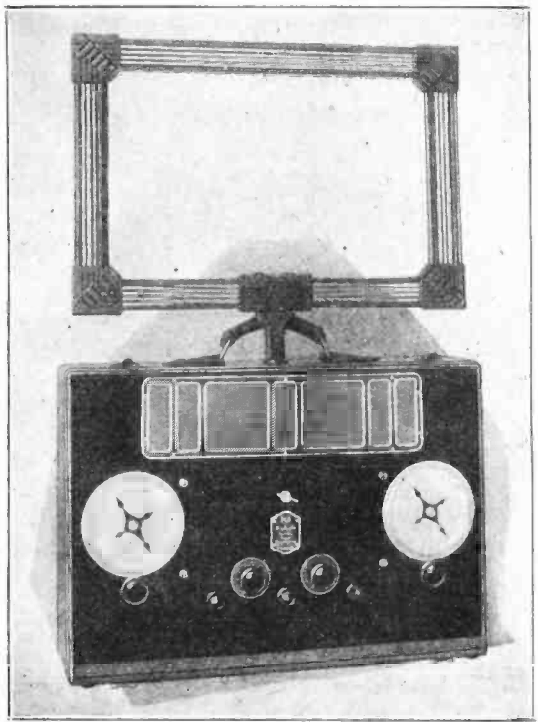


Fig. 7. Provision can be made to use either a loop or an antenna on a radio set, if the connections shown above, are made.

Good results with a loop depend upon the following conditions: When the set is a sensitive one (either regeneration or tuned radio frequency amplification may be used to gain good sensitivity); set is near or in the neighborhood of a steel structure; loop is in vicinity of a number of antennae; radiation takes place from a more powerful receiver, and when the territory is free from "dead spots." These are all very important items to be taken into consideration when summing up the reasons why good results can or cannot be obtained with a loop.

Comparison

Comparing results obtained with an antenna to those with a loop, we find that they are closely alike, so much so that with a good receiver, no appreciable difference can be noted. However, with a receiver of mediocre design, it is best to continue with the outdoor antenna. A loop may serve to bring in a few stations, but certainly, there will be a decided lack of volume and distance reception.



Very good success can be obtained when using a loop with a super-heterodyne. Here is one of the portable variety.

To the same extent, and even more imperative, it is necessary to keep the antenna well clear of surrounding objects and to insure a condition of good insulation, to keep the loop from the proximity of nearby metallic objects. Keep the loop away from the loud speaker horn, especially if the latter is made of metal.

In Fig. 8 is shown a method of insuring the best distance and volume which may be obtained with a loop. An outdoor antenna is connected to a loop fastened to the wall and preferably concealed. This loop may consist of about 10 turns of bell wire in a four-foot square form. The other end of the loop is grounded. An ordinary loop is then connected to the receiver and placed near, in inductive relation, to the one on the wall. In this instance, the loop loses its directional characteristics to an extent, but signals come in which might never have been heard before. The antenna is the collector, and through the process of inductive coupling advantage of maximum volume, minimum static, and greater distance-getting ability is assured.

In summing up, it need only be kept in mind that even though the loop as a collector of energy is very inefficient, still, its inefficiency is more than made up for by the powerful receivers we have today.

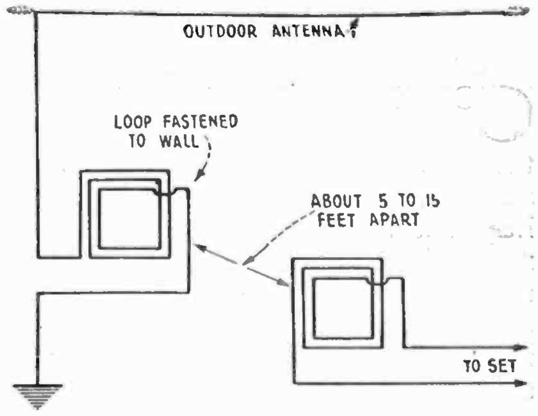
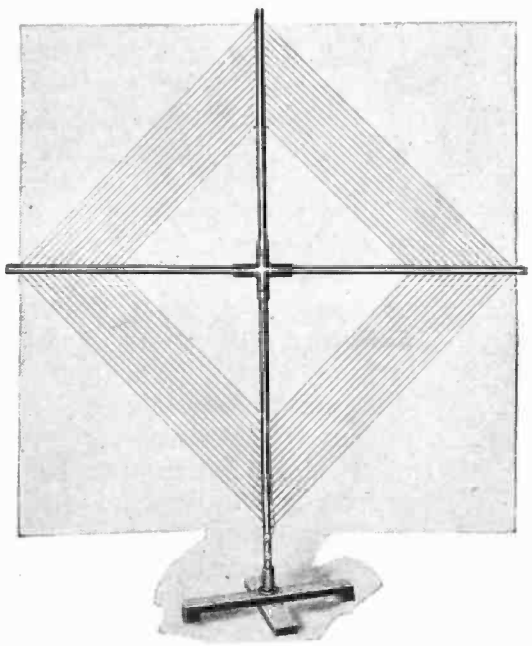


Fig. 8. A novel stunt to employ if you want to get extreme distance and greater volume. Two loop antennae are used in conjunction with an outdoor antenna.

Who can tell, but that at a later date, development will have progressed to the stage where the loop itself will take no more space than the average size inductance and receivers will be so small and compact that they will actually be "vest-pocket editions"?

Conclusion

In the last analysis, the use of either a loop or antenna with the right kind of radio receiver will give about the same results. In the first instance, tuning may be sharpened, volume may be slightly diminished and distance will probably drop off. In the second case, a maximum of volume, distance and slightly broader tuning may result. Static is decreased to almost a negligible quantity by the use of a loop and reception from all points of the compass comes in with the same directional characteristics.



A typical spiral type loop.

Now that it is summer time, one should go over his antenna installation and clean or replace the insulators, erect a new wire, put in a lightning arrester, ascertain that the masts are securely guyed and see to it that the lightning ground as well as the receiver ground is perfect.

New Radio Developments

By JOSEPH BERNSLEY

CONSIDERING the infancy of this fascinating industry, since the time that it first aroused the enthusiasm of the public (1921), we cannot help becoming fascinated at the remarkable strides in the development of radio apparatus, both in design and efficiency, new circuits, new apparatus, new principles, and a tendency to simplify and do away with the complications that retarded this industry's progress. It is not the purpose of this article to delve into and show the advances made, but rather to show the more radical departures from the old and exceedingly inefficient instruments that were used in the days of "wireless." Very few will recall the hardships of the "old timer" and "brass pounder," for there are now comparatively few B. C. L's who participated in those days, with apparatus that is now considered as antique but nevertheless served faithfully in its time and gave complete satisfaction.

Vacuum Tubes

There can be no doubts but what wireless or radio as it is now called made its first and most important step forward when the three element vacuum tube was invented and introduced by Dr. Lee DeForest, in 1906. It is the most sensitive device known and with it is made possible present day receiving and transmission. At the time of its introduction, the crystal detector was performing rather satisfactorily, but nevertheless had its difficulties which created a desire for a more efficient and sensitive detecting device. The crystal detector required constant readjusting, was not over sensitive, and had no dependable means of amplifying the signals. The vacuum tube in those days was a bulky but frail affair, consumed much filament current, and was rather unstable due to gases which were left within the tube in the pumping process. The vacuum pumps at that time were not as efficient as the present ones being used, there being no demand for a high degree of vacuum before that time. Slowly, vacuum tube design began advancing. Vacuum pumps were designed to create a high degree of vacuum. Tubes were designed for different functions, thus a soft or gaseous tube was developed for detection purposes (UV-200 and C-300). These tubes were very much more efficient than their predecessors, but required an enormous amount of filament current, one ampere for each tube used, to be exact, thus requiring large and bulky storage "A" batteries. However, as the old saying goes, "necessity is the mother of invention," and so tube design advanced. Research engineers experimented with metals that were known to have a high electronic emission when coated with certain alkaloids and therefore would not require as much current. As a result of this research work, we now have tubes with thoriated filaments (metal filaments coated with thorium) such as the 201-A or 301-A type, 199, WD-11 and 12, etc., which tubes consume only from .06 of an ampere for the 199 type, to .25 of an ampere for the storage battery tube. The enormous saving in filament consumption is obvious, if we use six of the old type tubes at one ampere apiece, six amperes are flowing; if we use six of the present type tubes, 199 type, only .36 of an ampere is required; six of the 201-A or 301-A type require only 1.5 amperes. Progress in vacuum tubes is still being made, vacuum tubes are being developed to operate direct from the lighting source, whether of the alternating or direct current type. Inventors are trying to eliminate the filament element from the tube, and use some material which will emit a sufficient number of electrons at ordinary temperatures to make the tube operative. We can safely rest assured that some material benefit will be derived from their present tedious experiments.

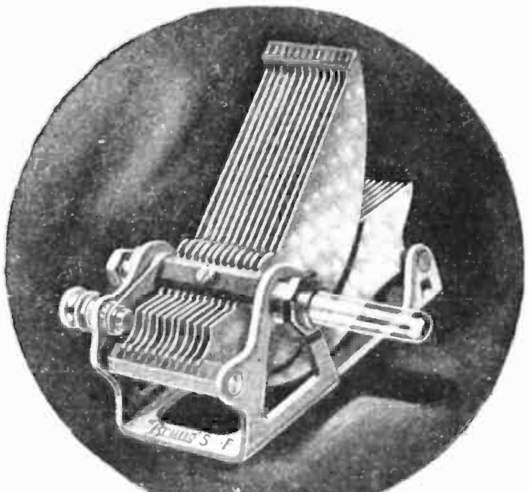


Fig. A. A revolutionary departure from conventional condenser design. In this case, the stator is connected to the frame and the rotor is an isolated unit, insulated from the stator plates.

Variable Condensers and Coils

As this new interesting method of obtaining entertainment and amusement took hold, the public became enthusiastic and compared notes on the amount of stations and number of miles received the night before. Thus, Mr. Jones would say to Mr. Brown, "Lessee now, last night I got the 'Night Owls' out in Minnesota, and the 'Tamborine Serenaders' in Gohgah, and etc. etc." and Mr. Brown would look somewhat hurt and puzzled and remark, "That's funny, last night all I could get was the locals." That night Mr. Brown would do some tall thinking, as a result of which would come the determination to purchase a new and wonderful receiver which would get him all the distant stations he would want, so that he too could boast to his friends of what he got the night before. There were many Mr. Browns at that time (there are now) or radio set owners who at that time responded similarly. Economics teaches us that "demand regulates supply" a result of which caused manufacturers to concentrate on the design of the instruments which make the receiver efficient,—the coils and condensers. They knew that there were a great many losses in these instruments that could be decreased to a minimum or eliminated, and so came about a revolutionary movement or fad called "low loss." Condensers were designed in all shapes and sizes, but all from a rugged mechanical and electrical standpoint. The plates of both rotor and stator units were soldered to decrease the resistance of the condenser, beside placing the dielectric that supports or holds the instrument together at the weakest points of the electrostatic field.

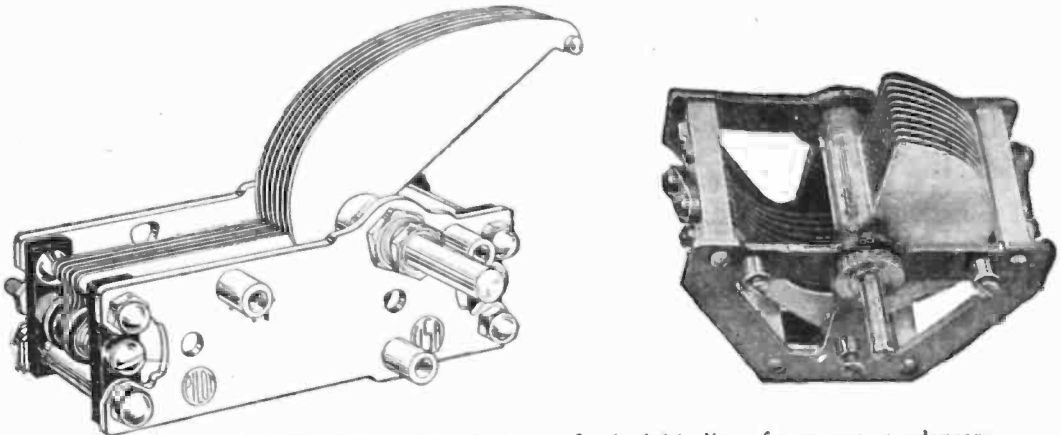
The story of the straight line frequency condenser is an interesting one. The first good type of condenser used (and there are still many being used and purchased at the present time), was that of the straight line capacity type, —thus if we made equal changes in the dial reading 0 to 100, equal changes in capacity would be obtained. The disadvantage of this condenser was, with broadcast stations as they are now arranged—200 to 550 meters, the stations between 200 and approximately 350 meters would crowd in on a relatively small portion of the condenser dial i.e. 0 to 30, whereas the rest of the dial would be comparatively "empty." The next step was the straight line wave-length condensers which for every equal change in the dial reading from 0 to 100 will give an equal change in meters or wave-lengths. Although this eliminated some of the crowding of the short wave stations (200 to 350 meters) that was experienced with the straight line capacity condenser it was not totally satisfactory, as stations were being assigned by frequency and 10 kilocycles apart. This left the only remaining possible solution (the solving of this problem of the straight line frequency condenser was exceedingly difficult from a design standpoint and from the manufacturer's angle of mass production) the straight line frequency condenser, which for every equal change in the condenser dial reading would result in an equal change in frequency.

Some very interesting samples of modern low loss straight line frequency types of condensers are shown in Figs. A, B and C. In Fig. A is shown a low loss straight line frequency condenser of unique construction and entirely different from conventional design. Contrary to the usual type, the stator is connected to the frame, whereas the rotor is a completely isolated unit and insulated from the stator plates. The shaft is made of a special bakelite composition (turned in a lathe), thus keeping all metal away from the front of the receiver and reducing any body-capacity effect that might result. The plates of the condenser are made from a special low resistivity brass alloy and are of uniform thickness being levelled to obtain this characteristic by a special receiver. Contrary to the usual run of straight line frequency condenser this condenser does not take up much room, its total length when both rotor and stator plates are engaged is approximately three inches.

Figs. B and C illustrate two other types of extremely rugged, both mechanically and electrically, straight line frequency condensers. Both types have been measured in our laboratory and found to have a very practical straight line frequency curve.

The subject of coils is a very peculiar one, the development of this instrument having branched off in several directions. The first attempt of manufacturers was to reduce the resistance of the coils which had so much to do with retarding the signal energy as it came in to the receiver and was amplified. This was done by using larger gauge wire and reducing the amount of dielectric support that held the coil in position as much as possible. With the advent of the Neutrodyne and other types of non-oscillating receivers a great deal of discussion was aroused as to the probable causes of oscillation, or "whistles" and "squeals" as the layman refers to it. Some engineers claimed that oscillation in an ordinary five-tube tuned R.F. set was produced by magnetic coil feed-back, and produced coils that had a limited magnetic field to prevent this interaction. As a result of their efforts we now have the toriod and binocular coils.

In the toroid coil we have a coil whose magnetic field, due to its peculiar construction is exceedingly small and close. Thus, if we place three such coils in a receiver with some little space between each (approximately two or three inches), we can easily see that no magnetic reaction could possibly result, thus preventing violent oscillation and instability which would ordinarily result. A very efficient coil of the toroid type of unique construction is that shown in Fig. D. The windings are rigidly fastened to a circular bakelite strip which winds around the top and gives the coils its circular shape. This feature tends to keep the coil at a constant inductive value which characteristic is usually spoiled by windings that are loose and constantly shifting.



Figs. B and C. Two other designs of straight line frequency condensers.

Fig. E illustrates a coil of the binocular type. It consists of two cylindrical windings connected in series with the primary wound within the secondary turns. Its magnetic field is also limited and in opposing fashion, thus giving a self-neutralized coil. The particular coil is shown in a rigid form all of which results in a very efficient coil of constant inductive value.

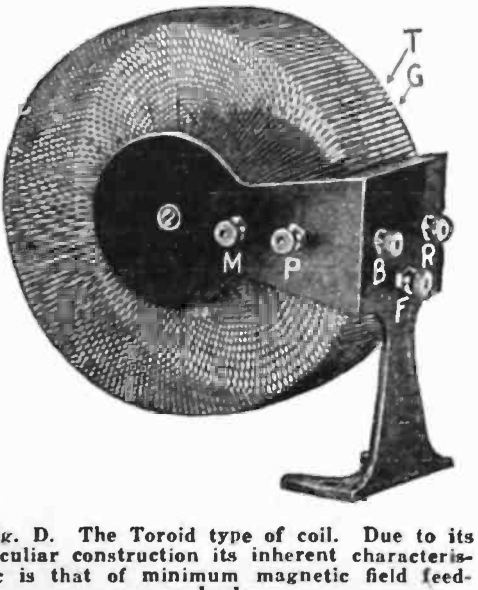


Fig. D. The Toroid type of coil. Due to its peculiar construction its inherent characteristic is that of minimum magnetic field feed-back.

It should not be understood that these coils can entirely replace the cylindrical type or coil wound on an ordinary cylindrical bakelite or hard rubber tube, as we know it. The aforementioned coils should only be used in certain receivers where interstage coil coupling is not desired, and where quiet operating receivers of the neutrodyne or neutralized type are preferred. Many people hold up their hands in horror when they listen to the squeals and whistles emitted from a loud speaker attached to a receiver of the regenerative or oscillating type. Still others believe only in regenerative receivers as being the most efficient and best distance-getters. Suffice to say that both types can produce equal satisfaction, this being only a question of personal taste.

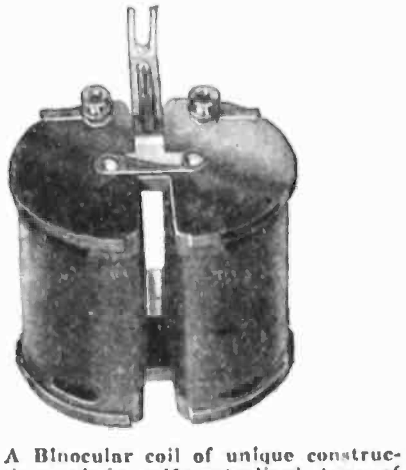


Fig. E. A Binocular coil of unique construction. It is used in self-neutralized type of receivers where oscillations or "squeals" are not desired.

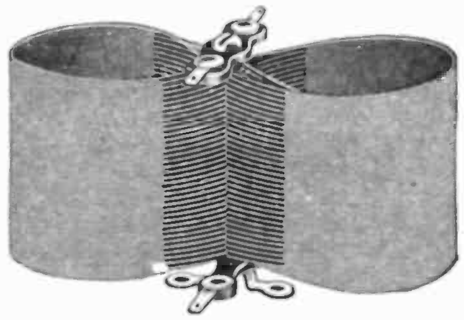


Fig. F. Another type of Binocular coil. This coil is of the self-supporting type to reduce di-electric losses.

Loud Speakers

Few realize that in the old days loud speakers (for radio reception purposes) were unheard of amongst the radio amateurs and enthusiasts of that day. The radio listener then would be tickled to death if the signals were audible with headphones. Loud speakers first became popular about 1919, but despite this late start have made enormous progress. Those who started in early in this industry will recall the loud speaker which was constructed so that an ordinary headset could be clamped on two openings on special projections leading from the sides of the loud speaker. The headset was functioning as what we would now term as the loud speaker unit, and the horn as the sound-box which supplies the necessary air column, and amplifying device. Loud speaker engineers weren't interested very much in the quality of reproduction, overtones, reproduction of high and low tones, etc., etc., but they became so later on. Loud speakers that were capable of giving extraordinary volume regardless of their reproduction factor at various audio frequencies, were next introduced. Some used power from an external source, such as the storage battery or from direct current lighting mains. Their popularity was extremely short, for the radio public was fast becoming educated as to the possibilities of a radio receiver and loud speaker. Scientifically constructed loud speakers and cone speakers are the results, and we can now listen to a radio receiver con-

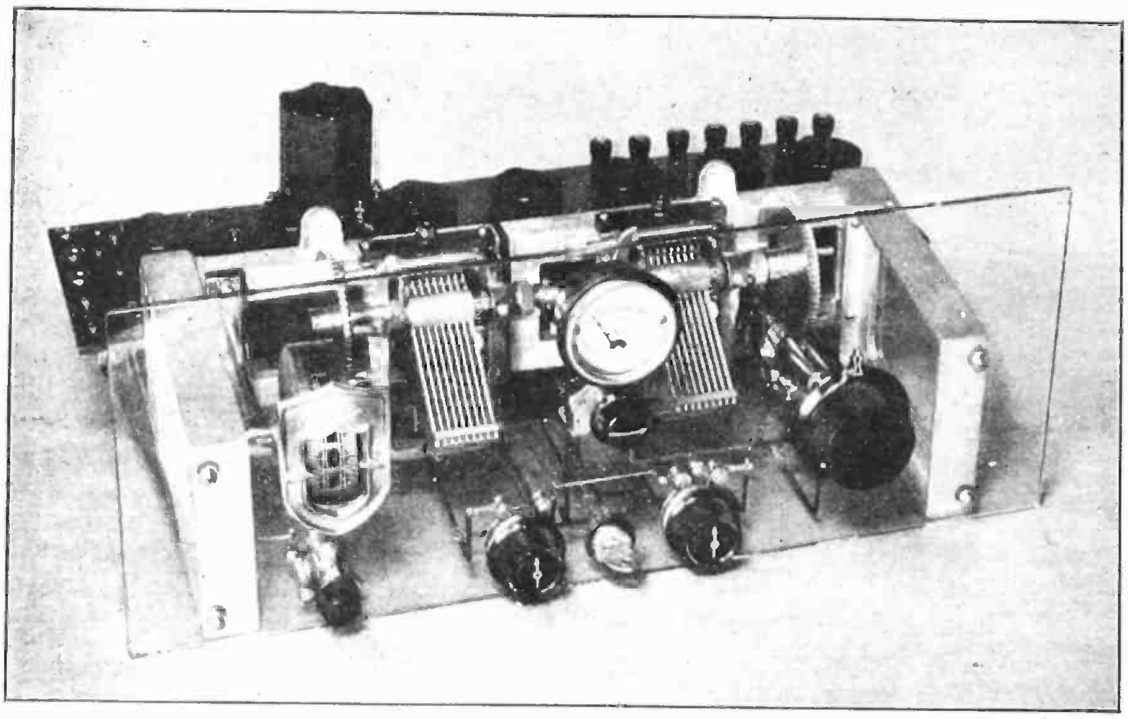


Fig. K. A Radio Receiver designed from an electrical and mechanical efficiency stand-point. The sturdy chassis construction permits the construction of a receiver that will last a life time.

nected to either of the above and notice the absolute fidelity of the tones reproduced, in many cases being as exact or superior to the quality of reproduction as obtained from a phonograph.

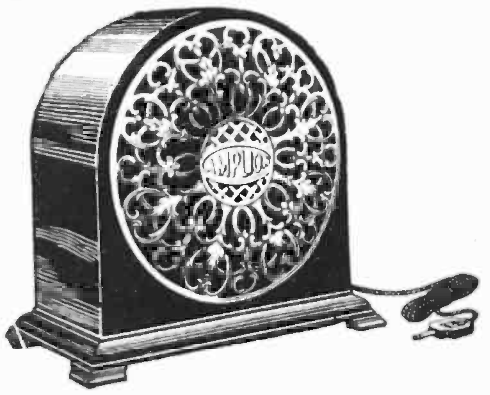


Fig. G. A loud speaker constructed on scientific principles. It is designed to fit in with the surrounding living room furnishings.

What present day loud speakers look like is clearly shown in Figs. F, G, and H. They are made so that they fit into ordinary living-room surroundings, not so obtrusive as their predecessors, harmonious, and entirely satisfactory. In Fig. F is shown a loud speaker constructed on scientific acoustic principles. Special wood and fibre is used practically throughout the entire construction, thus eliminating the metallic tones and reproducing sounds, naturally. In Figs. G and H are illustrated the cone type of loud speakers. These operate on the principle of vibrating side discs or parchment somewhat similar to the sides of a drum which are set into vibration. In this particular instance, the loud speaker units are used for actuating or vibrating the cone discs of parchment (some cone speakers employ different material), thus producing sound. The tone obtained from this type of speaker is exceedingly pleasing, even though in many cases the sound is not natural. In other words, the quality of reproduction is enhanced.

Receiving Sets

The greatest advance made was in the design of receiving sets, as can be easily seen by a comparison of modern receivers, with the old type of "wireless" using the old audion tube mounted on the front. Manufacturers are starting to realize that the more fool proof, and the greater the mechanical and electrical strength their product has, the easier it is to sell, besides their service or maintenance problems are decreased. Radio receivers have become so popular, and the consumers ideas, as to just what he would like to have the set as regards general appearances, furniture design, size, etc., so varied that we now have a number of receivers on the market, which although they serve the same purpose, are differently constructed as concerns the aforementioned. In one thing we can agree, and that is that the number of tuning controls on a receiver must be as low in number as possible. Too many controls confuse the prospective purchaser, make the receiver seem hard to tune and control, and usually results in the loss of a sale, when the radio retailer tries to explain in a technical way why numerous controls are sometimes beneficial. Just what constitutes too many controls is

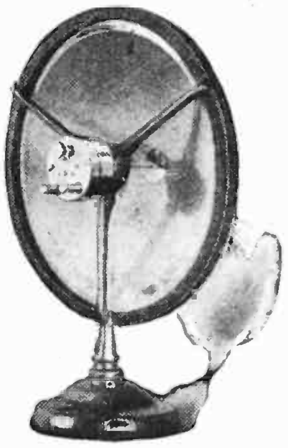


Fig. H. An earlier type of cone loud speaker which illustrates the various parts and mechanism which make up this style of speaker.

another and somewhat more difficult question. Some will be amazed to learn that this factor is dependent upon location. The following explanation although somewhat technical is the only satisfactory means of answering this problem. Those technically versed know that the greater the number of tuned circuits employed in a radio receiver the greater the selectivity obtained. So much for that. This class or "intelligencia" also know that in some particular localities where broadcast stations are from 150 to 300 miles away, the selectivity factor is not desired as there is no use for it. Interference is only experienced where the receiving station is in close proximity to the broadcast station. And so, in geometrical fashion, we can safely conclude that for those who desire receivers and are located near a broadcast station (20 to 25 miles) a receiver employing two or three controls should be sufficient, while for those located at a distance from the nearest broadcast station, one or two controls will be satisfactory.

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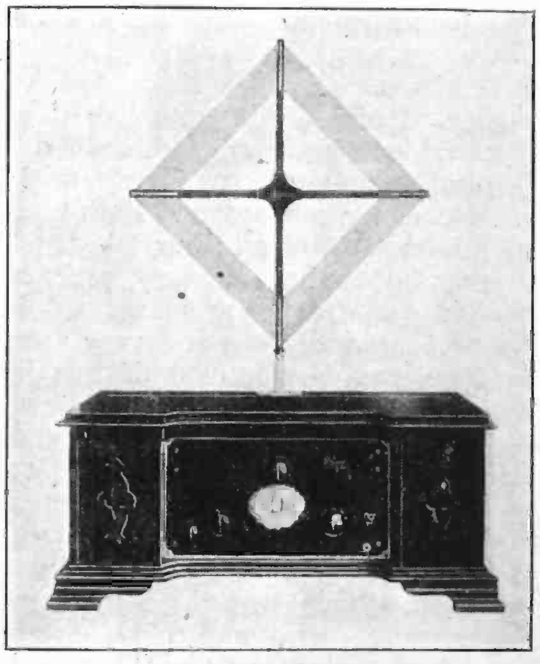


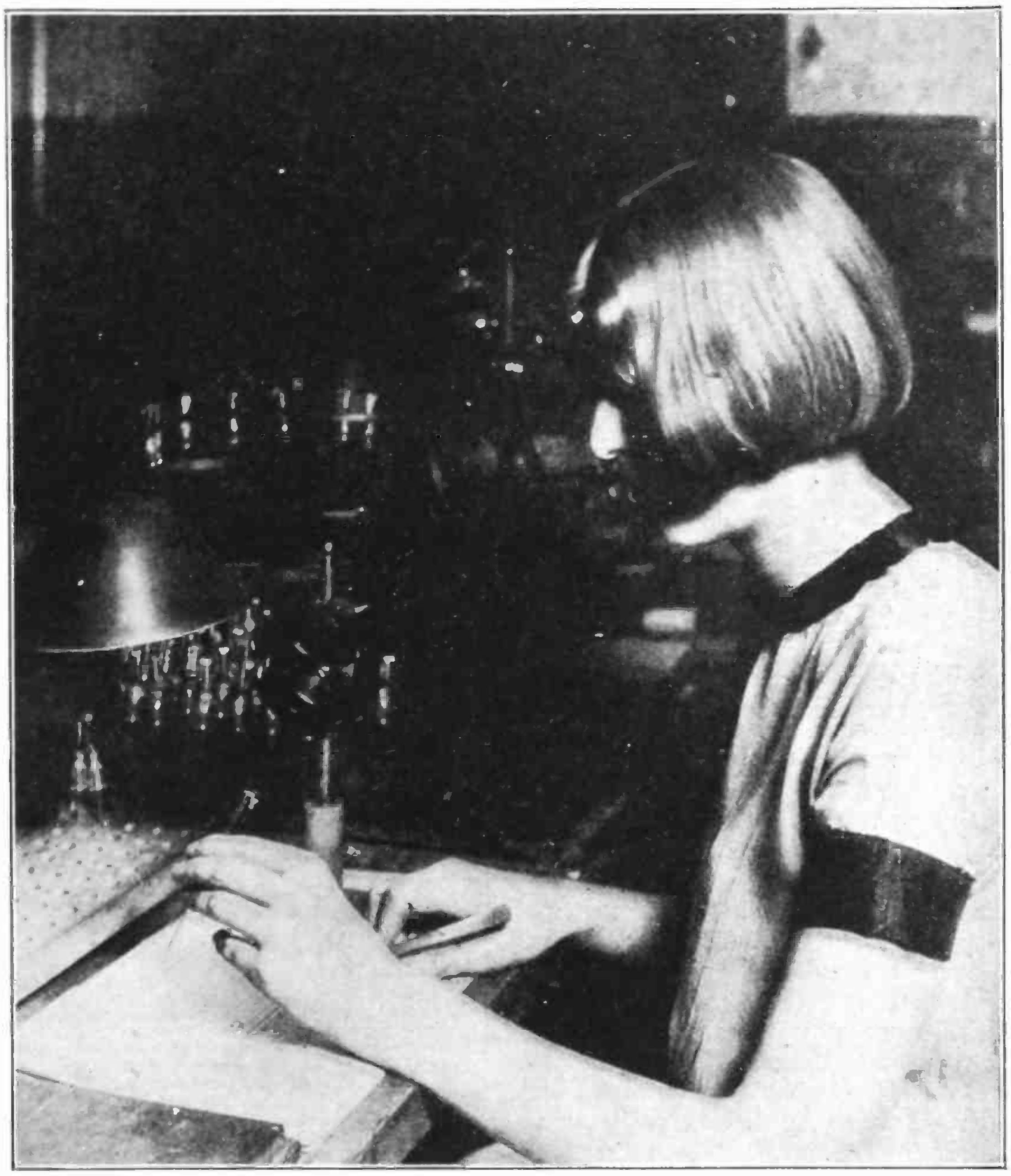
Fig. J. Radio sets as they are designed at the present day. The above illustration shows a self-contained, neat, receiving set. No antenna and ground is required.

Vacuum Tubes and Their Work

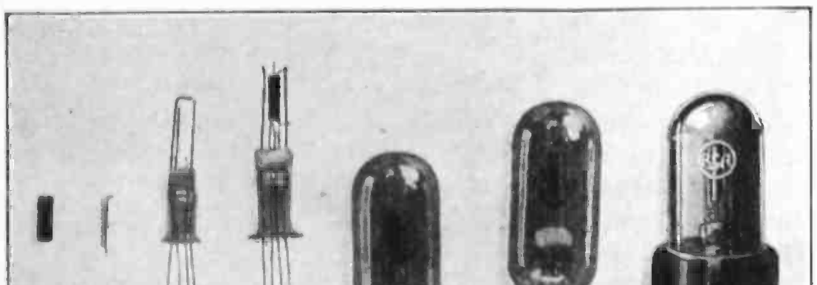
By Dr. ALFRED N. GOLDSMITH

THE entire broadcasting structure rests on a vacuum tube foundation. Otherwise stated, without vacuum tubes there would be no broadcasting stations, no radio programs, no sensitive and far-reaching receiving sets, no loudspeakers of remarkable volume and marvelous tone, and in fact no radio industry. There would be, however, the old-time void in home life, as well as the old problem of what to do with the long evenings spent at home.

It is doubtful if radio telephony, which is the technical basis of radio broadcasting, would have become practical without the vacuum tube. In fact, until the advent of the improved vacuum tube, radio telephony was a crude laboratory experiment. All prior devices for the generation of radio telephone waves were erratic in action and unsuited to musical reproduction. When a steady wave generator was eventually secured there was the problem of controlling the waves so that they might carry a faithful impression of the sound values to be transmitted through space. This process is called "*modulation.*" In the days before the vacuum tube *modulators* and so-called *speech amplifiers*, the wave-creating energy had to be handled by the microphone direct. And since the usual microphone can handle but a small current without frying and baking itself out of useful existence, it is evident that the early radio telephones were either limited in power or were supplied with a continuous flow of fresh and costly microphones as necessary replacements. But allowing that the radio telephone waves, in some manner or other, did get on the air, modulated to a degree, but essentially weak, the receiving sets then available were not capable of intercepting these over an appreciable distance. And when they did intercept the radio waves, the sound rendition was in the form of faint speech and phonographic music in the telephone receivers tightly and even painfully clamped to the perspiring ears of the listener. It was a wonderful exercise for the imagination, too, listening to those elusive signals!



This girl is a check inspector, which means that she checks up the inspections of other inspectors. In her hand is the complete "mount" or inside assembly of a UV-199 tube, with filament, grid, plate, supports, anchorages, flare tube and exhaust tube, ready for insertion in the glass bulb. To ensure the highest standards at all times, the check inspectors take a certain percentage of the parts, in this case the mounts, and give them an extra inspection. A powerful magnifying glass is required to inspect the delicate assembly.



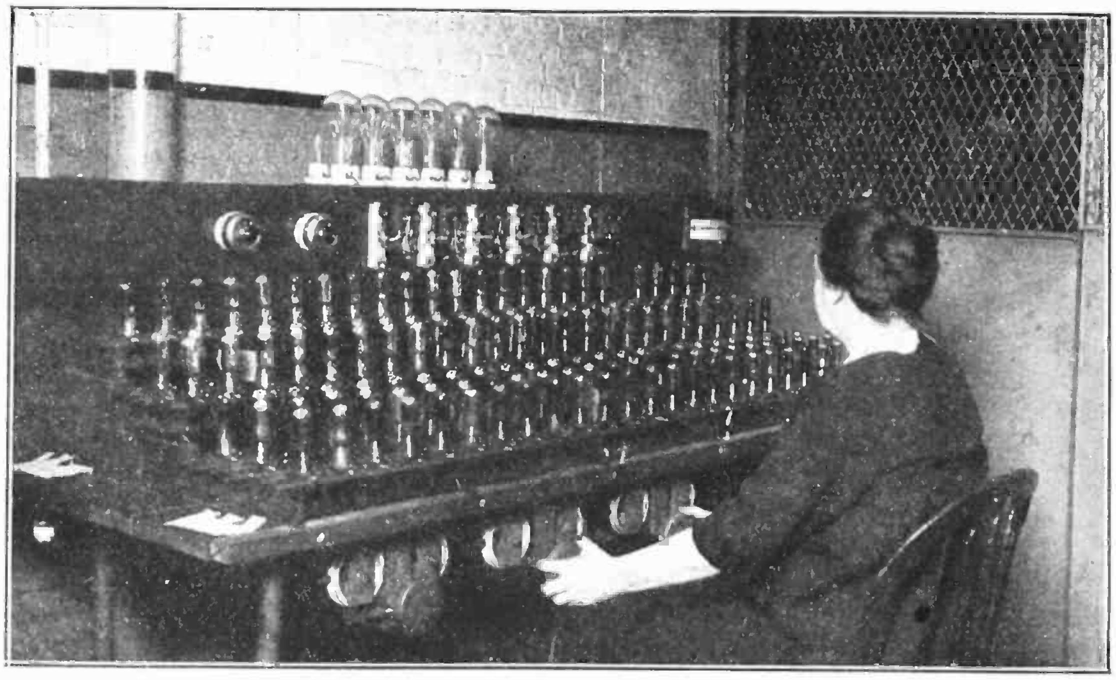
Successive stages in the manufacture of a dry cell vacuum tube showing how the elements are arranged with the glass vacuum bulb. From left to right are the plate, grid, filament on support, assembled elements, elements within tube and finally the completed tube.

Photos by Courtesy of Radio Corporation of America

Such is the doleful picture of radio telephony prior to the advent of the three-element or standard vacuum tube of today.

A Rival of Aladdin's Lamp

We have marvelled at the fantastic story of Aladdin's lamp which did all manner of things for its possessor through its command of the genii. Yet in the present-day vacuum tube we have a lamp that is as versatile and as valuable as the brass lamp of the well-known Aladdin. Our miracle lamp also controls a giant worker, electricity, and bids him do whatever tasks we may designate. Thus the present-day vacuum tube converts plain direct current into high-frequency current for propagating radio waves. The vacuum tube magnifies or amplifies delicate electrical varia-



On this large table 150 vacuum tubes are operated at one time, for the purpose of seasoning or ageing them. The tube filaments are operated at different voltages and for different lengths of time to prepare the filament material for the work to be done by the vacuum tube.

tions to unbelievable proportions and without distortion of the original values. The vacuum tube rectifies alternating current into direct current. The vacuum tube enables us to control a powerful current by the dictates of a very weak current. And there are many other things which this modern Aladdin's lamp will and does do in radio and other applications.

As a typical example of the amazing feats performed with our miracle lamp, there is the broadcasting station. The vacuum tube takes the voice of the man at the studio microphone and increases its power over 50,000,000,000 (yes, fifty billion!) times. We cannot conceive what that means, but perhaps this may help convey some impression of such voice magnification: if everyone on earth were to get together and shout in unison, the voice power produced would still fall far short of the voice of the broadcasting station. The world's call would be only about one-thirtieth as strong!

How the vacuum tube goes about magnifying the voice at the microphone is a story in itself. Suffice it to say here that a number of vacuum tubes are employed, so that the magnification or amplification takes place in steps or stages. In some instances there are as few as five or ten tubes; in others, as many as fifteen. Each tube in turn increases the power of the voice current until the final tubes give the full power for broadcasting. The initial stages involve small tubes, known as *speech amplifiers*. Then come the larger tubes known as *modulators,* which in turn control the giant *oscillator tubes* which generate the energy for the radio waves themselves.

And at the receiving end the process is quite the same. The delicate radio-frequency energy induced in the antenna or loop of the radio receiver

Here we have a girl inspector, examining the bakelite bases one by one for defects in appearance and construction.

is brought to the vacuum tube known as the detector, usually by way of one or two amplifying tubes which magnify the energy. The detector in turn controls a more powerful local source of energy, in exact accordance with the minute variations of the intercepted radio waves which thereafter is passed through one, two or three *amplifying tubes* until the final tube controls a current sufficiently powerful to actuate a loudspeaker. So, as in the transmitter, the receiving end takes a delicate current and builds it up step by step until the desired power is attained. In the transmitter, however, we start out with direct current for the studio microphone, which is converted into high-frequency radio energy in the aerial. In radio reception, the process is just the reverse, starting with the almost infinitesimal high-frequency radio energy and converting it into direct current which pulsates in accordance with the music and speech modulations at the transmitting station.

When Metals Evaporate, or Electrons in the Making

To understand the action of the vacuum tube, which is by no means baffling or complicated despite the scope of its applications, it is first of all necessary to know something about heated bodies and electrons.

Recent discoveries in the realm of physics have indicated that all material bodies are composed of minute divisions of matter termed molecules, and that these molecules are in constant motion inside the substance. Furthermore, it is believed that the rapidity with which these particles move and the temperature of the body may be closely related, so that the raising of the temperature brings greater molecular activity, and, conversely, the lowering of the temperature reduces molecular activity until the molecules come to an absolute standstill at the absolute zero of temperature, which corresponds to 273 degrees below zero on the Centigrade thermometer scale.

Electricity, according to physicists, is composed of a staggering number of infinitesimal divisions called "electrons," which are set in motion as an electric current flows through a circuit. Thus a conductor, according to this process of reasoning, is a material whose molecular structure permits electrons to pass through it. An insulator, contrariwise, has a molecular structure through which electrons cannot pass with sufficient freedom.

Now an electron is an exceedingly minute value. Indeed, it is so minute that the average mind cannot picture this ultra-microscopic entity. Perhaps this comparison may help: it has been estimated that the electric current re-

The grid is a most delicate part of the tube, especially in the UV-199 and WD-11 and WD-12 types. The machine in the background of this view winds the grids in a long string, which is then cut apart by these girls to the proper length. The separate grids are now inspected for spacing, size, ends and other characteristics, the faulty ones being rejected and the perfect ones passing on to the assembly department.

quired to light a 50-watt electric lamp is composed of a flow of 3,000,000,000,000,000,000 (yes, the figure is given correctly — six groups of ciphers) electrons per second!

So far, so good. Now let us consider evaporation and what it means.

We all know something about evaporation, because it is a common enough phenomenon. We have often experienced the evaporation of water, gasoline, alcohol and other liquids. It so happens that solids also evaporate. Solid water, or ice, evaporates at temperatures considerably below the freezing point. And metals will evaporate if heated to a sufficient degree.

Evaporation, according to scientists, can be explained within the bounds of "molecular motion" theories by assuming that some of the water molecules have attained sufficient speed due to the temperature to break through the surface and shoot into space. Likewise with metals. If sufficient temperature is attained, the molecules attain sufficient speed to be shot into space.

It so happens that not only molecules of the solid but also whatever electrons happen to be present in its structure are shot into space at the extreme velocities attained by the molecules. With an increase of temperature, more and still more electrons will succeed in breaking through the surface of the material and be flung into space. Thus, it will be noted, we have electrons, or electrical entities, as well as molecules or minute divisions of the material, given off during the phenomenon of evaporation. The electrons of electrical entities are of negative polarity.

Just as long as a body is cold, relatively speaking, there is no evaporation. No molecules and electrons are shot into space. But if that body is heated to the necessary degree, evaporation sets in, with molecules and electrons shot into space.

The Electronic Bridge of the Vacuum Tube

The history of the early discoveries and experiments and subsequent refinements leading up to the vacuum tube is long and involved. Suffice it

A batch of finished UV-201-A tubes undergoing the so-called jigger test, which means an electrical inspection for short-circuits, misplaced elements, broken or burnt-out filaments, and so on. The girl seated at the table attends to the jigger test, with a combination of lamps which tell-tales on defective tubes.

to say here that Edison, the inventor of the electric lamp, originally discovered that if a wire or plate were put in the vacuum of an electric lamp, along with the filament, and if that additional element were made positive in polarity with relation to the filament, current would flow across the vacuum from hot filament to cold plate. If, however, the plate were made negative with relation to the filament, no current flowed. The reason, of course, is that no electrons can escape from a cold mass. Edison knew nothing about electrons and could not fathom the mystery of this phenomenon, but nevertheless made note of it and since then we know this phenomenon as the "Edison effect."

In a vacuum tube, then, we have a heated filament, which is the heated metal body that gives off electrons as well as molecules. The filament is heated by passing electric current through it. For this purpose we make use of a suitable battery, called the

Among the various components supplied to the Radiotron factory are the plates. Here is a girl inspector, testing the plates one by one with a direct-reading micrometer size gauge.

"A" battery. In circuit with this current supply we place a device which places more or less obstruction or resistance to the flow of current and therefore regulates the heating of the tube filament. This device is called a *rheostat.*

Our vacuum tube filament is heated. We have a flow of electrons, or negative entities of electricity. Suppose we insert a small metal plate, which is called the plate, and give it a positive charge with relation to the filament. We may use another battery for this purpose, called a "B" battery. Instantly we have a flow of electrons from the heated filament to the plate. We have, to all intents and purposes, a bridge across the space in the tube. Shut off the "A" battery current, the filament becomes cold and the electrons no longer come out of the filament, so that our electronic bridge is broken. Turn on the "A" battery current and the electrons immediately re-establish the electronic bridge. If we make the plate negative with relation to the filament, the electrons are no longer pulled away from the filament and therefore no electronic bridge is established.

So here we have the principle of a

Here are the type UV-201-A tube mounts or inside assembly receiving the regular inspection. The inspector carefully examines each mount, to make certain that there are no mechanical defects. Her sole tool for this work is a pair of delicate tweezers, for this work is of the most delicate kind.

one-way traffic bridge. Electric current will flow across the electronic bridge from the filament to the plate, but not in the reverse direction. Feed alternating current, or current which changes its polarity many times per second, to the vacuum tube described, and all the energy of one polarity will be passed through, while the energy of the other polarity will be left behind, thus converting the alternating current into direct current. This is the principle of the *vacuum tube rectifier,* so extensively employed for storage battery rechargers.

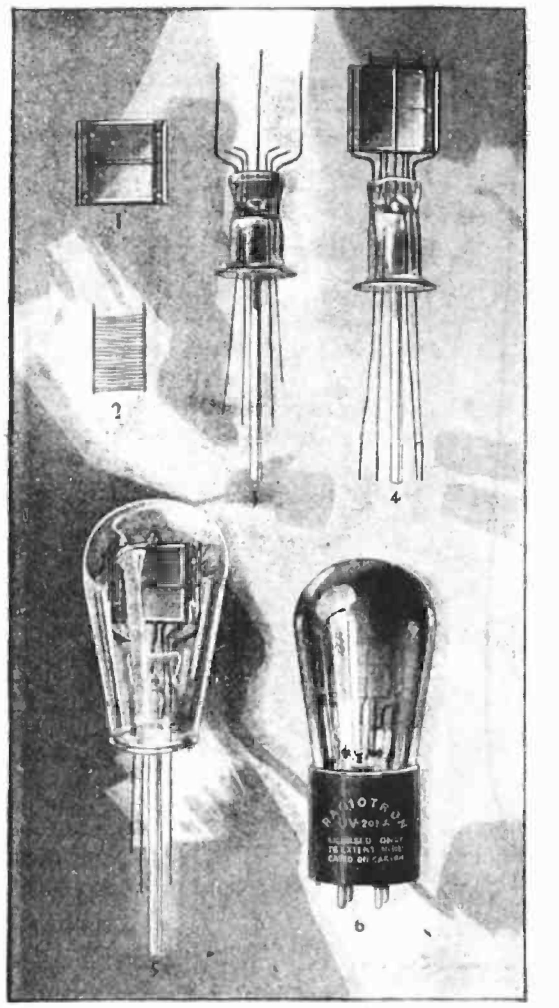
The addition of a plate or second member to an electric lamp gives us the *two-element tube* or *diode,* which is employed mainly as a rectifier in radio transmission and also in recharging storage batteries for the receiving end. In the early days of radio, two-element tubes or diodes were employed as detectors for reception, but these tubes lack the necessary sensitivity called for in present-day practice.

The Role of the Grid

Referring again to our electronic bridge with its one-way traffic, let us assume that we can assign a traffic cop to the task of regulating the flow of traffic. The authority of the law stands behind that cop. He merely raises his hand, with the expenditure of negligible power, and the traffic comes to a stop. He waves his hand or blows his whistle, and the traffic moves once more. He is actually controlling hundreds and even thousands of horsepower in the form of motor traffic, yet he is doing it with little or no effort of his own making.

Well, we have an electric cop who does just that job in the present day vacuum tube. We call him the *grid,* because it so happens that this member of our tube is made in the form of a grid, or several turns of wire.

With the expenditure of little energy, this grid controls the flow of traffic across the electronic bridge just as effectively as though it were a sluice



Step by step assembly of the larger size tube, such as used in the average storage battery type radio receiving set. This tube is the 201-A Radiotron.

gate of a hydro-electric power plant. By making the grid alternately positive and negative, the amount of current flowing from the hot filament to the plate can be increased and decreased, the grid itself taking practically no power.

It will now be noted that because of the delicate yet positive action of the grid, which gives us the three-element or triode tube, it becomes possible to control a relatively powerful local current by means of an exceedingly minute external influence. It is the difference between the grid charge and the plate current which determines the amplification characteristic of a vacuum tube. Thus, if this difference is 1 to 10, our tube is capable of a ten-fold amplification or, to put it another way, a drop of one volt in the grid will result in a corresponding drop of 10 volts in the plate. This also explains why a vacuum tube makes such a sensitive detector for the reception of radio waves. What is more, the plate current instantly follows every variation in the grid charge, so that we have perfect reproduction of the delicate grid variations, which is essential in handling voice currents.

The Necessity of High Evacuation

Electrons are delicate little things, as we have already learned. If they are to form an electronic bridge across the gap in the vacuum tube from hot filament to cold plate, through the control of the grid traffic officer, there must be no obstructions placed in the way. Obviously, if plenty of big gas molecules are left in the tube after the air has been withdrawn, the electrons are going to have a much harder time working their way from one side to the other, and we are certain to have a state of affairs quite similar to a subway rush.

Years ago the research laboratories took up the extensive study of the vacuum tube, especially from the angle of high evacuation so as to remove as many of the remaining particles of gas as possible from the so-called vacuum tube. Vacuum pumps were vastly improved; a complete study was made of the action of various gases on electronic evaporation; numerous experiments were performed to determine the effect of gases absorbed

In due course the flared tube is provided with a glass stem, the exhaust tube (for Radiotrons are now of the tipless kind, so that the exhaust tube has to be provided elsewhere but at the tip of the glass bulb) and the so-called welds or lead-in wires. There are seven wires imbedded in the assembly which this girl inspects, four passing through the pinched part of the flare tube, and three used as anchorages.

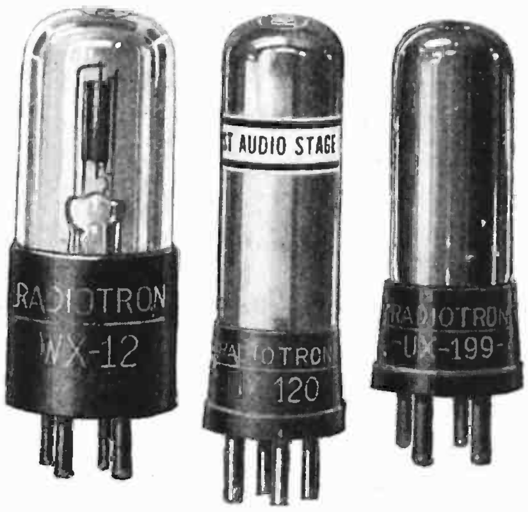
in the metal of the electrodes and the glass walls of the vacuum tube. The result of these extensive experiments and studies took the form of marked improvements in radio tube production.

In producing suitable amplifier and oscillator tubes, a high vacuum is essential. What is more, the residual gases must be removed from the relatively porous metal parts and glass walls, lest these gases interfere with the efficient operation of the vacuum tube. Today, the highest grade of such tubes, known as Radiotrons, are not only highly evacuated by means of the mercury diffusion pump invented by Dr. Irving Langmuir of one of the laboratories that stand behind Radiotron development, but every precaution is exercised to reduce the residual gases to the irreducible minimum. Thus the parts to be used are treated with special gases to absorb moisture and oxygen, while a suitable chemical, known as the "getter," is fired within the sealed tube so as to absorb the last traces of gases that may remain. The "getter," usually magnesium, accounts for the silver lining of some vacuum tubes.

More Electrons from Less Electricity

The early vacuum tubes made use of solid tungsten wire for their filaments, with the consequence that the usual receiving tube required about an ampere of current to heat the filament to the point necessary for prolific electronic emission. This heavy current drain necessitated a storage battery, and even when a single tube was employed in a receiving set the storage battery required frequent recharging. Obviously, where a detector tube and two amplifier tubes were employed, the storage battery had to be recharged every few days. The five and six tube receivers of today would not be feasible with those early tubes.

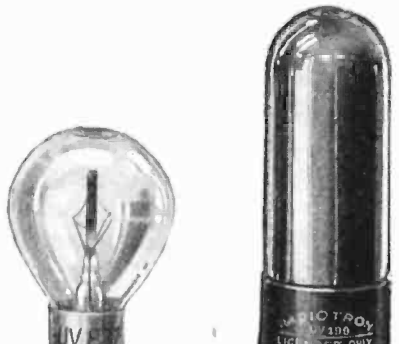
With a view to reducing the "A" or filament battery drain, the reseach laboratories made extensive studies and numerous experiments on filament materials. Soon the specially coated platinum filament was introduced in tubes. This consists of a thin, narrow ribbon to which has been cemented a thin coating of certain metallic salts. This coating results in the production of electrons with a fraction of the filament current required with pure tungsten. It is used in the well-known tubes WD-11 and WD-12 (and their corresponding new standardized base tubes WX-11 and WX-12). Still more re-



Three different types of tubes commonly known as dry cell tubes.

cently there was introduced the *thoriated tungsten filament*, which is also employed extensively. This filament is known as the "X-L" type. The thoriated tungsten filament is a tungsten mass containing a small admixture of thorium compound. The filament is mounted in the vacuum tube during manufacture, but even after the tube has been sealed and completed, the filament is not ready to function until subjected to a seasoning process. This process involves the heating of the filament to different temperatures and for certain periods. By this process a layer of thorium atoms one atom deep—and only one atom deep—is formed on the surface of the filament. This atomic layer of thorium is of high electron emissivity, so that sufficient electronic emission is obtained from it at surprisingly low temperatures and with but a fraction of the current necessary to produce satisfactory results with solid tungsten. The thoriated tungsten filament is continually giving off thorium atoms and electrons while the filament is heated, and new thorium atoms and electrons are continually being boiled out of the depths of the filament to form and maintain the surface coating or layer already described. Just so long as the proper operating conditions are maintained, the process functions of itself. But if excessive potentials are applied or if the tube has been in use for a normal life-time of such a tube, the coating may be worn through in spots and the performance is no longer perfect. In this event it is often possible to restore the coating of thorium particles and thus restore the efficiency of the tube by what is known as the reactivating process, described further on.

Suffice it to say that the metallic salt-coated and the thoriated tungsten filaments of these tubes have had a far-reaching influence on the development of broadcast reception. They



At the left is shown Radiotron UV-877 used to prevent damage to other tubes from shorted "B" battery circuits. The tube at the right is the UV-199, the smallest Radiotron made. This tube is used for dry battery sets.

have made possible the supersensitive receiving sets of today with five or more tubes, and the operation of receiving sets on ordinary dry cells.

A Product of Research and Precision Manufacture

A vacuum tube is quite deceptive. The plain truth of the matter is that appearances mean little or nothing, so far as the quality of vacuum tubes is concerned. It is the performance over a period of months which brings the total number of service hours to beyond the thousand mark of the honest tube. Too often the radio novice judges vacuum tubes by appearance or catchy name or similarity with genuine Radiotrons. Or again, the main attraction is low price; yet low price alone should be a caution signal, because good tubes cannot be produced at the low prices sometimes asked for nondescript tubes.

Good vacuum tubes are the result of extensive research. Behind the Radiotrons are the past and present efforts of several vast research and test laboratories, not only engaged in constant refinements and improvements in the product itself, but also in the development of new machinery and manufacturing process which will provide a still better tube at a popular price within reach of all. Furthermore, the test laboratories stand between the manufacturer and the purchaser, insuring that nothing but good tubes will ever reach the radio receiver.

The manufacture of tubes is an intricate process involving the most delicate form of glasswork as well as the making and assembling of metal parts to within tolerances of thousandths of an inch. There are thirteen stages in the production of a Radiotron, and at each stage that tube must be vigorously inspected and tested. If it fails to measure up to accepted standards at any stage, even the final stage, it is rejected. For this reason every Radiotron leaves the factory a faultless and matchless radio detector or amplifier, representing a supreme achievement of research.

Detectors, Amplifiers and Oscillators

So far as radio reception is concerned, vacuum tubes fall into three broad classes, namely, as detectors, as amplifiers, and as oscillators. The tendency today is to employ the same type of tube for the three classes of service, although for super-amplification or power amplification there are special tubes. Oscillators employed in certain kinds of receiving circuits, such as the Super-heterodyne, employ the usual amplifier tube; but when it comes to larger oscillators for laboratory and transmitting purposes, special transmitting tubes are employed.

For those who desire a super-sensitive vacuum tube detector, irrespective of the more critical adjustments involved in its operation, there is the *"gassy"* type of tube, with a lesser degree of vacuum than the *"hard"* or highly evacuated amplifier tubes. One type of Radiotron which is a supersensitive detector is the UX-200. The UX-200 has a tungsten filament and requires an "A" battery current of 1 ampere at 5 volts, necessitating a storage battery for efficient results.

For detection and amplification, as well as the oscillator, there are three families of Radiotrons, namely, the highly economical UV-199 and UX-199 Radiotrons of small size and intended for dry-battery operation; the WD-11, WD-12 and WX-12, all of the same type but with different style bases, operating on dry cells; and the UV-201-A and UX-201-A, intended for storage battery operation.

The UV-199 and UX-199 Radiotrons are highly economical in battery

A UV-201-A tube is shown at the left and the new UX-112 power tube at the right.

current drain, and have been designed specifically for portable or home receivers having more than five tubes. The "A" battery voltage should be 4.5 volts, with a rheostat to reduce the applied filament voltage to 3 or 3.5. The battery current consumption is .06 ampere, or almost 1/20 ampere, which is truly remarkable. The thoriated-tungsten filament, together with the close spacing of the elements within the tube, accounts for this economy.

The WD-11, WD-12 and WX-12 Radiotrons are the proud descendants of the first dry-cell Radiotrons ever introduced, and remain one of the most popular and widely used detector-amplifier tubes. The "A" battery consists of a single dry cell for each tube, with about 1.1 volts applied to the filament. The current drain is a quarter ampere, so that for efficient operation one dry cell should be added

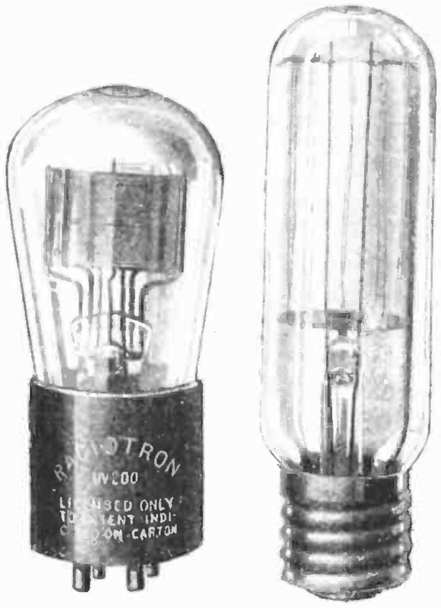
The UX-201-A and the UX-200, the latter type being the most efficient detector.

for each tube, the cells being connected in parallel. These tubes have oxide-coated filaments.

The UV-201-A and UX-201-A Radiotrons have been accepted as the flexible all-round storage battery tubes, giving ample volume in any detector, amplifier or oscillator circuit. A six-volt storage battery is required for these tubes, with the applied voltage held at about 5. The current consumption is about one-quarter ampere per tube.

Power Tubes for Super-Power Reception

Because of the demand for greater loudspeaker volume without sacrifice of tonal quality, it has become necessary to employ larger Radiotrons which will not become overloaded, with subsequent distortion, in the last stage of an amplifier. Thus there is the Radiotron UX-120, which, like its companions UV-199 and UX-199, operates on three cells of dry battery with the same voltage and a current



Another popular type of storage battery tube is shown at the left, while at the right is a current-regulator tube used in power units.

consumption of but .125 ampere. UX-120 is essentially a *power tube* and should be used exclusively in the last audio amplifier stage, with a plate potential of 135 volts as compared with 45 to 90 volts generally employed with the tubes already mentioned. Radiotron UX-120 can be used in any existing UV-199 tube socket by means of an ingenious adapter which not only takes its new base but also permits of applying the additional plate voltage.

Then there is UX-112, which does for storage-battery receivers what UX-120 does for the dry-battery receivers. UX-112 takes the place of the last UV-120-A or UX-201-A in the audio amplifier. It will deliver more energy than the average loudspeaker requires, which means ample volume, fine tonal quality, and long life. If desired, two UX-112 tubes may be employed in the audio-frequency circuit, with remarkable results for tone and volume. This tube has a coated filament which burns a dull red. A six-volt battery furnishes the filament current of .5 ampere.

For those who desire the maximum of loudspeaker volume with the best in tone quality, there is the UX-210, which is a super-power amplifying tube designed primarily for use with an eight-volt storage battery or a specially designed rectifier for operating from the usual alternating current socket. This Radiotron may, if necessary, be employed with the usual 6-volt battery, with reduced output, of course.

Tubes That Harness Lighting Current to the Radio

Since the insistent public demand for operating radio receivers from the usual electric light socket instead of from batteries, there have been introduced special tubes which are known as *rectrons*. These tubes are rectifiers, serving to convert alternating current into direct current of suitable voltage and characteristics, in conjunction with auxiliary equipment. There is rectron 213, which is a *full-wave rectifier*, thus rectifying the two sides of an alternating current into uni-directional receiving-set current, and there is rectron UX-216-B, a *half-wave rectifier*. The usual practice is to employ a single UX-213 rectron or two UX-216-B for full rectification.

In the train of rectifying tubes or rectrons, there must be various tubes for controlling and regulating the voltages handled by rectifiers. Thus there is Radiotron UX-874, which is a

Above shows the UX-213 full wave rectifier tube and the UX-874 voltage regulator as used in power units.

voltage regulator tube designed for use primarily in rectron power units which eliminate batteries. The UX-874 is so constructed that when properly connected it maintains a potential of 90 volts to the radio receiver at the 90-volt tap. It is an automatic intelligence, so to speak, which sees to it that the proper plate voltage is always supplied under normal fluctuations of line current.

Another device is Radiotron 876, which is also a *current-regulator tube*. It is employed in the rectron power units as a silent sentinel which is always on guard over the line current. Unless the current is thus regulated, the output to the receiver is not constant. This type of tube is sometimes called a ballast tube—a descriptive term.

The UX-216-B is commonly used as a half-wave rectifier in power units. The UX-210 at the right is a super power amplifier for use on 8 volt filament supply.

Then there is little Radiotron UV-877, which is a *protective device* designed as a safety valve to prevent damage to the Radiotrons of transformers resulting from shorted "B" or plate battery circuits. This Radiotron introduces a high resistance when a short-circuit occurs in the plate circuit and thus protects the equipment, while in normal operation its resistance is negligible.

The Importance of Proper Connections

It is of the utmost importance that all Radiotrons be properly connected for detection or amplification. Not only does the connection for amplification differ from that of detection, but the connection for detection is not the same for all Radiotrons. In the case of the UV-200 and UX-200 Radiotrons, the grid return lead is connected to the negative side of the filament.

Considerable leeway is allowed in the value of the little combination device known as the grid leak and condenser, which is employed between grid and grid return of the detector tube. For very weak signals, the highest recommended value will generally give greatest sensitivity. The lowest value of grid leak recommended is generally best for average work, however, because of the better quality of reproduction on average signal strength.

How to Get Better Results from Your Radio Batteries

By JOHN T. VORPE

IN these days when radio has become a regular institution in millions of homes, the minds of receiving set owners are continually busied with the equally important problems of obtaining best results and maintaining a low up-keep cost.

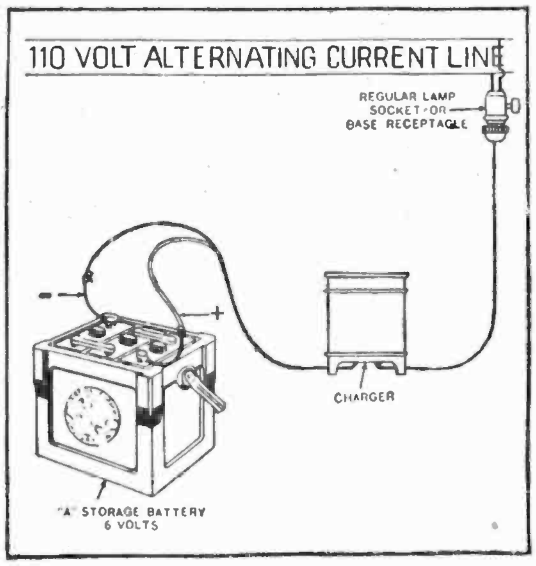


Diagram No. 1. Showing method of charging "A" battery with charger from 110-volt A. C. line.

The radio set itself requires but few replacements over several years' time. The electrical current to run the set, however, must be obtained from batteries, either dry or storage. If the radio set utilizes dry cells it is necessary to replace worn-out batteries periodically. On the other hand, if storage batteries are used, it is necessary only to have them recharged at various intervals.

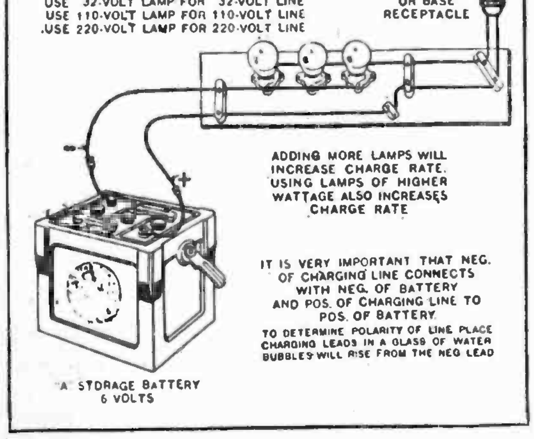


Diagram No. 2. Showing method of charging "A" battery from lamp bank.

Regardless, therefore, of the medium of power used, there is necessarily some expense from time to time. But even this expense may be comparatively small or large depending on several conditions.

Chief among these conditions are the following:

1. Number and kind of tubes used in the receiving set.
2. Frequency of use of the set.
3. Type of batteries used—dry cell or storage.
4. Care of batteries.

Number of Tubes Determines Expense

The radio sets which are finding most popular favor today are the larger and higher powered sets. More and more the radio public leans toward sets having not only the power and efficiency to bring in distant stations, but the power to bring them in clearly on loud speakers. The set that can do this is a multi-tube set, using from four to eight vacuum tubes. Naturally, such sets draw heavily on both "A" and "B" batteries. Batteries, in spite of improvements in construction, are more quickly run down than in the early days when the single tube, two and three tube sets were in vogue. Dry batteries require frequent replacement. Storage batteries must be more frequently recharged. Thus the increasing number of tubes on sets means not only greater first cost of set but also a greater upkeep cost in power.

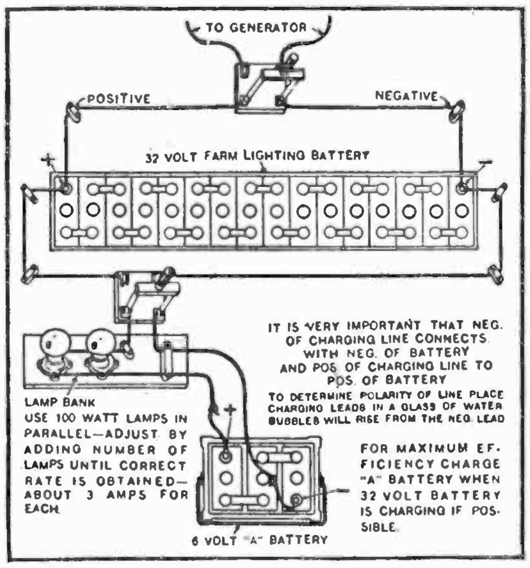


Diagram No. 3. Showing charging "A" battery from 32-volt lighting plant battery.

Use of Sets Determines Expense

Anyone knows that if a pair of shoes is worn all day long every day they will wear out much quicker than the Sunday pair. The same is true of batteries. If the set is used continuously, it is necessary to replace dry cells oftener or to recharge storage batteries more frequently. No rule can be made which will cover all batteries. There are just so many hours of charge in a battery. A storage battery which is used only one hour each evening will naturally require less frequent recharging than one that is used two hours each evening. Storage batteries last longer on one charge than any dry cell "A" battery. So the frequency with which the set is used will also influence the cost of running it.

Kind of Batteries Determines Expense

The first cost of storage batteries is naturally greater than the cost of dry batteries. But dry batteries must be replaced frequently, and the larger the number of tubes, and the more frequently the set is in use, the more often the set owner must discard worn-out dry batteries and purchase more. In many cases within the first year the first cost of a storage battery will be less than the cost of replacing dry cells over a like period of time. This is true for both "A" and "B" batteries.

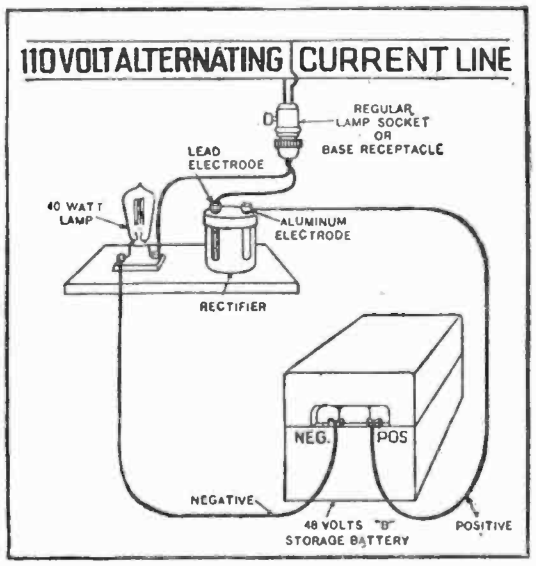


Diagram No. 4. Showing recharging of "B" battery using chemical rectifier.

A mistake which the set owner is very liable to make after deciding to use storage batteries is in the choosing of the wrong kind of radio storage batteries.

The capacity or amount of energy which is contained in a storage battery, is designated in ampere hours. There are "A" batteries on the market running all the way from 20 to 120 ampere hours of capacity. It is necessary to choose an "A" battery that has enough capacity to run the set for some weeks before requiring a recharge. Thus it would be foolish to select a battery of low capacity for a multi-tube set.

If a set owner is looking toward

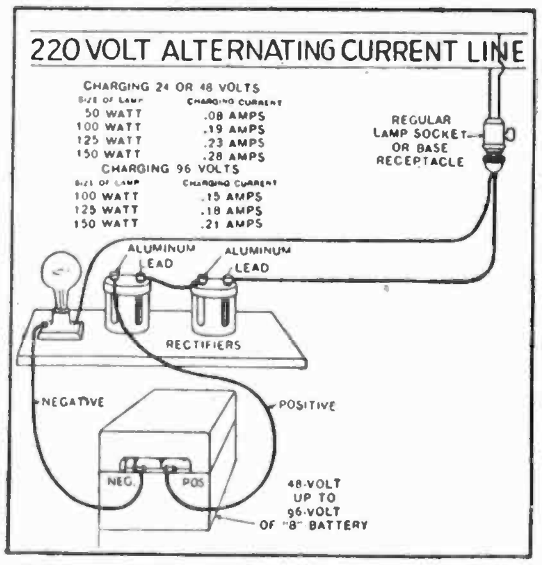


Diagram No. 5. Showing method of charging 48-volt unit from 220-volt A. C. line.

economical upkeep of his set, it is wise to select an "A" battery with due consideration of the number of tubes and their hourly draw of current and the number of hours a day or week in which the set is used.

The same principle holds true in selecting "B" batteries. While the hourly draw of current from a "B" battery is very low as compared to that of the "A" battery, nevertheless frequent recharging of a storage "B" battery means inconvenience and more money spent for recharging.

For the convenience of set owners who are at a loss as to the right storage batteries to buy for their particular sets, charts have been worked out by battery manufacturers, which contain the recommended types for each type of tube. Additional information and advice can usually be obtained from the reliable battery dealer who should be consulted when doubt exists as to the procedure to be followed.

Care and Use of Batteries

Notwithstanding the fact that battery engineers are daily learning new ways of making batteries longer-lived and more efficient, there are a few simple and easily understood rules which if followed religiously will insure maximum results with very little expense of upkeep.

The level of the electrolyte should always be kept above the tops of the insulators in both "A" and "B" storage batteries. This is done by periodically adding distilled water only. In the usual "A" batteries it is recommended that the level of the electrolyte be kept ⅜ inches over the plates.

Noises in a receiving set may often be traced to corroded or dirty terminals and connections. Terminal posts and connections may be kept clean by covering them with a thin coating of vaseline. To secure best results and quiet operation posts should be absolutely clean and free from corrosion.

Nothing but distilled water should ever be added, by the battery owner, to a storage battery for any reason whatsoever. If it is ever necessary to add sulphuric acid, only an authorized battery service station should be allowed to do this. No acid is ever lost from the battery unless it is accidentally spilled. It is the water only that evaporates and this may be easily replaced from time to time.

It is well to place batteries on rubber mats or on a dry shelf. They should never be placed in locations subject to extreme heat or cold or dampness.

Hydrometer and Voltmeter

The hydrometer and voltmeter are two very useful instruments to have to determine state of charge of radio storage batteries.

The hydrometer is used to test the specific gravity or state of charge of a storage battery.

These directions should be followed:

1. Remove vent plugs from cells.

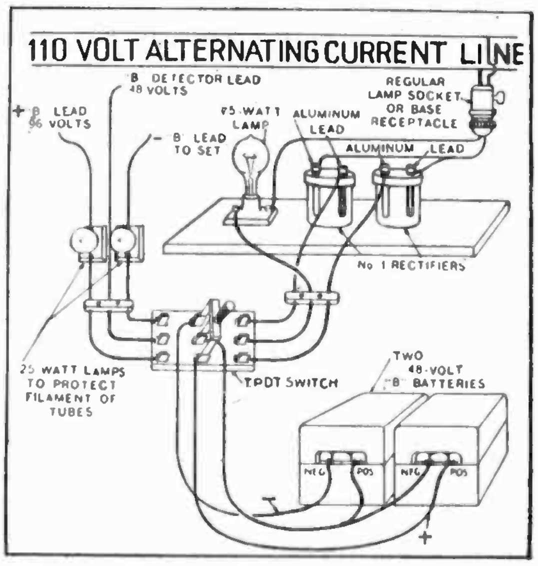


Diagram No. 6. Showing charging switch circuit for two 48-volt units.

2. Compress bulb of syringe hydrometer.
3. Insert small soft rubber tube through vent hole into electrolyte.
4. Release bulb until sufficient solution is drawn into the tube to cause the hydrometer float to rise.
5. With the syringe in vertical position so that float does not touch sides of tube, specific gravity reading is taken on scale at level of solution.
6. Compress bulb and allow electrolyte to run back into the same cell from which it was taken.
7. Replace vent plugs.

A fully charged radio "A" battery should show a reading between 1.275 and 1.300. To insure the best results at all times, an "A" battery should be recharged as soon as it tests as low as 1.200 or even before. When it reaches 1.150 it is completely discharged.

Until but recently the voltmeter was the only practical instrument to test the charge of storage "B" batteries.

A 24-cell storage "B" battery when fully charged may read up to 50 or 52 volts. For maximum and continued good results the battery should be recharged when it drops as low as 45 volts. Heretofore the hydrometer has not been practical for testing "B" storage batteries because of the small amount of liquid contained in each cell. One of the storage battery companies has designed and perfected a small but accurate "B" hydrometer which will easily show the state of charge.

It is vitally important that both hydrometer and voltmeter be reliable and accurate. To assure this it is well to secure only standard high quality instruments made by reputable concerns.

Charging "A" Batteries

When the gravity of the "A" battery is shown to be low it should be placed on charge. There are many chargers on the market that are suitable for charging the "A" battery and the instructions for the use of this charger should be followed very closely.

In every case the leads will be marked as to their polarity and the greatest care should be taken to be sure that the positive lead of the charger goes to the positive pole on the battery and the negative of the charger to the negative of the battery.

Turn on the charger and if it has a meter on it showing charge or discharge be sure that the battery is charging. If the charger does not have a meter it is a good policy to note any change in gravity of the electrolyte by the use of a hydrometer. If the gravity starts to rise you will know that the battery is charging. Charge until all cells gas freely and until the gravity stops rising. This is found by taking a hydrometer reading. After two hours take another reading and if the gravity has risen keep on charging.

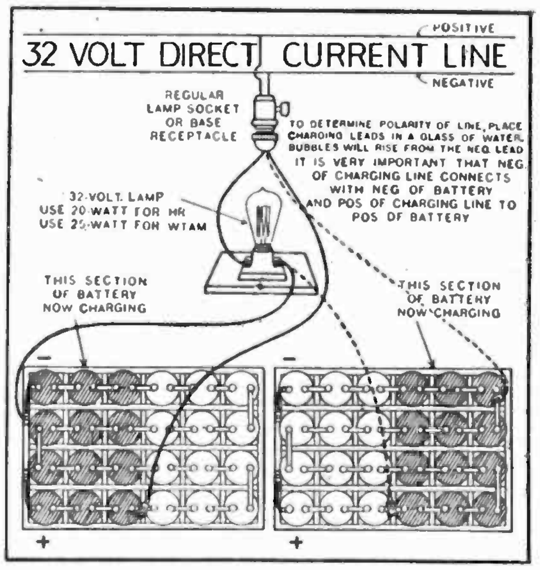


Diagram No. 7. Showing method of charging 48-volt "B" battery from 32-volt D. C. line.

Continue to take readings at intervals until the gravity does not show an increase, then you can be assured that the battery is fully charged.

The charging leads should be disconnected immediately after the rectifier is shut off.

Before recharging the "A" battery the "A" battery leads to the receiving set should be removed as otherwise the vacuum tubes are liable to be damaged.

In case direct current is the source of power, a rectifier is not required and the battery may be recharged directly from the line by the use of a lamp bank; that is, a series parallel bank of lamps in series with the battery, as in diagram No. 2. It is very important when charging from direct current that the correct polarity of the line be obtained. This may be secured by placing the leads in a glass of water. Bubbles will arise from the negative lead. If bubbles arise from both leads, that having the greater number is the negative lead. It is well after the polarity is found to use some distinguishing mark so that you will know in the future which is the negative and which is the positive.

In case the source of current is 32-volt direct current, the more efficient way to charge "A" batteries from a standpoint of current consumption is to charge from the 32-volt lighting plant batteries while these are being charged as in diagram No. 3.

When the current source is 110 or 220 volt direct current it is more efficient from a standpoint of current consumption to charge "A" batteries from a motor generator than by a lamp bank. In most cases, however, a motor generator of the 110 or 220 volt D.C. type is not available, and in such cases it will be necessary to use the lamp bank charging method as shown in diagram No. 2.

Charging "B" Batteries

Storage radio "B" batteries may be recharged from either direct or alternating current. On page 90, in No. 6, is a diagram showing how the batteries may be recharged from 110 volts alternating current by the use of the standard make rectifier. All that is necessary is to place this rectifier in series with a 110-volt lamp as shown in the diagram, being sure that the positive pole of the battery goes to the aluminum of the rectifier which is plainly marked on the rectifier and battery. As in recharging the "A" battery, the "B" battery leads to the receiving set should first be removed.

It is possible to charge only 48 volts of "B" battery in series at one time. If greater voltages than this are to be recharged at one time the batteries must be placed in parallel with separate rectifiers and separate circuits used for each 48 volts of battery as shown in diagram No. 6. By placing the batteries in parallel we mean the positive of one battery to the positive of the other, and the negative of one to the negative of the other. The recommended way is to charge one 48-volt unit at one time.

In such cases as it is necessary to use two or more colloid rectifiers in series, as in diagrams No. 5 and No. 6, in order to obtain the highest efficiency, first place one rectifier on the line until the lamp is dimmed, then replace this with the other rectifier until the lamp is dimmed. Then put both rectifiers on the line as in diagrams No. 5 and No. 6.

In using a switch in the circuit to charge two 48-volt units from 110-volt A.C. line, the detector tap should be changed to 48 volts for charging as shown in diagram No. 6. When charging has been completed the detector tap may then be shifted back to the voltage demanded by the individual set if it does not happen to be 48 volts.

When 110 volts direct current is the source of power, the rectifier is not required and all that is necessary is to use a 40-watt 110-volt lamp in series with the battery and line being sure that the correct polarity is obtained as previously described.

In case of 32-volt direct current such as the farm lighting plant, etc., one 24-volt section of "B" battery may be recharged at one time.

This is accomplished by the use of a 32-volt 20-watt lamp in series with each 24 volts of battery, being sure that the correct polarity of the line is first obtained.

Some Fundamental Facts About Radio

(*Continued from page* 75)

frequency current are much too fast for the heavy, slow-moving diaphragm of telephone receivers to respond to them. It is the variation in strength of these vibrations, caused by the control of the sound waves at the studio to which the diaphragm must respond. But this variation, as the current is received, is equal in the plus direction to that in the minus direction, and the effect in the telephone receivers is zero. In other words, the forces tending to cause the receiver diaphragm to move in one direction are always neutralized by exactly equal forces tending to make it move in the opposite direction. To overcome this difficulty, one half of the vibrations is blotted out, thus allowing the forces in one direction only to be effective. This is done by means of a "detector," a device which allows the radio current to flow through it in but one direction. The most common detectors are vacuum tubes, though crystals have been, in earlier times, extensively used, and are still in use for local reception.

The radio current received from a station many miles away is very weak. For instance, even forty or fifty miles from a powerful broadcasting station, the current as received and delivered to the headphones in a crystal receiving set is ordinarily too weak to make an audible sound in the phones. To overcome this, means must be used for amplifying the received current. Tubes are used for this purpose, each tube being described as a "stage of amplification." Amplifier tubes are said to be "radio-frequency," or "audio-frequency," according as they are used to amplify the current before, or after half of it is blotted out by the detector tube.

Thus, the mechanism of broadcasting consists essentially of a generator of high-frequency vibratory electric current, which sends out waves from an antenna; a receiver, consisting of an antenna to pick up the waves, and a detecting device to blot out one half of the received vibratory current, and (if desired) amplifiers for making the current stronger; a microphone for controlling the strength of the outgoing radio waves in accordance with the sounds at the broadcasting station; and a pair of headphones or loudspeaker at the receiving station, for giving out sounds in accordance with the fluctuating signal strength controlled by the microphone at the studios. The problem of broadcasting is primarily the problem of telephony—its chief additional difficulties being introduced by the necessity of using a vibratory current in order to produce energy which will travel through space unaided by wires.

With these simple fundamental considerations in mind, the layman should be able to picture the process of broadcasting. There are of course many more intricate and more difficult problems. It is not all so simple as these fundamentals. Yet a thorough foundation house can be built, and the same reasoning applies to science—those who acquire thoroughly the fundamentals will find the more complicated superstructure comparatively easy.

How to Read a Radio Hook-up

JOSEPH F. ODENBACH

THE purpose of this article is to show the prospective radio constructor how easy it is to read a radio hook-up.

The hook-up diagram is a concise set of directions, in picture form, telling where to connect each wire and how to place each component part. It is meant to simplify the work of construction. Unfortunately, in the hands of the inexperienced novice it often has just the opposite effect, appearing complicated and in some cases preventing him from constructing something which he is perfectly competent to make, not only from a mechanical but also from an electrical standpoint.

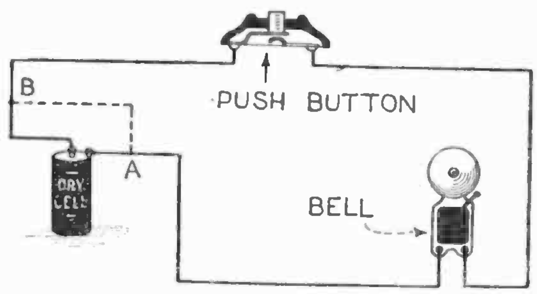


FIG. I

Diagram of a simple bell circuit.

The plain facts about constructing a radio set are that the various parts can be purchased factory made and perfect, and it is possible, with just a little effort, to put together a most excellent set. In many cases the home built radio set contains superior features unobtainable except in the highest priced factory assembled products.

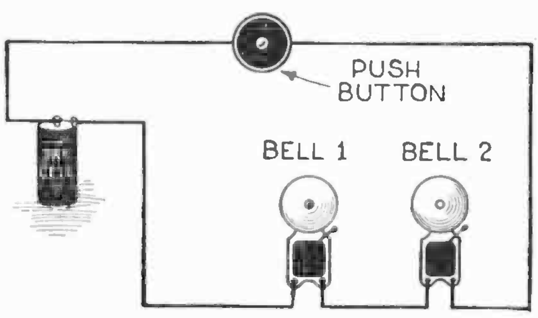


FIG. 2

An illustration of a series circuit.

Almost anyone can learn to build a radio set. The process can be termed assembling rather than building, since in most cases, it is simply a question of properly connecting various parts by means of bus bar wiring.

In order to understand a radio hook-up it is desirable to have a knowledge of elementary electrical circuits. For example, we will start with a very simple, everyday circuit, the electric door-bell. In this circuit there is a battery (usually a dry cell) a push button and a bell. These three parts are connected by wires. The diagram in Fig. 1 shows this simple circuit. When the push button is pressed, the circuit is known as a *closed circuit*, since current then flows from the battery and causes the bell to ring. When the push button is not in use, no current flows, and the circuit is known as an *open circuit*. An open circuit may be defined as an electrical circuit which does not offer a complete path for the flow of electricity. There may be one or more breaks in the path. On the other hand, a closed circuit is an electrical circuit which allows current to flow and thus permits the transference of electrical energy.

Suppose that a wire is connected at A and B as shown by the dotted line

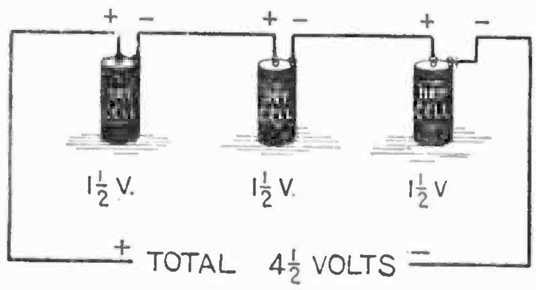


FIG. 3

Dry cells in series, showing how voltage adds up.

in Fig. 1. This would effectually prevent the bell from ringing, no matter how much the push button was pressed. Such a condition is known as a *short circuit*. In other words, a short circuit refers to a condition of an electrical circuit, whereby an external path of low resistance is connected across the source of electrical energy. A short circuit is accompanied by an increase in current flow although this current is no longer usefully employed. Short circuits may be guarded against by fuses or circuit breakers, which operate automatically producing an open circuit, if the current becomes too great.

When two or more parts of an electrical circuit are so connected that the same current flows through them, as in the case of the two bells shown in Fig. 2, they are said to be in series and the circuit is called a *series circuit*. When a number of cells are connected together in series with the positive terminal of one connected to the negative terminal of another as shown in Fig. 3, the total voltage of the battery will equal the sum of the separate voltages.

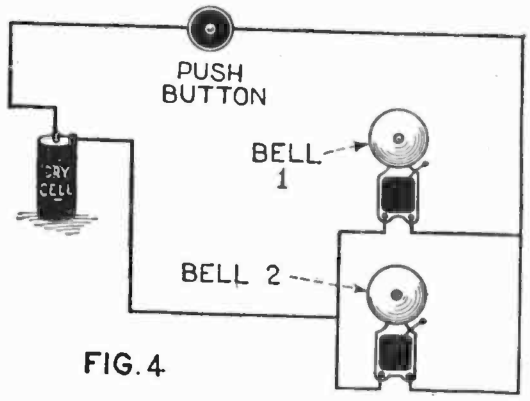


FIG. 4

The two bells are shown connected in parallel.

When two or more parts of an electrical circuit are connected so that the current divides between them, they are said to be in parallel. Fig. 4 shows an example of a *parallel circuit,* the current from the dry cell dividing between the two bells. Other names which mean the same thing as parallel circuit are *multiple circuit, divided circuit* and *shunt circuit*. In a parallel circuit several branches are connected together at the same points. Where a number of parts of a circuit are in parallel, the same voltage is impressed on each part. The current flowing in each branch will depend upon the impressed voltage and upon the resistance of that particular branch. For example, if bell 1 in Fig. 4 has a greater resistance than bell 2, then more current will flow through bell 2.

Fig. 5 shows four dry cells connected in parallel. It can be noted that all the positive terminals are connected together and all the negative terminals are connected together. In this case

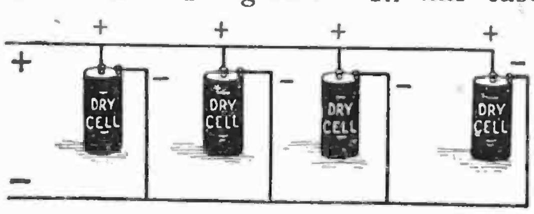


FIG. 5

Connecting four dry cells in parallel, as shown, gives no increase in voltage.

there is no increase in the total voltage. The more cells thus connected in parallel, the less will be the total internal resistance and the greater will be the current capacity.

The *series-parallel circuit* is a combination of series and parallel circuits. The term "series-parallel" usually refers to a series circuit having certain minor branches in parallel. The term "parallel-series" usually refers to a parallel circuit having certain minor parts in series. Fig. 6 illustrates a series-parallel circuit having two dry cells in parallel and three dry cells in series. The push button and the bell are also in series.

Radio diagrams and hook-ups are further simplified by the use of *sym-*

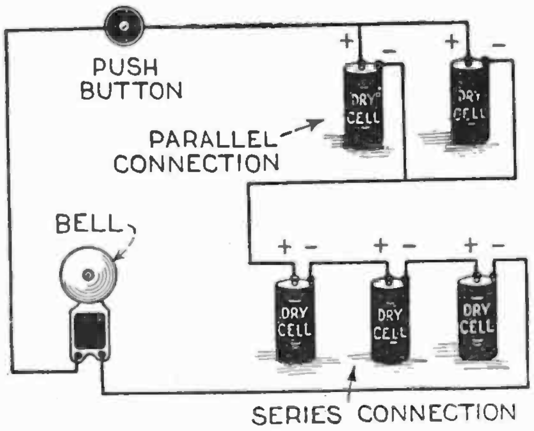


FIG. 6

An illustration of a series-parallel circuit.

bols. These are signs which are used to represent electrical and radio apparatus. Thus instead of going to all the trouble of drawing an actual picture of a battery, we can represent it more simply by a light and a heavy line. In most instances these symbols follow very closely the actual apparatus they are intended to represent so that with a little study, they will be learned readily.

Fig. 7 is a repetition of Fig. 1 using symbols instead of pictures.

Fig. 8 shows the hook-up of a simple crystal set. In this case, the various symbols are also named, although the names are often left out in actual practice. However where a piece of apparatus such as a fixed condenser is shown, the diagram would be incomplete unless the capacity of the condenser was shown alongside the symbol. Where a number such as .001, .00025, etc., is shown near the symbol of a fixed condenser, this means that the condenser has a capacity of .001 microfarads or .00025 microfarads, as the case may be.

Fig. 9 represents the elementary circuit of a vacuum tube. This should be studied carefully as it is the fundamental basis of every receiving circuit utilizing vacuum tubes. It consists essentially of the input circuit which receives its energy from the aerial, the filament circuit, and the output cir-

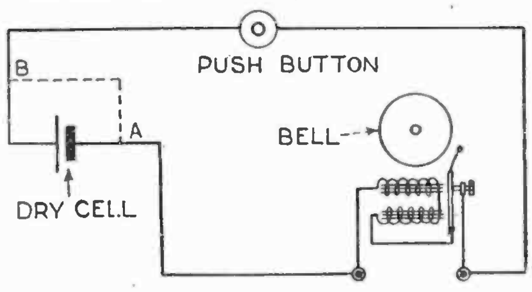


FIG. 7

Hook-up of the simple bell circuit shown in Fig. 1, using symbols instead of pictures.

cuit, which passes its amplified currents to the head set or loud speaker. As can be seen from Fig. 9, the input circuit within the tube is between the filament and the grid, whereas the output circuit (within the tube) is from the filament to the plate.

In Fig. 10 is shown the method in which the energy from the aerial circuit is applied to the vacuum tube. The aerial intercepts the electric waves, and these are converted into high frequency alternating currents which oscillate rapidly in the aerial circuit (that is between the aerial and the ground). The energy is transferred from the aerial circuit to the tuned circuit

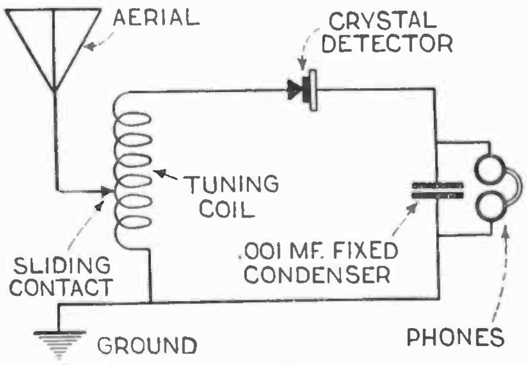
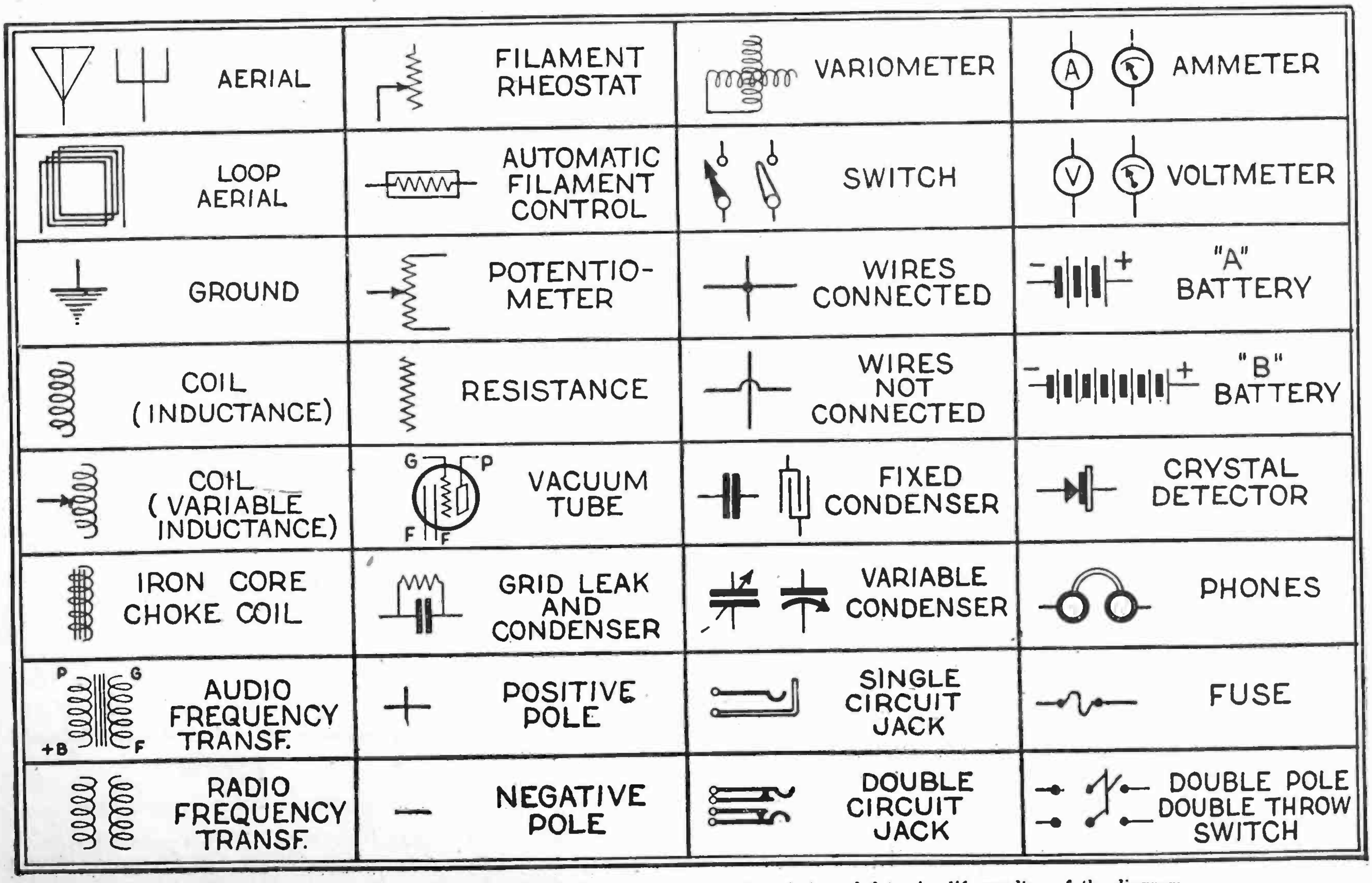


FIG. 8

Hook-up of a simple crystal set.

(shown in heavy lines in Fig. 10) by means of the transformer which has a primary P and a secondary S. The variable condenser tunes the circuit to the correct wavelength. The high frequency current flows to the grid of the vacuum tube actuating this by varying its potential in exact accordance with the incoming signals. The filament circuit is complete when current from the "A" battery flows through the filament, lighting it up. As soon as the filament is lit, it emits electrons which pass through the grid to the plate. It is necessary to keep the plate at a higher potential than the



Standard symbols used in radio hook-ups. The use of these symbols is intended to simplify reading of the diagram.

filament and grid and this is accomplished by means of the "B" battery shown in Fig. 11. The grid under the influence of the incoming signals, acts like a regulating valve allowing a smaller or a larger number of electrons to pass from the filament to the plate.

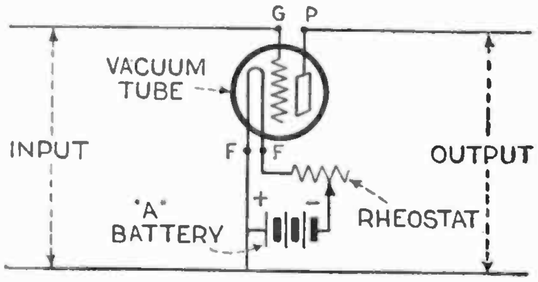


FIG. 9

The input, output and filament circuits of a vacuum tube are shown in this diagram.

Fig. 11 shows the complete circuit of a one tube set. In this circuit, the "B" battery and the headset are shown. The current through the headset is direct and pulsating, varying according to the variations of the grid. It is rectified (uni-directional) since the

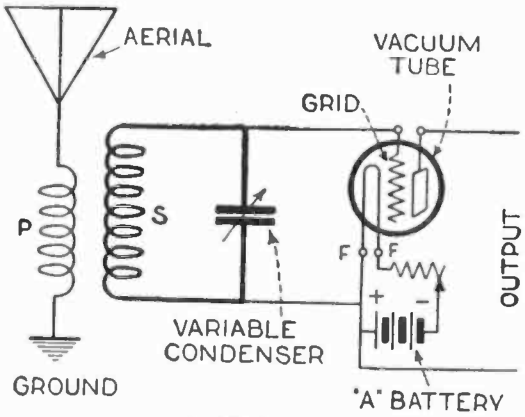


FIG. 10

This hook-up shows how energy from the aerial circuit may be applied to a vacuum tube.

electrons can flow only from filament to plate but not in the reverse direction.

A careful study of Figs. 9, 10 and 11 and an understanding of the principles involved will enable one to read and understand any hook-up no matter how many tubes are used.

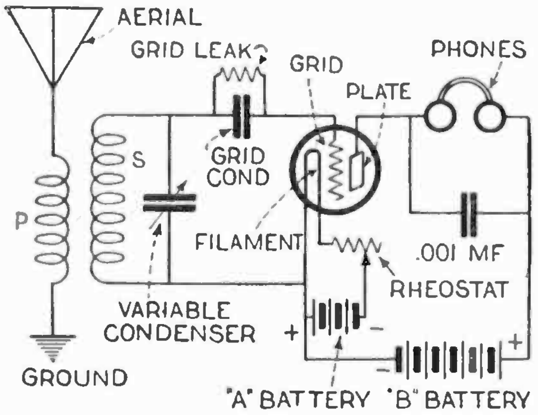


FIG. 11

The hook-up of a one-tube radio receiving set.

Figure 12 shows a wiring diagram of a three-tube receiver. In this drawing the "A" battery or filament circuit is indicated in heavy lines, while the other portions of the hook-up are shown in lighter lines. In tracing through the "A" battery circuit it can be seen that this consists of the battery, the filament switch, the controlling rheostats and the filaments of the three tubes. The tube at the left, which is the detector tube is controlled by one

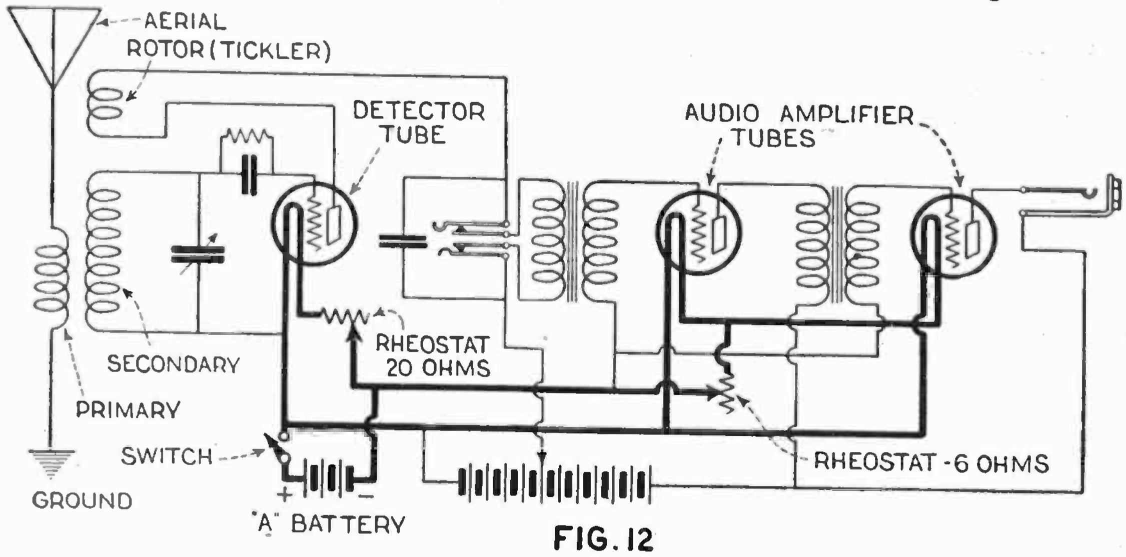


FIG. 12

Wiring diagram of a three-tube receiving set. Note that the filament is shown in heavy lines.

rheostat, whereas the two audio amplifier tubes are controlled by the second rheostat. If there is any doubt as to which is the detector tube, this can be

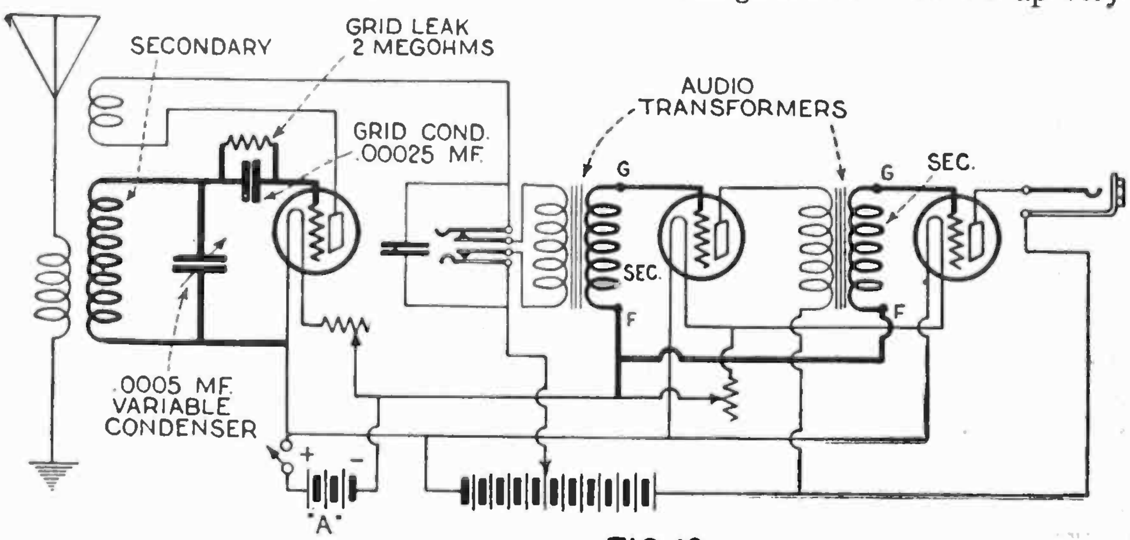


FIG. 13

This is the same as diagram shown in Figure 12, only grid circuits are here drawn in heavy lines.

readily located by looking for the grid leak and grid condenser located in the grid circuit. Any other tubes shown between the detector tube and the aerial circuit are radio frequency tubes

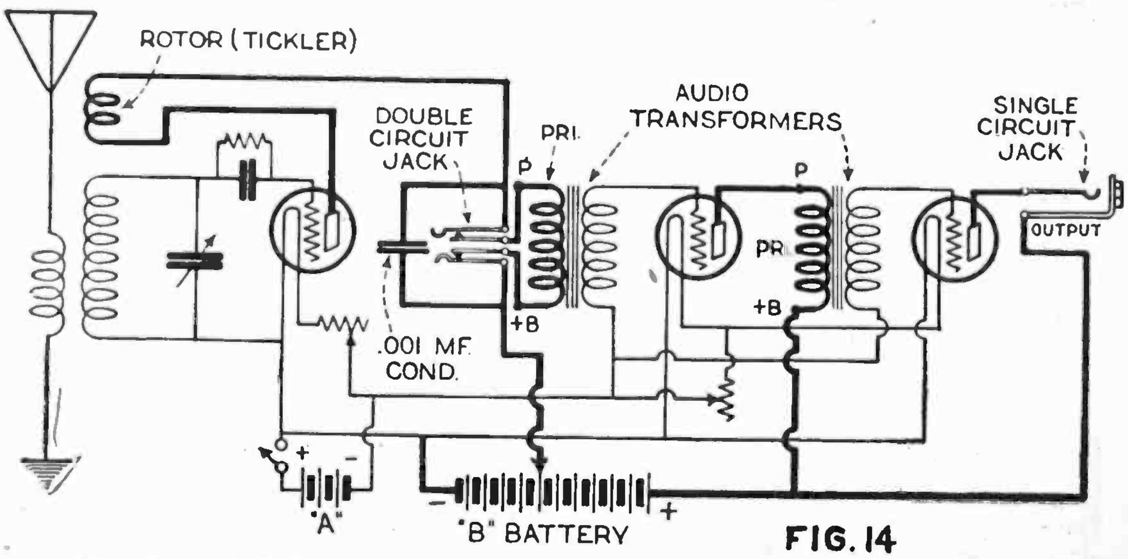


FIG. 14

Same three-tube hook-up as shown above, but with plate circuits drawn in heavy lines.

while the tubes on the other side of the detector tube are audio frequency tubes. Audio frequency tubes are preceded by audio frequency transformers.

In order to make clear the various circuits shown in Fig. 12 we will trace these out one by one. In Fig. 12 the filament circuit is shown in heavy lines as noted above. The aerial circuit, consisting of aerial, primary of the tuner and ground also shows up very clearly in the diagram, and hence needs no further comment. The grid circuits will next be traced out. These are shown in heavy lines in Fig. 13, all the other circuits being drawn in with light lines. Starting at the grid of the detector tube the grid circuit leads through the grid leak and grid condenser (which are in parallel) thence to the secondary of the tuner and finally to the positive side of the "A" battery. The secondary is shunted by the .0005 mfd. variable tuning condenser. The grid circuits of the two audio frequency amplifier tubes pass through the secondaries of the two audio transformers as shown by the heavy lines in Fig. 13, the other ends of the secondaries being connected together and leading to the negative side of the "A" battery or filament circuit.

Fig. 14, shows the same circuit, only with the plate circuits drawn in heavy lines to make them stand out from the remainder of the hook-up. The plate circuit of the detector tube can be seen to lead from the plate through the tickler coil through the double circuit jack and finally to the positive side of the "B" battery. The negative side of the "B" battery is connected to the positive side of the "A" battery. With the double circuit jack in the normal position, the detector plate circuit includes the primary winding of the first audio transformer. With the plug inserted the transformer is cut out and a head set substituted. A .001 mfd. condenser shunts the jack. The "B" battery voltage should be varied to meet the requirements of the detector tube used. This is indicated by the arrow-head shown on the end of the line leading to the "B" battery. The plate circuit of the first audio tube leads directly from the plate to the primary of the audio transformer, thence to the positive terminal of the "B" battery. The plate circuit of the second tube goes to a single circuit jack, which permits the plugging in of a loud speaker in the circuit and then to the positive side of the "B" battery. The plate circuit is sometimes referred to as the "high potential" circuit to differentiate it from the filament or "low potential" circuit.

The process of separating out a hook-up into its elementary circuits, as carried out in Figs. 12, 13 and 14 greatly simplifies any diagram, no matter how complicated it may appear at first. Since every vacuum tube hook-up contains filament circuits, grid circuits, plate circuits, etc., the addition of more tubes does not make the reading of the diagram any more difficult.

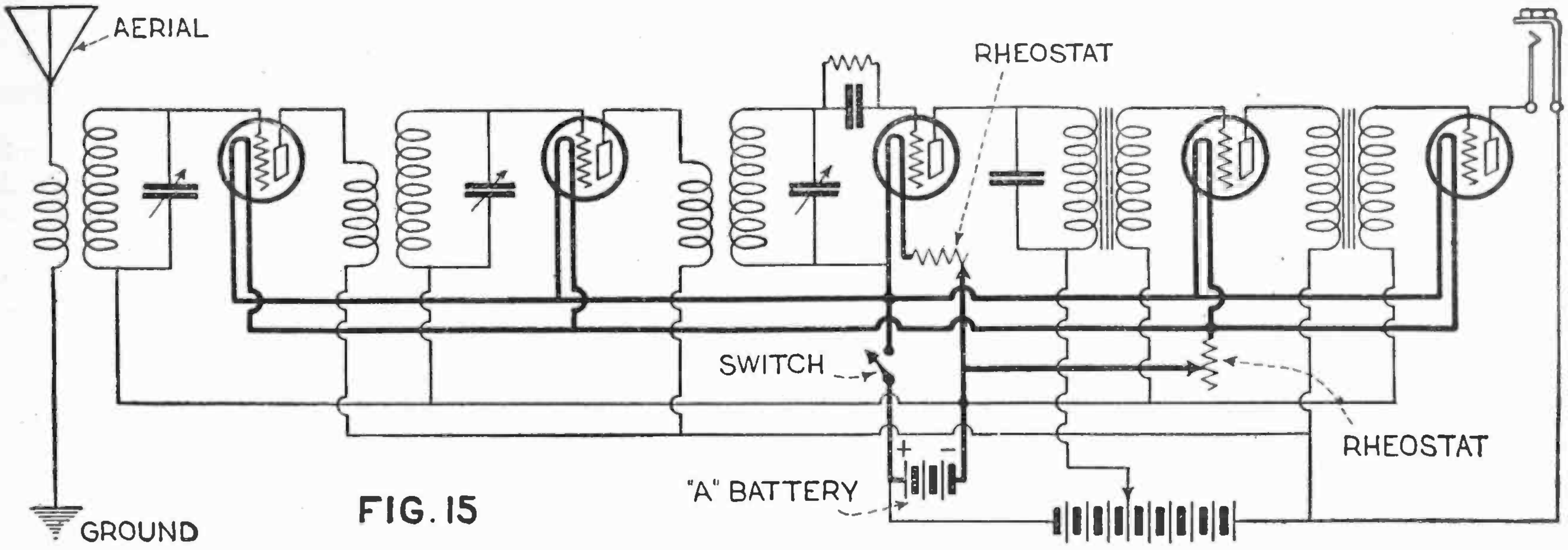
A typical five-tube tuned radio frequency hook-up is shown in Fig. 15. The values of the various condensers, etc., are omitted since the purpose is simply to furnish further exercise in analyzing and understanding radio hook-ups.

An examination of the circuit shows that there are five tubes. The center tube having the grid leak in the grid circuit is the detector tube. The two tubes at the left of the detector can be recognized as radio frequency tubes, while those at the right can at once be identified as audio frequency tubes. In Fig. 15 the filament or "A" battery circuit is shown in heavy lines. It will be noted that the rheostat at the left controls the filament voltage of the detector tube alone, whereas the rheostat at the right controls the two audio frequency and two radio frequency tubes. Wherever two rheostats are shown, one controlling the detector and the other the remaining tubes, the detector tube invariably uses the rheostat having the larger resistance.

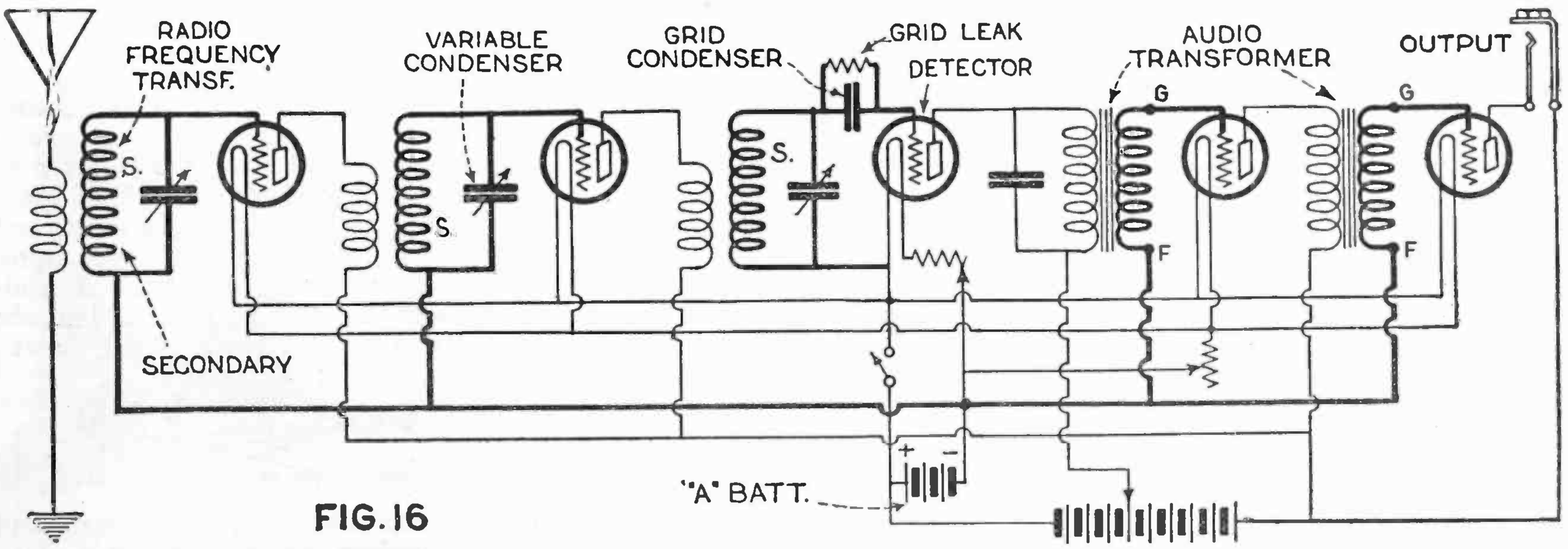
Fig. 16 shows the same hook-up only with the grid circuits traced in heavy lines. The radio frequency circuits are tuned by the three variable condensers. These circuits are simple and need no further explanation.

In Fig. 17, the plate circuits are shown in heavy lines. These can be

(*Continued on page* 101)



A typical five-tube tuned radio frequency hook-up with filament circuit emphasized by heavy lines.



Same hook-up as shown in Fig. 15, but with grid circuits drawn in heavy lines.

Wiring the House for Radio

By A. J. CARTER

THE time when "no home is complete without a radio" is here. The time when "no home is complete without a radio in every room" will soon be here. Most of us can remember the days when a central heating plant with heaters in every room was the exception rather than the rule. There may have been many rooms in the house, but when warmth was desired one had to go to the old fireplace or the large stove for it.

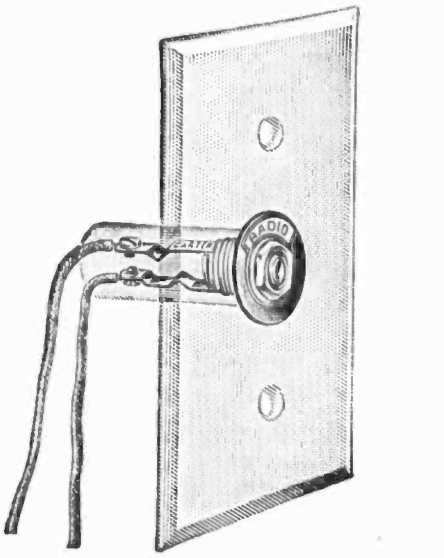


Fig. 1. A wall type jack such as used in up-to-date homes, hotels, restaurants, etc., for loud speaker outlets.

Now, no one would think of building a house without heaters in every room. Radio is gradually going through the same transition. The attic used to be the only place for the radio installation. Slowly, as the appearance of receivers was improved it was granted a place in the living room. Until lately it has been considered a means of entertainment to be enjoyed in a given portion of the house, or room.

Now, however, it has become a necessity in every room. Mother needs it in the kitchen to while away the hours when she is hard at work preparing the family meals; Father needs it in his study; the boy needs it in his room;

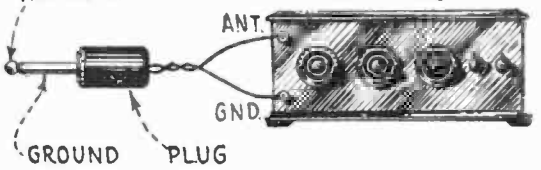


Fig. 5. Showing how a plug is employed for a convenient aerial and ground connector from the set itself.

Grandma needs it in the bedroom when she is not well, and the whole family wants it in the dining room when the dinner music starts up.

Of course it is out of the question to put a complete installation in every room, but it is entirely feasible to extend the wiring and provide outlets so that a loud speaker or number of loud speakers can be connected into the circuit to provide entertainment in different parts of the house.

This has been done in many hotels and apartment houses where the program from one of several stations is always on tap in any of the rooms. An operating room with an operator in charge is provided in one room. From one to a half dozen sets are available for tuning in different programs. A loud speaker is installed in each room with an outlet so that the loud speaker can be plugged into the loud speaker circuit of any of the receivers. In this

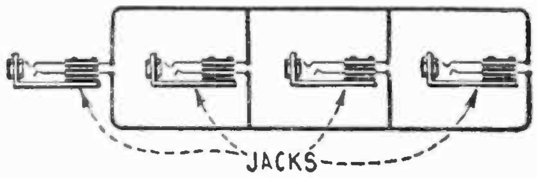


Fig. 2. How the outlet jacks are connected in parallel in order to have loud speaker outlets in any number of rooms.

way a tenant can listen in on any of a number of programs tuned in with the receivers in the operating room. There is no need for tuning. Just the mere formality of plugging in on different outlets or telephoning the operator to switch to any particular broadcasting station.

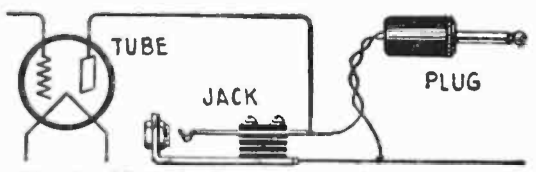


Fig. 3. Method of connecting the plug across the output of the last audio frequency stage.

In the Hudson View Gardens in New York, each apartment is provided with a loud speaker, and an outlet or baseboard receptacle with four different jacks. Each jack is connected with a different set in the operating room so that a tenant has a choice of four different programs.

In the Robert Morris Hotel, in Philadelphia, every room is provided with earphones, and the larger rooms with loud speakers, which can be plugged into wall receptacles.

Many smaller houses are supplying baseboard outlets for aerial and ground connections. The aerials are erected in orderly fashion on the roof, and the leads are brought down through the walls to the receptacles.

For the average home the best type of installation is one which connects a number of wall jack receptacles in parallel. A wall receptacle jack of this type is shown in Fig. 1. A regular type of phone plug can be used to make connections to the wiring circuit into which the jack is connected.

You will notice that one spring of the jack has a depression farther from

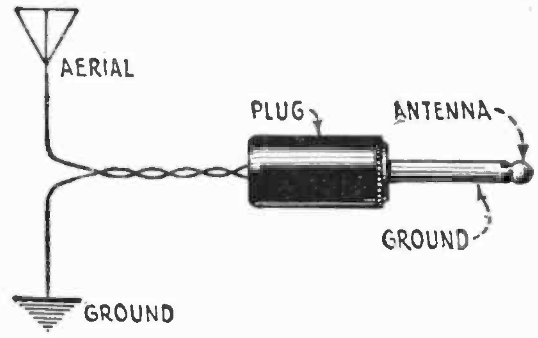


Fig. 4. Using a plug for an aerial and ground connector from the aerial and ground leads.

the plate than the depression on the other spring. The depression farthest from the plate makes contact with the tip of the phone plug while the one nearest the plate makes contact with the sleeve of the jack.

In wiring a number of jacks, it is important that corresponding springs of the jacks be connected together. A parallel connection of several jacks of this type is shown in Fig. 2.

If the set is to remain in one room and all that is required is a loud speaker or phone outlet in every room, the circuit shown in Fig. 2 should be used. A phone plug and cord should be connected with the output circuit of the receiver, one end of each wire of the cord to each side of the jack of the last audio amplifier stage as shown in Fig. 3. Plugging this plug into any of the receptacle jacks of Fig. 2 connects all of the receptacle jacks with the output circuit of the receiver so that a loud-speaker can be plugged into any of the jacks to obtain music and entertainment in any of the rooms provided with the outlet jacks. A loud-speaker can also be plugged into the receiver jack for use in tuning the set.

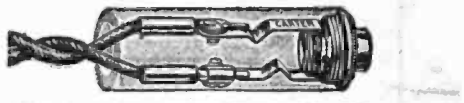


Fig. 6. An extension cord jack.

In this case the set is stationary and loudspeakers are provided in various rooms. All the tuning however must be done in the room in which the set is placed. Where a lengthy program from a single station is received this arrangement is quite satisfactory.

It is a nuisance however to be running back and forth when a good deal

(*Continued on Page* 162)

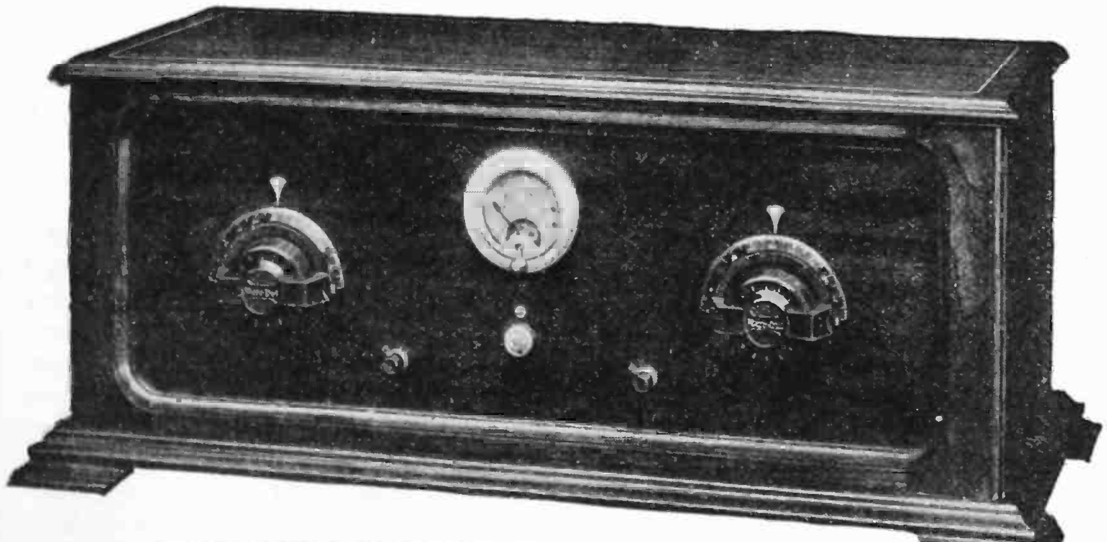
The Use of Meters in Radio Sets

By SYLVAN HARRIS

BEFORE entering into a discussion of the use of meters in radio receivers, it will be well first to show one or two reasons why it is advisable to use them. Perhaps the most potent reason is one which has a direct bearing on the life of the vacuum tubes, which has a rather intimate connection with the pocketbook of the experimenter.

The natural life of the average vacuum tube, barring accidents and other causes of untimely ends, when operated at the exact voltage prescribed by the manufacturer, is something near one thousand hours. Let us say for the sake of argument, that it is one thousand hours. These tubes have been designed to operate under a filament voltage of five volts. Furthermore, they have been so designed that no considerable increase of the electron emission occurs when the voltage across the filament is greater than five. In other words, nothing is gained by putting the full six volts of a storage battery on the filament of a 201-A type of tube.

On the other hand, the voltage does have a considerable effect on the life of the filament. Let us consider the thoriated filament, which is a small wire made of tungsten which has been impregnated with a small amount of oxide of thorium.

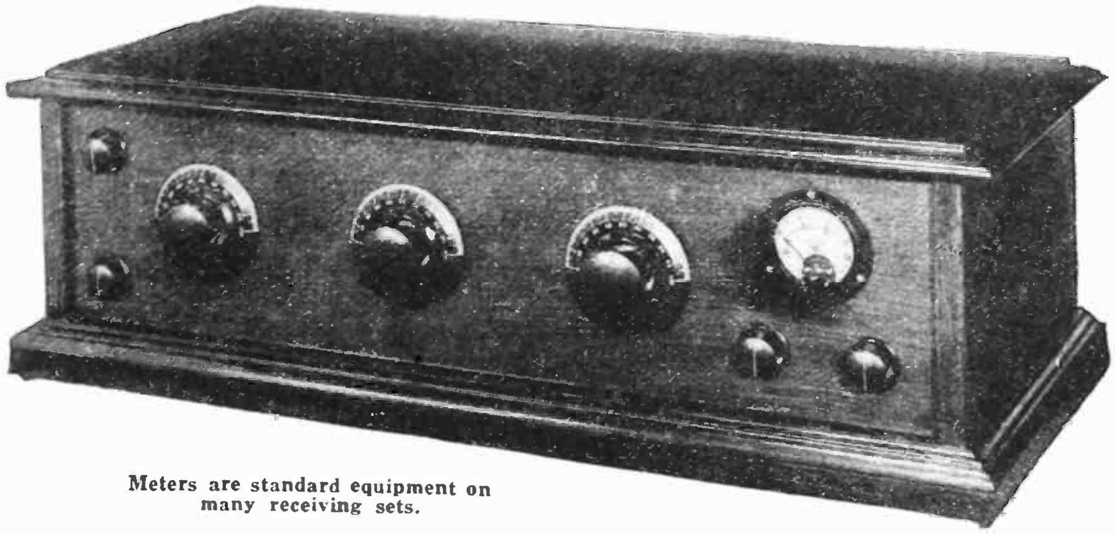


Another typical radio receiving set equipped with voltmeter.

The electron emission comes mainly from this thorium oxide, although some of it comes directly from the heated tungsten and depends on the current flowing in the filament. There is a limited amount of the thorium oxide in the filament, and when this has become entirely exhausted, the tube, for all ordinary purposes, has become useless.

Now, what has all this to do with the life of the tube? The answer is easy and can be stated in a few words. The speed at which the thorium oxide seeps through the tungsten to the surface of the filament, when it releases the electrons, is proportional to the heat in the filament; the heat generated in the filament is proportional to the *square* of the voltage applied to its terminals; that is, the life is inversely proportional to the square of the voltage.

In other words, by increasing the filament voltage from five to six, the life of the tube has been shortened in the ratio of 25 to 36, or about five-eighths. Actually, it is worse than this, on account of the crystallizing of the filament at the higher temperatures, and other effects. We may say, roughly, therefore, that by increasing the voltage on the filament of a 201-A tube by about one volt, the life of the tube may be cut in half. Conversely, by operating it one volt lower than the rated voltage, the life may be nearly doubled. To summarize:



Meters are standard equipment on many receiving sets.

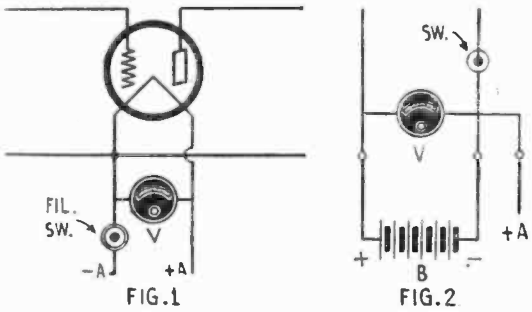


Fig. 1 shows connection of filament voltmeter.
Fig. 2 shows the connection for the "B" battery voltmeter.

OPERATED AT	HAS AN AVERAGE LIFE OF
5 volts	1000 hours
6 volts	500 hours
4 volts	2000 hours

The importance of keeping tabs on the filament voltage at once becomes apparent. One volt more or less may double or halve our tube expenses. Unfortunately, it is not generally feasible to operate tubes at low voltages, for the required filament emission cannot then be obtained. But, also unfortunately, there is only one means of telling whether the filament is being operated at over five volts, and that is by using a filament voltmeter.

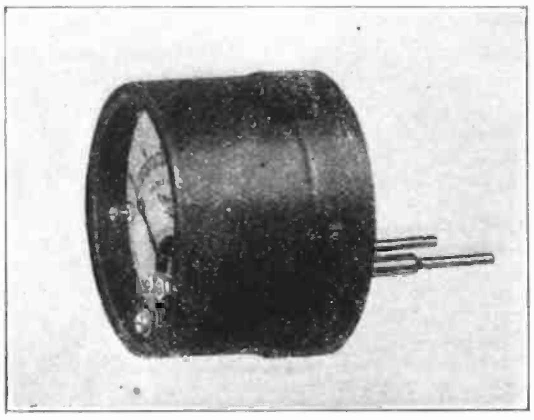
Figure 1 shows how a filament voltmeter is connected in the filament circuit. It is connected directly across the terminals of the filament, and should be between the filament and the filament switch. The reason for this is that it is desirable to switch off the meter together with the battery when the set is not in use. The range of the meter should be from zero to about 8 or 10 volts. It is not advisable to use a meter with a larger scale than this as it will not then be possible to read the voltage indication accurately.

As regards the voltage placed on the plates of the tubes, this does not affect the life of the tubes but it does affect their operation. And, to come back to our pocketbook again, it does affect the life of the B-batteries materially. It will generally be found that little if anything is gained by using higher voltages than about 90 volts on the plates of amplifier tubes of 201-A type, especially in the audio amplifier where ordinary amplifier transformers are used. Of course, where resistance coupling or impedance coupling is used it is often advisable to use voltages higher than this.

But even when using resistance or impedance coupling there is a limit of plate voltage beyond which it is not practical to go. One hundred and thirty-five volts should be sufficient to operate any resistance or impedance coupled amplifier satisfactorily. If satisfactory operation is not obtained, the trouble will be found in either the resistances or in the stopping condensers. Perhaps the grid resistance is too low or the plate resistance too high; or, perhaps the stopping condenser is too small.

But as regards the plate batteries there is another important point to consider and that is the effect on the total battery system that a rundown battery may have. A rundown battery placed in series with good batteries will considerably reduce the voltage of the whole system, especially when current is being taken from the batteries. This is an important fact to remember when measuring the voltage of B-batteries, or any other batteries of the dry type.

When testing any dry batteries, never use an ammeter. The proper meter to use is a voltmeter, and the voltmeter used should have as high a resistance as possible. The reason for this is that when current of any appreciable amount is being taken from the battery when its voltage is being measured, the terminal voltage of the battery will drop, and the meter will indicate low. It is for this reason that when measuring the terminal voltage of B-batteries, it should be done when the



Voltmeter which plugs into pin jacks provided in the panel of the receiving set.

set is in operation. If no current is being taken from the batteries, the terminal voltage will in many cases be almost normal, but when they are being used to supply the plate current for a set, the voltage may drop considerably. However, as it is the voltage of the batteries when in operation that interests us most, we should always measure them under these conditions. Of course this cannot be done when buying the batteries in the radio shop, but here we must use good judgment and do our buying in reputable shops so that we know we are getting fresh batteries.

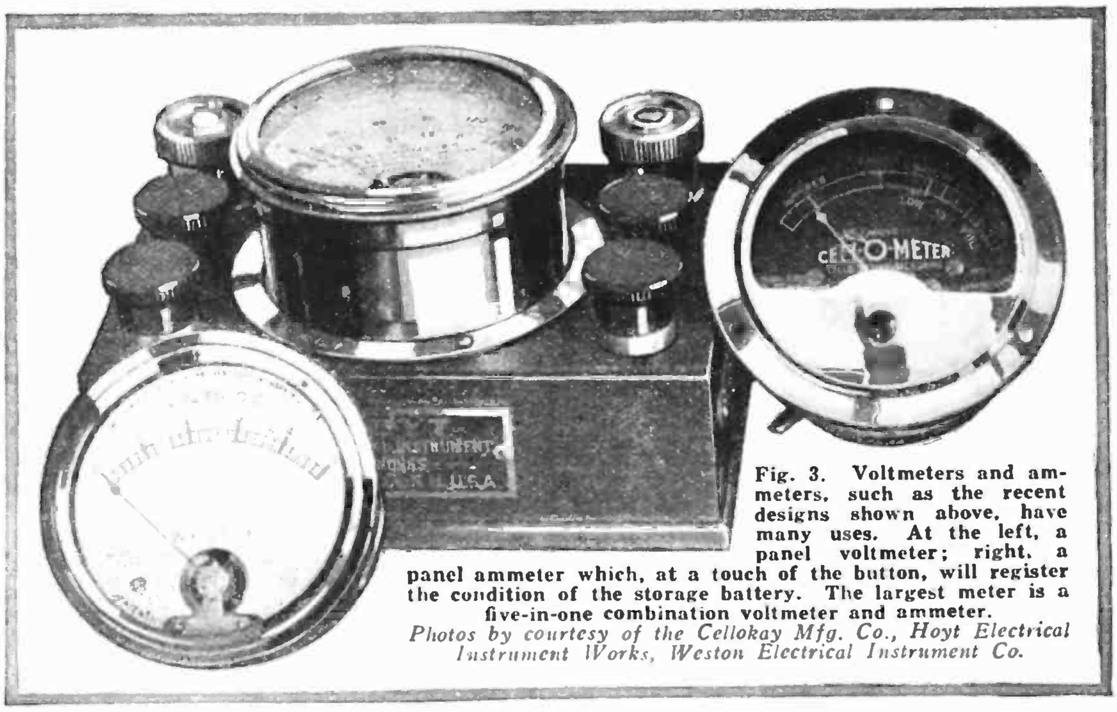


Fig. 3. Voltmeters and ammeters, such as the recent designs shown above, have many uses. At the left, a panel voltmeter; right, a panel ammeter which, at a touch of the button, will register the condition of the storage battery. The largest meter is a five-in-one combination voltmeter and ammeter.
Photos by courtesy of the Cellokay Mfg. Co., Hoyt Electrical Instrument Works, Weston Electrical Instrument Co.

The voltmeter for measuring the voltage of the B-batteries should, just like that used for measuring the voltage of the A-batteries, be connected directly across the terminals of the batteries, and also should be connected above the switch. The A+ and B— connections are generally the same, so that if the switch is connected in this lead from the set, it should disconnect both the filament and B-battery voltmeters at the same time. The connections for the B-battery voltmeter are shown in Figure 2.

Another meter which is found very useful in radio receivers is a milliameter. This is an ammeter designed for measuring small amounts of current, such as the current which flows in the plate circuits of vacuum tubes. This current is very small, generally of the order of one or two thousandths of an ampere, and for this reason is reckoned in milliamperes. (A milliampere is a thousandth of an ampere.)

The value of this meter is found when anything goes wrong. If for some reason or other the plate current ceases to flow, the meter immediately indicates this, and we know that something is wrong in the receiver. Or, if the plate current gradually falls off in value, we have another indication that the B-batteries are failing. As a matter of fact this is a better way of keeping tabs on the B-batteries than by using a B-battery voltmeter.

The connections for the milliameter in the plate circuit are simply made. The meter is connected directly in series with the B lead of the B-batteries. Ammeters should always be connected in series with the source of electromotive force, while voltmeters should be connected in shunt. The range of this milliameter should be about zero to 100 milliamperes. Although ordinary receivers rarely take as much current as 100 milliamperes.

An interesting meter has recently appeared on the market which should prove to be of considerable value to all users of storage batteries. This meter is shown in Figure 3 on the right. It is an ammeter of special design which is to be connected in series with the storage battery on charge. There is a third terminal on the back of the instrument by means of which the same instrument can be used to measure the current consumption of the filaments. The hydrometer, which is generally used to determine the condition of the storage battery is at best a sloppy instrument to use, although there is no doubt that reliable information about the battery can be obtained by means of this instrument. However, the instrument described is one which no one need hesitate to use, as it not only affords a means of keeping tabs on the battery, but avoids all danger of putting holes

(*Continued on Page* 171)

Noises in Radio Sets and Their Cures

By H. WINFIELD SECOR

EVERY radio receiving set at some-time or other develops a noise of some kind. The noise may be merely a subdued steaming sound which is more or less objectionable, or it may be more of a sharp, scratchy intermittent nature. Below are given twelve common causes of noise in radio receiving sets and their remedies.

1—Run down or defective "B" batteries. Replace with new ones; also connect a ½ to 1 microfarad condenser across the "B" battery.

else too high a plate potential on radio frequency and detector tubes. Present practice is to use 45 to 67½ volts "B" battery on radio frequency tubes and 16 to 22½ volts "B" battery on detector tube, even if it is a 201-A type.

9—Try small 3 volt—UX 199 tube in place of UV 201-A, using higher resistance rheostats or put extra rheostat in series with "A" + or — battery lead.

10—"Ground" A.F. transformers cores and negative filament line.

be well guyed and placed in such a position that the wire cannot touch tree limbs, woodwork on buildings, or anything else. The lead-in wire should be supported about six inches from the surface of the house by stand-off insulators. If these are not available the wire can be kept away from the building by means of small sticks having insulators secured to the end of them. The writer makes it a practice to always use No. 14 electric light, rubber covered wire for the lead-in, and this

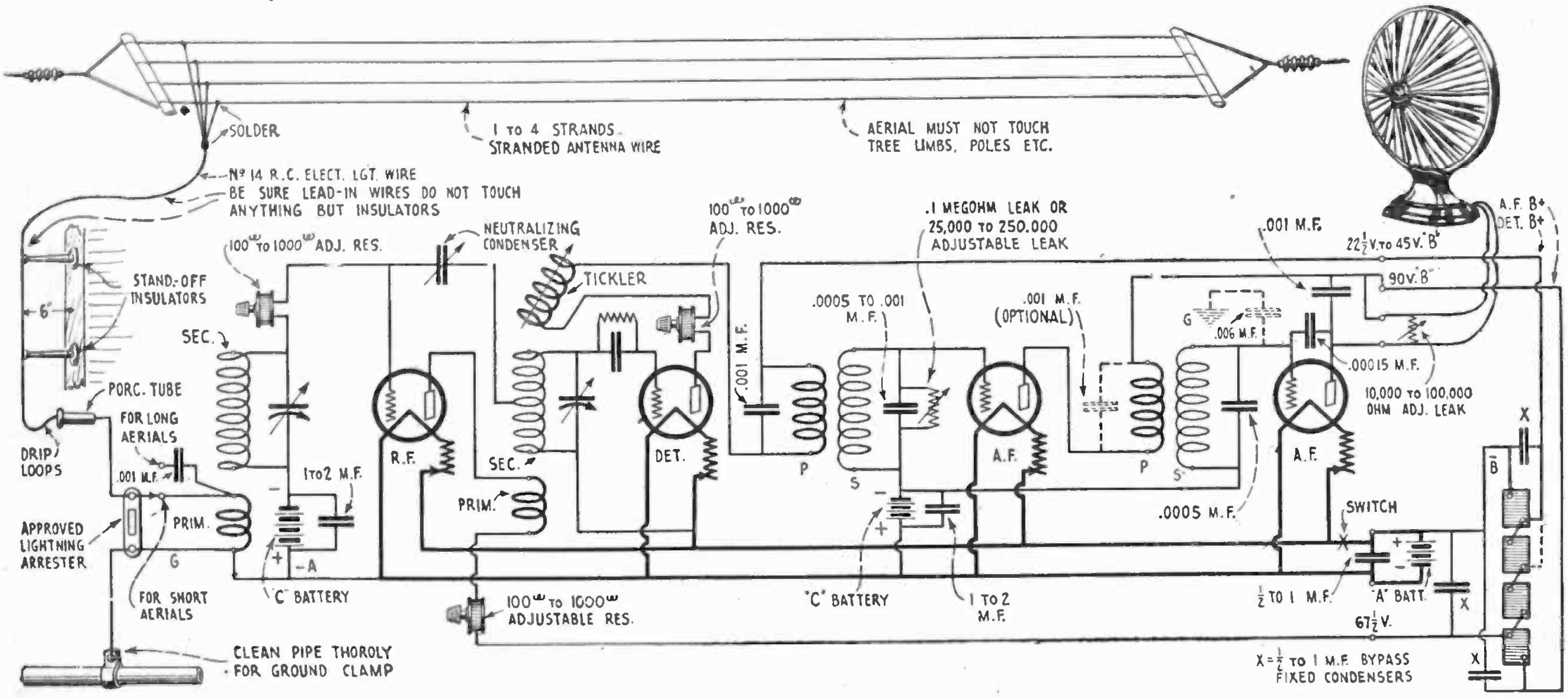


Fig. 1—In the diagram above there is shown the Hammarlund-Roberts circuit as employed by the author. Many refinements of slight cost are incorporated in this circuit with the object in mind to give quiet operation on the loud speaker and extremely clear reproduction of speech and music.

2—Storage "A" battery old or needs charging. Replace with new battery; recharge battery; also connect a ½ to 1 microfarad condenser across "A" battery terminals.

3—Tubes noisy. If more than one year old, test individually in detector socket with phones for noise.

4—Tube contacts dirty—sandpaper gently. Bend spring in sockets, if necessary.

5—Storage battery lead clips corroded—clean clips, also storage battery terminals.

6—"C" battery causes noise. Connect a 1 to 2 microfarad condenser across "C" battery.

7—Noise from leaky transmission line in neighborhood. To ascertain if noise is external to set, disconnect aerial and ground; if set is quiet, noise is probably external to set.

8—Steaming noise heard in loud speaker, but not annoying in detector stage with phones. Audio frequency tubes too far advanced—regeneration too great (tickler turned too far), or

11—Change grid leak and grid condenser—may be leaking or of wrong values. Average values .00025 microfarad condenser and 2 megohms leak.

12—Examine all soldered connections. They sometimes loosen up but appear tight. Shake them and resolder if in doubt. Solder all aerial and lead-in connections both inside and outside of house.

If the noise still persists after looking for the above causes, and providing you are not quite a radio expert yourself, it will probably pay you to call in an expert from your local radio dealer, as nothing is so annoying as excessive noise forming a background to the musical reproduction from the set.

Referring to the large diagram, Fig. 1, appearing herewith, a great many causes of noise in radio receiving sets and methods for eliminating them are illustrated. Intermittent sharp scratchy sounds are frequently caused by the swinging of aerial or lead-in wires against leader pipes or tree limbs. The aerial, of one or several strands, should

may be either solid or stranded. This wire is carried through a porcelain tube extending all the way through the wall of the house, and the hole for this tube or tubes is drilled either just under the window-sill or else just above the baseboard. Where one long tube is not at hand, two six or eight inch tubes can be used, pushing them into the hole from either side until they meet.

Be sure that the ground connection is thoroughly made, scraping or sandpapering the water pipe before the ground clamp is placed around it. All joints in the ground wire and lead-in system should be soldered. People often complain that their set is not as good as it used to be, the signals sounding considerably weaker. This is frequently due to unsoldered or improperly soldered joints between the lead-in wire and the antenna.

Getting back to our subject of noises in radio sets, one of the first things to do if noise of any kind is to be eliminated is to thoroughly clean all battery contacts and see that they are tight.

Next all soldered and other connections inside the receiving set itself should be carefully examined, and if they look at all doubtful they should be resoldered. Be sure that you examine the grid leak cartridge found on most receiving sets, and which is frequently placed under the vacuum tube shelf, where it is not in plain sight. This grid leak cartridge should periodically be taken out to see if the ends are clean, and then turned

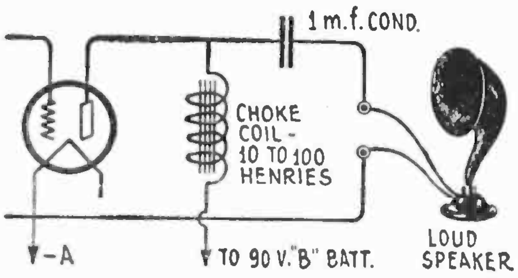


Fig. 2—Most loud speakers operate more efficiently when the "B" battery current is kept out of the speaker itself. This method of feeding the loud speaker through a 1 m. f. or larger condenser is shown in the diagram above: the larger the choke coil the better.

around several times in the spring clips, which should also be examined for cleanness of contact. If you cannot get at the grid leak clips but only can feel them under a tube shelf, a piece of emery cloth held between the fingers can be rubbed over them and the cartridge replaced, in this way making quite certain that there is no dirty contact between the grid leak cartridge and the clips.

One of the most frequent sources of noise in receiving sets and also the cause of either very weak or no voice reproduction at all, is due to either a poor or else no contact at all between a tube tip and one of the socket springs. These should be examined periodically, especially if any noise is present, and the springs sometimes have to be bent a little in order to make proper contact with a tube tip. Just because they look all right is not saying that they are all right. A tube may light up because the two filament springs are making good

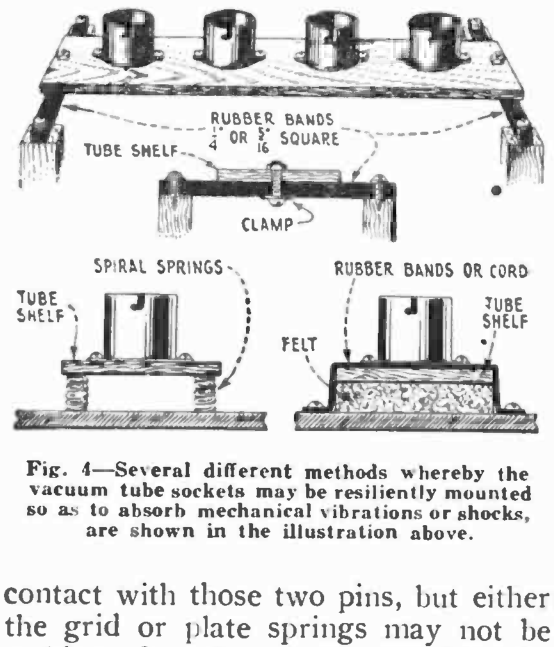


Fig. 4—Several different methods whereby the vacuum tube sockets may be resiliently mounted so as to absorb mechanical vibrations or shocks, are shown in the illustration above.

contact with those two pins, but either the grid or plate springs may not be making first-class contact with the other two pins on the base of the tube; this will result in either a weak signal or no signal at all, and yet the tubes would all light up. In making a preliminary hunt for this sort of trouble, simply take hold of the tube gently and work it around as well as up and down in the socket a few times. Many times where a set has stopped talking suddenly, or dropped about fifty per cent or more in volume, the voice will suddenly jump out in full volume and you have found the trouble. The remedy of course is to bend the springs and clean the tube contacts by scraping with a knife or piece of emery paper, or else replace the defective socket with a new one.

Speaking of vacuum tube sockets, many sets having more than five tubes are super-sensitive to microphonic noise, the least jar causing the tubes to reproduce a noise in the loud speaker. The remedy for this trouble, which is particularly noticeable when using UV 199 tubes, is to either use the new sockets fitted with spring or rubber shock absorbers, or else mount all of the sockets on a strip of bakelite or hard rubber, and in turn suspend this socket strip on springs, rubber bands, felt or sponge rubber. In many cases the remedy will be found in the form of a few pieces of sponge rubber placed under the corners of the radio cabinet. These hints for providing the sockets with shock absorbers are illustrated in Fig. 4.

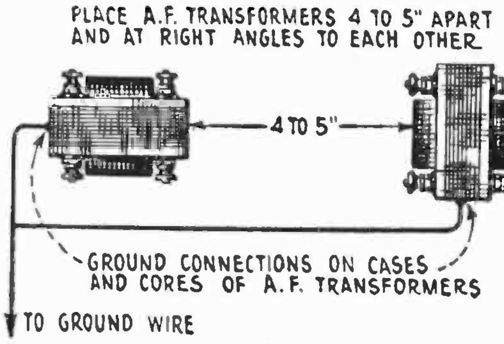


Fig. 3—Where a receiving set has any undesirable noise or whistle in the loud speaker, these undesired effects can often be eliminated by grounding the iron cores of the audio frequency transformers, as depicted in the diagram above.

In the diagram Fig. 1 which shows the Roberts circuit as used at the present time by the writer, a number of improvements to quiet the set and give good control of the various tube circuits are shown. An Allen-Bradley 100 to 1,000 ohm adjustable resistance is placed in series with the grid of the radio frequency tube. Also one of these adjustable resistances is placed in series with the plate of the radio frequency tube and likewise in series with the plate of the detector tube. It has been found in several cases that "C" batteries have given rise to a steady hissing noise in the set due to the battery becoming old, or else due to an internal action or a poorly soldered connection inside the battery. The remedy is to shunt "C" batteries with a condenser of at least ¼, and preferably 1 to 2 microfarads capacity.

On practically all receiving sets it is generally found advisable to place a .001 microfarad condenser across the primary of the first audio frequency transformer, and sometimes it is found advisable also to place one of these across the primary of the second audio frequency transformer. Many experts recommend a stabilizer for the audio frequency end of the set in the form of an adjustable resistance running from 25,000 to 250,000 ohms placed across the secondary of the first audio frequency transformer. At present the writer is using one of these resistances shunted by an .0005 microfarad condenser. This seems to work very well and you may try as high as .001 micro-

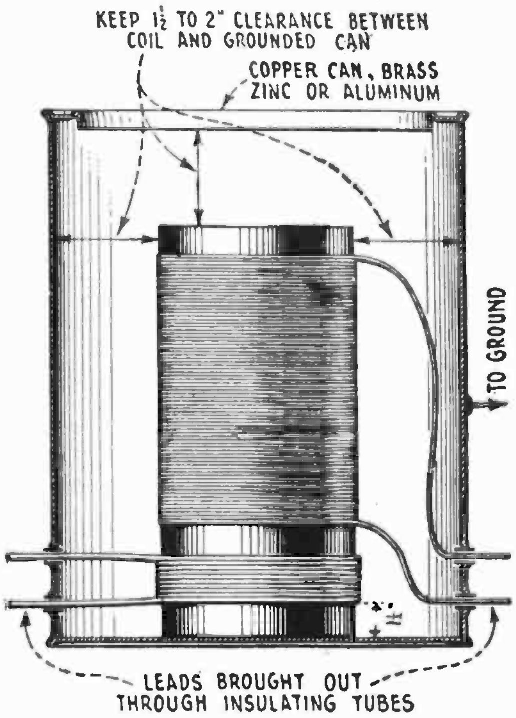


Fig. 5—One of the best receiving sets on the market today, the Isofarad, utilizes shielded radio frequency coils or transformers. The shield, which should entirely enclose the coil, should be made of non-magnetic metal and the shield grounded. About one and a half inch clearness should exist between the shield and windings in any direction.

farad in this position. The Hammarlund-Roberts experts recommend a small condenser of about .00015 microfarad connected across from grid to plate of the second audio frequency tube, as shown in Fig. 1, to cure a whistling noise which sometimes develops in audio frequency amplifiers. The writer has all the condensers shown in Fig. 1 on his Roberts circuit, and it certainly is about as quiet as anything he has heard, without sacrificing appreciable volume. In fact this four tube set, as shown in Fig. 1, is giving more volume than many five tube sets costing as high as $150.00, which means of course high frequency. The two audio frequency transformers used are Rauland Lyrics, but other transformers also have given very fine results in the writer's tests.

The secondary of the second audio frequency transformer is shunted by a .0005 microfarad condenser, but a .001 microfarad size may be tried here. A .001 microfarad condenser placed across the output of the loud speaker seems to improve the quality and doesn't reduce the volume any. In some cases especially when using a paper cone speaker, it is advisable to try an adjustable rheostat, such as a Bradleyohm or a Clarostat across the loud speaker terminals as shown. For most speakers this resistance need be no higher than 50,000 ohms. In one particularly obstinate case, a weak but persistent objectionable whistle, was cured by grounding the grid terminal of the second audio frequency tube through an .006 microfarad condenser, as indicated in Fig. 1.

The "A" and "B" batteries should both be shunted by by-pass condensers, using at least ¼ and preferably ½ to 1 microfarad capacity units. The detector, radio and audio frequency "B" battery circuits should have their own "by-pass" condensers, although one placed across the "B" battery will prevent noises in case it runs down or develops internal poor joints or chemical action conducive to noise.

Referring to Fig. 2, a new trick to help quiet loud speakers is to feed the plate current through the last audio frequency tube through a choke coil of 10 to 100 henries as shown. This choke coil is sold in all radio stores. The loud speaker is fed through a one microfarad condenser, and this should be experimented with until the best quality and volume are obtained. The diagram at Fig. 3 shows another trick for quieting noisy receiving sets, which consists in connecting to ground the shells and cores of audio frequency transformers. Be sure in wiring up a set that the rotor plates are grounded and not the stator plates. Fig. 4 shows how to "shock-proof" your vacuum tube sockets with springs, rubber bands, etc. Fig. 5 shows how to "can" your radio frequency transformers or coils. In many cases receiving sets have an objectionable *steaming noise*, especially when two or more stages of radio frequency are employed in standard circuits, which is due to feed-back action caused by the extraneous magnetic fields of one transformer reacting on another one. The latest technique in radio set building is to shield the various stages one from the other, such as in the *Isofarad* set and many other leading commercial makes. It is very valuable to remember that in Neutrodyne sets if the radio frequency transformers are shielded, they do not have to be placed at any fancy angle, as is the case when they are not shielded. This new idea is followed in the Stromberg-Carlson and 7 tube Music-Master Ware Loop sets.

As Fig. 5 shows, the secret in shielding sets with "grounded" shields or "cans" made of any metal except iron or steel, that is of non-magnetic material, is to keep the shield surfaces at least 1 to 1½" from all coil windings, either from the side or the end of the coil, to prevent undue losses due to induction.

The quietest sets that you will hear today are those provided with shielding around the radio frequency transformers without a doubt, and this applies to Super-Heterodynes of course, except where the transformers are spaced quite a ways apart; but there is a limit here due to long grid wires and other leads which should be kept as short as possible, all things considered. One-thirty-second inch copper or other non-magnetic shield is usually about as efficatious as a 1/16" copper shield. The separation shields between radio frequency stages should also separate the condensers, as these have a considerable electrostatic field surrounding them, which may react on another stage. The shield, to be efficient, should form a complete can or box which should of course be made accessible by having the top lift off, or else by cutting the sides diagonally after the idea found in many of the present commercial sets.

Another source of noise of a steaming nature is frequently that due to over-loading of the last audio frequency tube. Today there are available at reasonable prices special amplifier tubes intended to be used in the second stage of audio frequency amplification, in other words, in the last socket. With these power tubes, which do not consume an exorbitant amount of "A" battery current, there is to be used a plate voltage or "B" battery potential higher than 90 volts, the usual amplifier tube potential.

How to Read a Radio Hook-Up

(*Continued from page* 95)

readily traced through and present no unusual features.

In connecting tubes to amplify signals, the output or plate circuit is always coupled to the input or grid circuit. In case of radio frequency currents, the coupling is through radio frequency transformers, while in the case of audio frequency currents, the coupling is through audio frequency transformers having an iron core. Of course, there are other methods of coupling such as resistance coupling, capacity coupling, etc., but these will not be discussed in this article.

If the principles set forth above have been thoroughly grasped, they can be readily applied to the reading of any circuit.

This means that the radio hook-up will no longer offer any mysteries to the beginner, in which case the purpose of this article will have been accomplished.

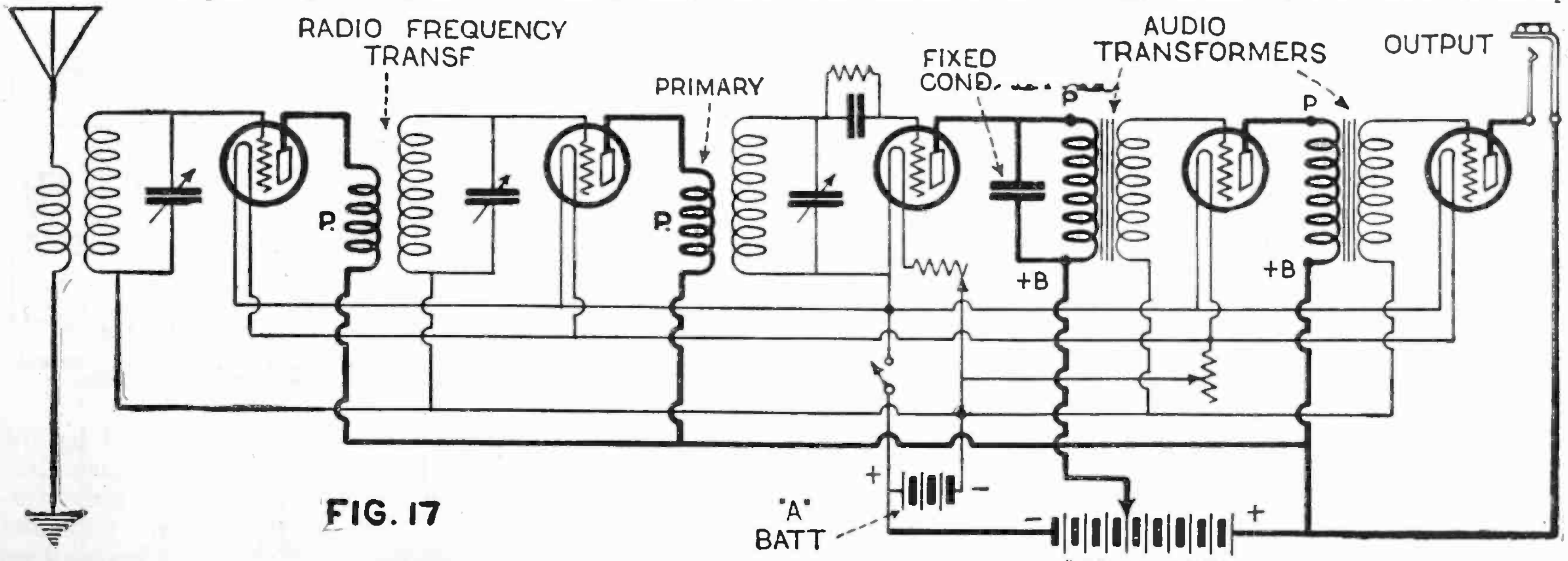


FIG. 17

The hook-up shown in Figures 15 and 16 is here repeated, with plate circuits shown by heavy lines.

Switches and Jacks in Radio Sets

By A. P. PECK, Assoc. I. R. E.

IT is surprising to note the various things that can be accomplished with a radio receiving set if a suitable quantity of jacks and switches of different types are judiciously employed. In this article we will point out various ways in which a radio set can be made much more flexible and much easier to


Fig.1

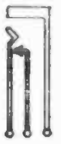


Fig.2


Fig.3


Fig.4

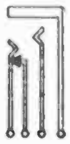


Fig.5

handle by the use of some of these little instruments.

In order to familiarize the reader with the various types of jacks that are in general use today, we illustrate in Figs. 1 to 5 different forms. In Fig. 1 is what is known as an open circuit phone jack such as is universally employed in the last stage of audio frequency amplification where filament control is not desired. In Fig. 2 is a single circuit closed jack wherein the insertion of the phone plug opens another circuit. In Fig. 3 is a single circuit filament control jack used in the last stage of audio frequency amplification to control the filament of the last tube. In Fig. 4 is a standard two circuit jack and in Fig. 5 is another form of the same type.

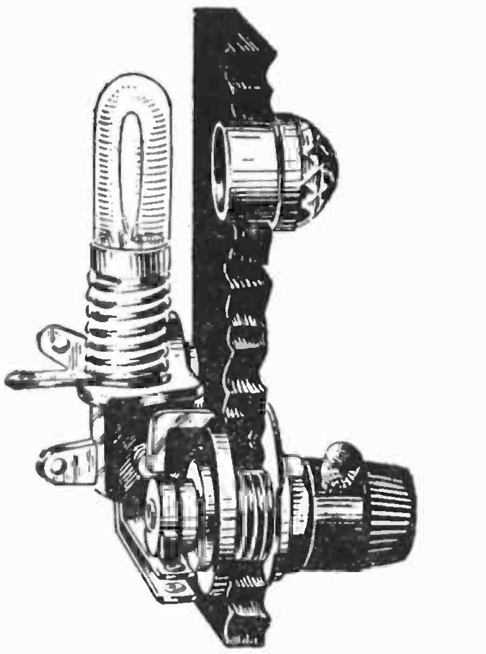


Fig. 10. A combination battery switch and pilot lamp.

Of switches there are a multitude and it is usually desirable, in order to conserve space and to make the entire set more compact, to use those of the type known as cam switches. There are many forms and Figs. 6 to 9 illustrate several of them. In Fig. 6 is a standard type of single-pole single-throw switch such as is frequently used for controlling the filament circuit. In Fig. 7 is a single-pole double-throw switch of varied uses. In Fig. 8 is a five spring switch of which more will be said later. The switch shown in Fig. 9 can be very frequently used in different parts of sets and for switching batteries from one set to another. It gives the effect of a double-pole double-throw switch and is easily mounted and connected.

On the switch that controls the filament circuit of a radio receiving set it is often very convenient to have some sort of an indicator to show positively whether or not the current is still turned on. Of course, this is found

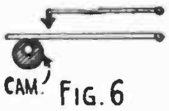


Fig. 6

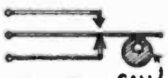


Fig. 7

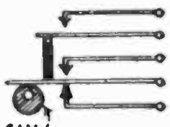


Fig. 8

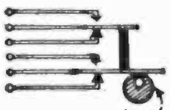


Fig. 9

where indicating marks are employed but these marks cannot be read from a distance. If, however, a pilot lamp is combined with a switch as shown in Fig. 10, it is possible to note whether or not the receiver is turned on even though you may be several feet distant from it. The light shines through a small colored glass bull's eye which is mounted on the panel and so, since the light is connected in parallel with the filament circuit, you will always be sure whether or not the "A" circuit is closed. This is a very compact arrangement of this nature and is mounted merely by drilling two holes, one for the bull's eye and one for the single hole mounting of the switch.

A good many experimenters use a double range volt-meter, reading from 0 to 8 or 0 to 120 volts for testing both "A" and "B" batteries. This is a nice form of instrument to have around the laboratory but it is rather inconvenient to have to be connecting and disconnecting it all of the time. If, however, the volt-meter is mounted on the panel of the receiving set together with a cam switch of the type shown in Fig. 11, a flip of the switch from one side to the other enables the operator to instantly read either his "A" or "B" battery voltages. It will be noted that the external resistor is connected in this circuit as this is what allows the volt-meter to give a double reading. In case you have an instrument in which the compensating resistance is placed within the case, you will just leave out the external resistor shown in Fig. 11 and make your connections accordingly. In case you do not have room to mount this volt-meter and switch on your panel, a small battery control panel might be made, hooked up and placed directly alongside of your set.

It is more and more coming to be a fact that many homes are equipped with radio throughout the house so that a loud speaker can be employed in any room. This is frequently accomplished by having one radio receiving set that is capable of giving ample volume located at some convenient point and connected to a series of jacks that are placed in the various rooms. Then, by pushing the loud speaker plug into the jack, radio entertainment is had at any desired place. One company is now putting out a jack that is particularly adaptable to this purpose and in fact was made for just such an installation. This jack is shown in Fig. 12 and is illustrated as designed to be placed in a standard electrical wall receptacle. In this way, unsightly wires are eliminated as they can be run through the walls and the jack can be installed in neatest possible manner.

Now let us see how a standard five tube receiver of the tuned radio fre-

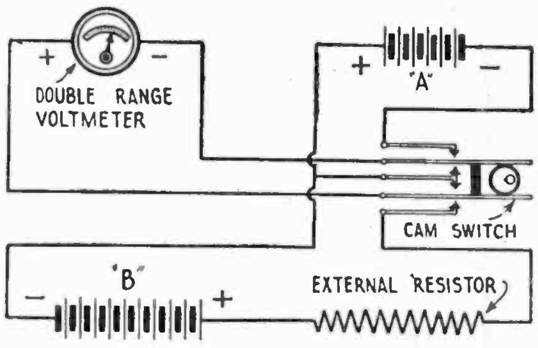


Fig. 11. Method of employing an external resistor by means of a cam switch.

quency type can be improved by the use of jacks in a greater number than is usual. Starting with the radio frequency end of the set, we find that five jacks can be employed here. Two plugs are also required and one of them is connected to the aerial and ground and the other to the loop. Now the antenna plug can be placed in the jack indicated by J1 which is of the type shown in Fig. 1 and the entire receiver used in the usual manner. When it is desired to use loop reception, the loop plug is placed in the jack, J2, and it is then tuned by the regular secondary tuning condenser, the first radio frequency coil being cut out by a jack of the type shown in Fig. 4. If a local station is being received from, the antenna plug can be placed in the jack,

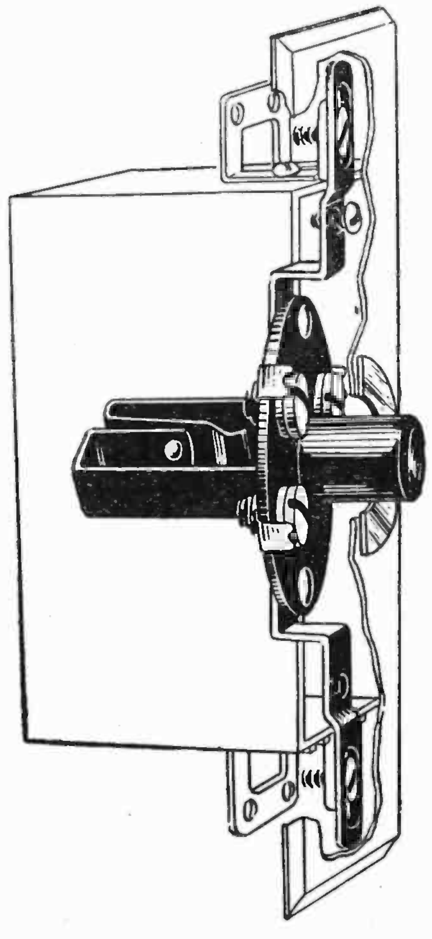


Fig. 12. A wall receptacle jack cut away to show the constructional details.

J3, and the filament of the first R. F. tube extinguished. In this way, only four tubes are employed and economy is practiced inasmuch as five are not necessary for local reception. If a very powerful local station is being received, and static is particularly bad, the loop can be plugged into the jack, J4, and only one stage of radio frequency amplification be used. For receiving from the same station, when atmospheric conditions are good, plug the antenna into the jack, J5, and extinguish both of the radio frequency tubes. Reception is then being accomplished with the detector and audio frequency amplifier alone.

Two jacks are shown in the audio frequency amplifier and J6 is of the standard two circuit type to be used for cutting out the second stage of audio frequency amplification. In conjunction with this is used the jack J7 which is of the type shown in Fig. 3 and which automatically extinguishes the filament of the second audio frequency amplifying tube, when the plug is removed from it. Of course a similar type of jack to this could be employed for extinguishing the filaments of the radio frequency amplifying tubes when they are not being used, but this would unnecessarily complicate the wiring and, therefore such an arrangement is not shown. J8 in the circuit Fig. 13 is a cam switch of the type shown in Fig. 6 and serves to control the filaments of all the tubes simultaneously.

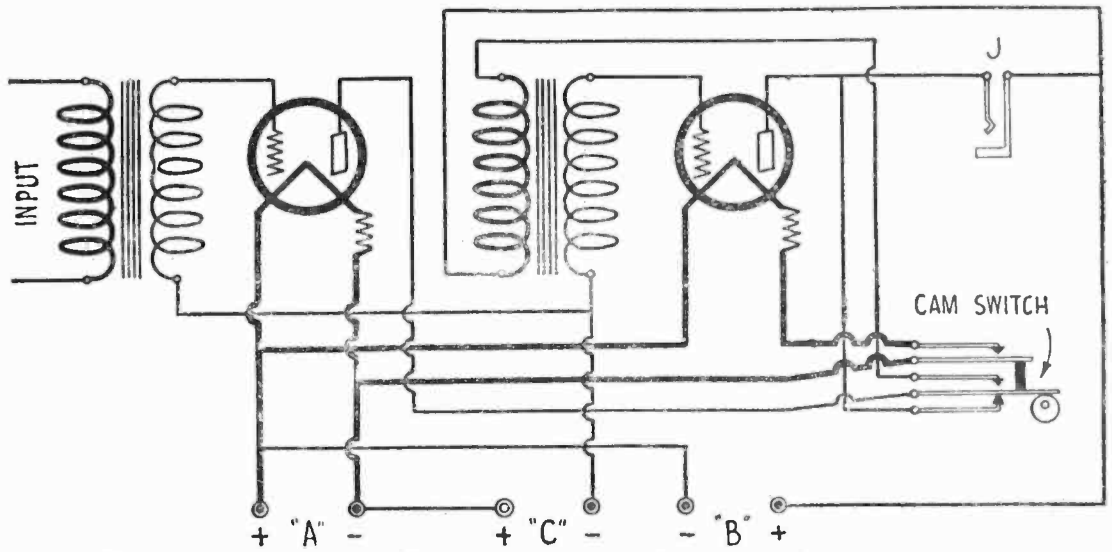


Fig. 14. A system used to eliminate two jacks can be arranged by means of a cam switch shown above.

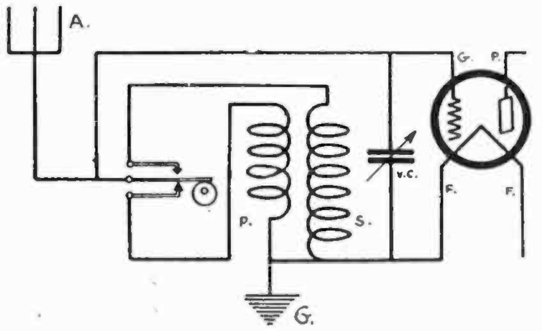


Fig. 15. A cam switch used to change from tuned to untuned circuit and vice versa.

In order to eliminate the necessity of having two jacks and a plug in an audio frequency amplifier circuit, a cam switch of the type shown in Fig. 8 can be hooked up as shown in Fig. 14. Throwing it to one side connects the jack J in the plate circuit of the first audio frequency amplifying tube and extinguishes the filament of the second tube. Throwing the switch to the other side, automatically connects J in the plate circuit of the second tube and lights the filament of that tube. The jack J can be replaced by binding posts mounted on the rear of the set and so the only amplifier control necessary on the panel will be the cam switch.

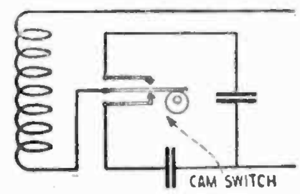


FIG. 16

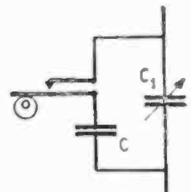


FIG. 17

A single-pole double-throw type of cam switch can be employed as shown in Fig. 15 for throwing from a tuned to an untuned antenna circuit. By placing the switch in the upper position, the antenna will be connected directly to the tuned secondary whereas by throwing the switch down, the antenna will be connected to the untuned primary. Where great selectivity is not

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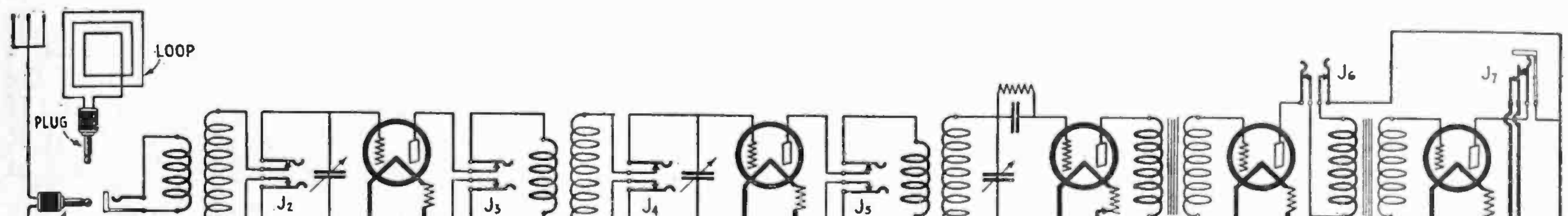


Fig. 13. A five-tube tuned radio frequency receiving circuit showing how jacks and plugs can be employed to make interchangeable connections.

Resistance Coupled A. F. Amplification

By G. C. B. ROWE

IN the not so far distant days of the beginning of the present radio era, one of the highest compliments that could possibly be paid to a receiver was that it brought in Station WXYZ on the loud speaker so that it could be heard all over the house. This last phrase "all over the house" is that with which we are particularly in-

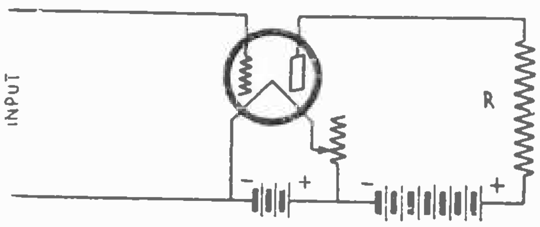


Fig. 1. The introduction of the non-inductive resistance in the plate circuit of the tube is the first step for explaining the principles involved.

terested, as there is a world of meaning wrapped up in those four words.

It was indeed an achievement in those days to fill a house with so-called music, even if the transmission was received from a local broadcast station. Generally the good old stand-by regenerative receiver with honeycomb coils was used with two or more stages of audio frequency amplification, using transformers as a means of coupling. And the one thing besides distance that was the goal in those days was volume—and lots of it!

What did quality of reproduction mean to the average fan in 1920 and '21? As well as we can remember it meant freedom of the music from most of the noises that broadcasting in general had and most important of all, sufficient clarity so that the call letters of the station could be understood when the announcer finally told them. This last item was very, very important. Many times we have heard the wish expressed, "Why don't they say who they are oftener?" Did the dyed-in-the-wool radio fan give two whoops whether a famous tenor was to sing an aria from "Faust" and if so, would it come in on his set well? No, indeed, DX and volume were the two lodestones that attracted the radio hound in those early days.

But like everything else the usual changes have occurred. We do not venture to say that in these enlightened days of 1926 radio fans no longer care for distance and volume of reproduction, but these have developed into a trio, the third member being quality.

To illustrate this is very simple. Consult the pages of advertising of any radio publication of five years ago and then turn to those of a current date. There will be very few advertisements in that old magazine that will mention very much about the quality of reproduction, but in the latest one—every loud speaker, every receiver, in fact everything down to the baseboard and mounting screws are guaranteed to give excellent quality of reproduction.

Now there are many factors that enter into the production of music in the loud speaker of a receiving set, that is as near like that played in the studio of the broadcast station. There are the tubes, the condition of the batteries, the loud speaker, the type of detector circuit and last, but far from being the least important, the type of audio frequency amplifier. There are four types of these amplifiers, viz., transformer coupled; resistance coupled; impedance coupled and push-pull. Each of these types has its advantages and disadvantages, but as we are primarily interested in quality let us consider the second type mentioned in the previous sentence, resistance coupled amplification.

Before we go any farther it should be borne in mind by the reader that it is not the intention here to prove that resistance coupled amplification is the best type to use for quality reproduction, but it may be said that it is pos-

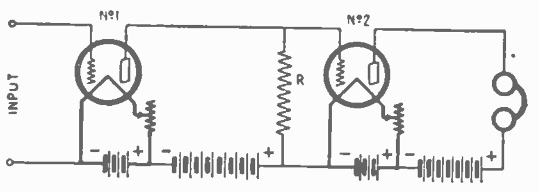


Fig. 2. In this circuit there must be two sets of batteries, but even then the grid of tube No. 2 will have a positive bias, which is undesirable.

sible by careful construction and experimenting to build an amplifier using only resistances and condensers, which will meet the requirements of the most critical listener. Also another error that might creep into the reader's mind is that resistance and impedance amplifiers are really amplifiers whose coupling is accomplished by means of the resistances and the coils in the circuit. This is not the case, for the coupling between two adjacent tubes is accomplished by the condenser separating the plate and grid of the two tubes. In reality and strictly speaking, it should be called capacitative coupling.

One of the first things that the reader should impress upon his mind is that in a resistance coupled amplifier the vacuum tube really does *all* the amplifying, the resistances and condensers being nothing more than coupling devices used to transfer the energy from the plate of one tube to the grid of the next tube.

To comprehend the action of a resistance coupled amplifier it is assumed that the action of the ordinary amplifying vacuum tube is understood, for here there is no room to explain the action of the tube. If this is not the case, then the reader must take our word for it, that when an alternating current is introduced into the grid circuit of a vacuum tube, there is as a result an alternating current exactly the same, except that it has a greater magnitude, set up in the plate circuit. This magnified current must come from some source, which is, in this case, the "B" batteries attached to the plate of the vacuum tube.

Not considering the true function of the vacuum tube for a moment in order to simplify the explanation let us say that in some mysterious way there appears in the plate circuit a much greater current than there was in the grid circuit. What does this magnified current depend upon? Upon one thing only and that is the amplification constant of the vacuum tube, which is always designated by the Greek letter, Mu.

Now let us consider Fig. 1. Here we have a vacuum tube with the input coming from the plate circuit of a detector tube and in the plate circuit of the tube a resistance, R. When a signal is impressed upon the grid circuit of this amplifying tube there is a corresponding voltage set up in the plate circuit. The resistance, R, in the plate circuit causes a voltage drop to occur in two places in the tube. The total resistance of the plate circuit is equal to the internal resistance of the tube added to the resistance, R, and if the "B" battery has 90 volts and if R is equivalent to the tube resistance at

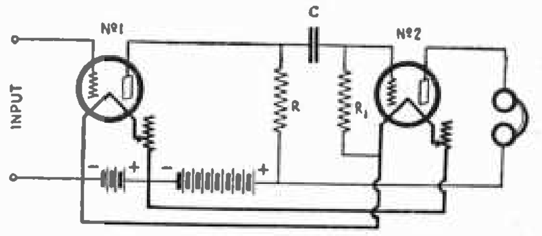


Fig. 3. The resistance coupled amplifier circuit with the introduction of a grid leak and condenser. The reasons for this are explained in the accompanying text.

that moment, the voltage drop across the tube will be 45 volts and the same value across R. We will not attempt to explore the extreme cases that are involved in the problem of the correct values for the resistance, R, but the reader should be able to grasp the fact that theoretically it is possible to vary the voltage drop across R from 0 to almost 90 volts.

If we discount the very small resistance of the "A" and "B" batteries, there will appear a changing voltage across filament and plate, when the grid potential varies and also across resistance, R, and that these last variations depend upon the tube resistance and the resistance, R. Also it can be easily grasped that these variations will be largest when the two resistances are alike, or better still, when R has a greater resistance than the tube. To understand this statement it is only necessary to imagine R smaller than the tube resistance, or even completely absent. In that case the full voltage fluctuations in the plate circuit are confined to the two terminals of the tube, the resistance of the rest of the plate being neglible, and therefore not showing any voltage drops whatsoever.

However, the resistance or impedance of the tube is constantly in a state of change and can assume very high values, and for this reason then the value of R should be equal to the higher values of the tube impedance, in order to maintain maximum effectiveness. Therefore the value of R should be extremely high, but in that case it would be impossible to use the apparatus in practice. To understand this clearly it should be remembered that the vacuum tube needs an effective plate voltage for proper functioning. With a given "B" battery voltage the mean voltage across plate and filament depends on the plate-filament resistance and the resistance, R, so that if we make the latter unduly large the effective plate voltage decreases to a point where the tube can not function any more. To attain in those circumstances a suitable plate voltage it would be necessary to increase the total plate voltage and this of course can only be done to a certain extent, as otherwise the voltage employed would become quite dangerous and leakage would occur in the "B" batteries. Therefore we must assign to the resistance R, a value in the neighborhood of 100,000 ohms, which will be found to be nearly perfect for all purposes.

Let us now see how the voltage variations across R can be used for the purpose of application to the grid circuit of another tube. The two tubes in Fig. 2 have the same circuit as that in Fig. 1; however, now the resistance R lies in the grid circuit of tube 2 as well as in the plate circuit of tube 1. Now it will be remembered from the foregoing that due to voltage changes or fluctuations, in the grid circuit of No. 1 there were corresponding changes in the plate circuit and therefore across R. Now these same magnified changes from No. 1 are transferred from R to the grid and filament of No. 2, thus the latter tube will be affected directly by the output circuit of the first tube, so that we will have amplification in both of the tubes, thereby causing a resultant magnified signal to be heard in the headset. However the same "A" and "B" battery cannot be used for both tubes and it must be admitted that this is a serious drawback. If we did use the same batteries to supply each tube with the necessary power it would mean that there would be a positive charge on the grid of tube No. 2 and this tube would then not function. However, as the circuit is shown in Fig. 2 the two tubes would act as a satisfactory amplifier, as all that would affect the grid of No. 2 are the fluctuations across the resistance, R.

teries. As the condenser, C, conducts the variations very easily, the voltage fluctuations across R are then effective also across the filament and the grid of tube No. 2.

Now it is quite necessary that the grid of tube No. 2 have a grid return. With most tubes the grid would accumulate negative charges, due to the electronic emission from the filament and irregular action of the tube would result. Therefore, it is imperative that we supply a grid leak, R1, for the charges to leak off the grid to the filament. This grid leak at the same time serves the purpose of a by-pass to voltages, which due to the leaks that might occur in the condenser, C, would tend to make the grid positive, thus allowing a grid current to flow and

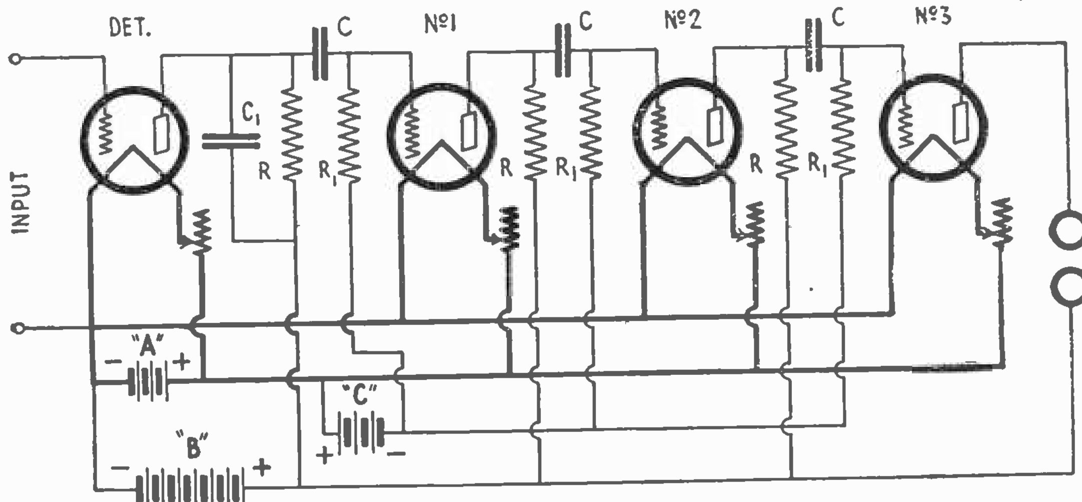


Fig. 4. Three stages of resistance coupled amplification are here shown with a "C" battery to give the proper grid bias.

Naturally it would be quite impossible to use a circuit having so many batteries, so a means must be found whereby it is possible to have a power supply consisting of but one filament battery and one plate battery for any given number of tubes in an amplifier. In order to do this it is imperative that the grids of the tubes must be separated electrically from the high voltage of the plates of the preceding tubes, but only as far as the steady voltage is concerned, while the fluctuating voltages of these plates must be impressed on the grids of the following tubes. The logical method of doing this is to introduce condensers between the two resistances, as condensers are well known to be an effective block against direct currents while they afford easy passage to alternating currents. Fig. 2 is then changed to Fig. 3 by the introduction of this condenser between the plate and grid resistances.

Upon inspection of this new figure it will be seen that although tube No. 1 remains the same, the plate instead of being connected directly to the grid of tube No. 2 is separated from the latter by means of the condenser, C. If voltage fluctuations now occur across the resistance R, they will also be effective across the grid and filament of tube No. 2, because R exerts its influence between plate and filament of tube No. 1, when we disregard the bat-

stopping the perfect action of the tube as an amplifier.

Now the grid leak, R1, is a direct shunt across the grid and the filament of the tube No. 2. This means that if the value of R1 is made small the voltages developed in this grid circuit will also be small, and the amplification of which the tube is capable can not be attained under these conditions. Therefore we will make this value relatively high, retaining as a result the highest possible amplification. R1 should have a value lying somewhere between 500,000 and 2,000,000 ohms. If this resistance is made variable it will be possible to control the resulting amplification completely.

Naturally we would like to have the fullest benefit of the voltage fluctuations across the resistance R and this means that we will want the influence of the condenser, C, to be as small as possible, or, in other words, its apparent resistance to alternating voltages should be as small as is practically possible. Now the reactance, as this resistance of a condenser is called, decreases with its size and the frequency of the alternating currents in the circuit. Therefore we must select a condenser which has a low reactance at the lowest frequency we will ever apply to the amplifier. This frequency for audio frequency amplification will be in the neighborhood of 16 to 32 cycles per second, as the former number is just about as low as the human ear can hear.

That this is true will be seen from the following: Condenser, C, and the grid leak, R1, are in series as far as the potential fluctuations across the resistance R are concerned. If R1 has a value of 0.5 megohm (500,000 ohms) and the reactance of C has the same value at 20 cycles for instance, the voltage fluctuations will be equally divided between C and R1. However the voltage fluctuations across R1 are the only ones that are effective on the grid of the tube No. 2, so that this grid would only have fluctuations equal to half of the total fluctuations across R. If we increase the frequency, the reactance of C decreases, therefore the proportion of the voltage fluctuations across R1 to the total fluctuations available increases—thus the resulting amplification increases and the result is unequal amplification at various frequencies. We must therefore choose a size for the condenser, C, that its reactance at 20 cycles, for instance, is negligible beside the resistance of the grid leak, R1. This condition can be obtained only when a condenser in the neighborhood of one microfarad is employed. If such a condenser is used its reactance at 20 cycles is about 8,000 ohms, so that if R1 is equal to .5 megohms, the voltage fluctuations across R1 will be practically all used.

Any fan who has worked with audio frequency amplifiers will know that if the grid of an amplifier tube is allowed to have a positive charge, the tube will not operate as it should, as it will be operating on the wrong portion of the characteristic curve. This is generally prevented by the introduction of a "C" battery, which has its negative terminal connected to the grid of the tube, generally through the secondary of an audio frequency transformer or in the case of resistance coupled amplifiers, through the grid resistance. The outward result of allowing the grid of the tube to become positive is distortion in the output of the set.

Referring again to Fig. 3, if an extremely strong signal serves as the input and there is a considerable positive potential on the grid of the tube No. 2, this grid will start to draw a certain amount of grid current, or in other words, electrons will be attracted to the grid of the tube. These electrons will accumulate on the condenser, C, because the grid leak, R1, will not allow them to leak away quickly enough. This means that the tube is liable to become paralyzed, and in any case to distort the signals; because, first, through the influence of the attracted electrons, which represent negative charges, the grid cannot complete its full swing to its highest potential, attainable in the absence of electronic charges accumulating upon it. In the second place, when the grid fluctuates towards its highest negative potential, the grid becomes too negative, due to the presence of the electronic charge, in as much as the latter did not yet leak off. The result is therefore blasting and distortion in the loud speaker.

The use of a "C" battery has been the subject of a great deal of discussion among designing engineers. It has been recommended by some and condemned by others. However in some cases the use of a grid biasing battery vastly improves the quality of reproduction. Referring to Fig. 4 there will be found a circuit diagram of a resistance coupled amplifier, in which is incorporated a "C" battery. The value of the resistance R in the plate circuits of the tubes is 0.1 megohm (100,000 ohms) and the value of the resistance in the grid circuits of the tubes is 1 megohm (1,000,000 ohms). The condenser, C, has in each case a capacity of 0.05 mf. The value of the "C" battery is about 4½ volts, but this value of grid bias should be experimented with in order that the best results might be determined, depending upon the plate voltage.

In Fig. 5 we have shown a diagram of a resistance coupled amplifier in which there is no grid biasing battery needed. However in this circuit the values of the several resistances have undergone a change. This is, however, with the exception of the resistances in the plate circuits, which retain the value given in Fig. 4, viz., 100,000 ohms. In the circuit of Fig. 5 the resistance, R1, has a value of 1 megohm (1,000,000 ohms); R2 a value of 0.5 megohms, and R3, 0.25 megohm. The values of the condensers remain the same. There should be in the neighborhood of 135 volts used as a plate voltage ("B" battery) on both these amplifiers. The value of the fixed condenser in the plate circuit of the detector tube, C1, in both diagrams is between 0.0005 and 0.001 mf.

Sometimes it is considered quite an aid to the controlling of the volume of a resistance coupled amplifier to have the resistance in the grid circuit of the second tube (tube No. 2 in Figs. 4 and 5) one which can be varied. It is placed in this position rather than in the first or last grid circuit, so that the volume when controlled with a given resistance, will not be too sharp or too broad in its adjustments.

The type of vacuum tube that is used in resistance coupled amplifiers is one that has a high amplification constant. It will be remembered that it was previously stated in this article that it was the tube, and the tube alone, that did the actual amplifying in an amplifier of this kind, so the higher the constant of amplification the better. Therefore if the experimenter is contemplating building the amplifier described herein it would be a very wise thing if he would consult the data available on the various constants of the many different vacuum tubes now on the market, and choose from these tubes for his amplifier that have as high a constant of amplification as possible.

The radio fan who is really interested in the best quality of reproduction that it is possible to obtain with his set, should not blame the loud speaker if the music or speech is distorted or otherwise garbled. Too often the loud-speaker is blamed for distortion, when the fault really lies in the poor design or poor operation of the audio frequency amplifier.

The same thing is true with any type of amplifier. In the case of transformer coupled amplification, certain transformers are designed to work with vacuum tubes which have certain definite characteristics and they only work at maximum efficiency with these tubes. Also the tubes are designed to operate best as amplifiers at certain plate voltages and if they are not employed, the general output will suffer, not only in volume but in quality as well.

As with all radio apparatus it must not be thought that even if directions are closely followed the apparatus will function at maximum efficiency as soon as the filaments of the vacuum tubes are lit. No matter how carefully the tubes are made there is generally more or less variation in the constants and therefore a little experimenting is generally necessary before the set can be said to be operating in a first class manner. It is worth while to take trouble with a resistance coupled amplifier because the results that are possible with this type of amplifier are truly remarkable and the experimenter or fan will be proud of the receiver when it is completed.

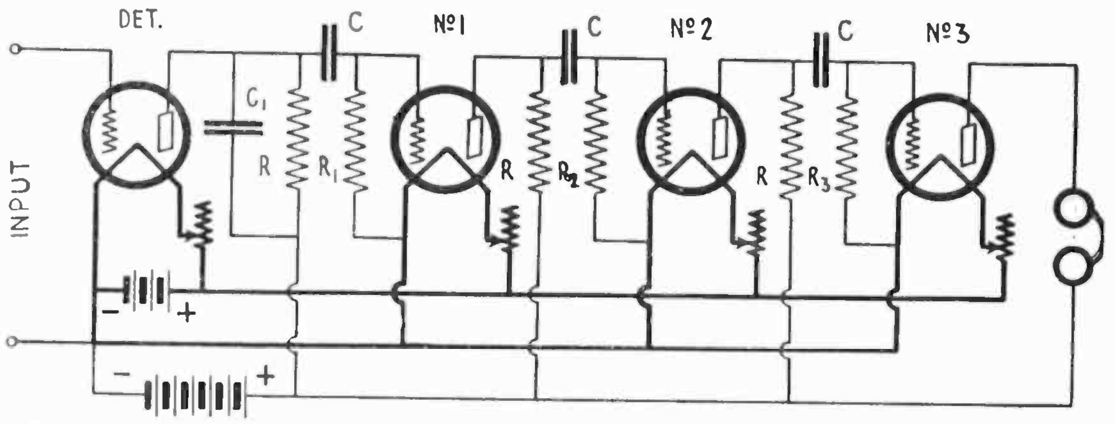


Fig. 5. The amplifier above needs no "C" battery as the values of the grid resistors take care of the proper grid bias.

Fixed Condensers in Radio Receiving Sets

By A. P. PECK, Assoc. I. R. E.

IN every store handling radio parts and accessories you will find a multitude of little instruments that have no working parts and that seem to be rather unnecessary in most circuits but which when properly used, will enable the experimenter to accomplish many things that could not be done without them and to accomplish these things in the easiest and quickest possible way. The purpose of this article is to point out some of the applications of these little instruments, fixed condensers, to radio sets and to show the various purposes to which they can be put.

One of the greatest uses for fixed condensers, especially in the radio experimenter's laboratory, is the employment of them to reduce or increase the effective capacity of variable condensers or to change the effective inductance of coils of wire. Let us discuss these features first. Reference to Fig. 1 shows a condenser, C, and an inductance, L, connected in a way that is known as in parallel. By shunting a condenser across an inductance in this manner, the wave-length to which the entire circuit in which the inductance is connected will be raised. Obviously if the condenser, C, was of the variable type, the wave-length to which the circuit would respond could be changed at will but in some cases it is merely necessary to raise the wave-length to a certain point and therefore it is frequently found that a standard size of fixed condenser can be employed as shown.

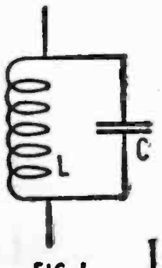


FIG. 1

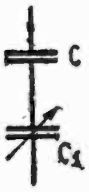


FIG. 1A

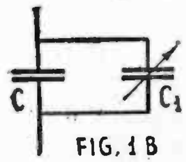


FIG. 1B

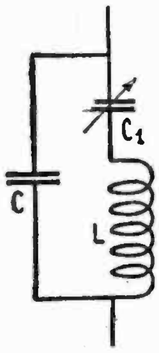


FIG. 2

If a fixed condenser, C, is connected in series with a variable condenser, C_1, as shown in Fig. 1A, the effective capacity of the condenser C_1 will be reduced. If C has a capacity of .001 mf. and C_1 is of the same size, the resulting capacity of the combination will be .0005 mf. The exact formula for figuring the capacity of a condenser connected in series is given in the statement that the resulting capacity is equal to the reciprocal of the sum of the reciprocals of the various capacities so connected. For example:

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

If two capacities are connected in parallel as in Fig. 1B, the effective capacity of the entire circuit is equal to the sum of the capacities of the two condensers. Therefore, if in the circuit shown, C and C_1 both have a maximum capacity of .0005 mf., the resulting effective capacity will be .001 mf., but it will be variable only from slightly more than .0005 mf. to .001 mf. It will be obvious from the above statements that fixed condensers can often be used in connection with variable condensers in order to obtain a capacity that could not otherwise be had with the variable instruments at hand. In case you desire a still wider variable range, switches could be introduced into the circuits so that as the variable condenser is turned from maximum toward minimum, the switch can be opened and the fixed condenser C removed from the circuit allowing the variable condenser to be moved through another effective capacity range.

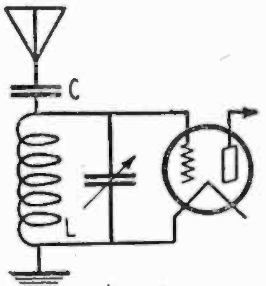


FIG. 3

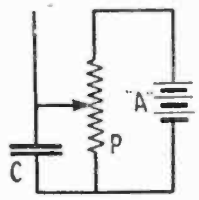


FIG. 4

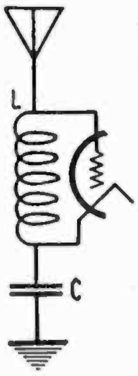


FIG. 5

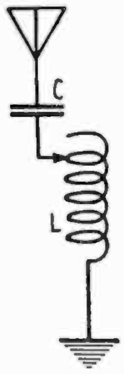


FIG. 6

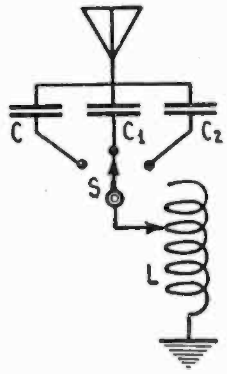
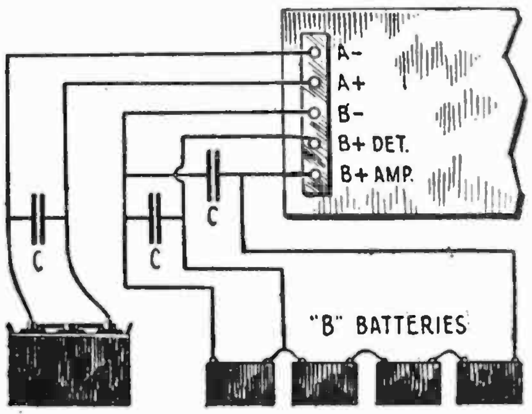


FIG. 6A

Sometimes when a variable condenser and an inductance as C_1 and L in Fig. 2 are connected in series, it is desired to raise the wave-length of this circuit and this can be done by connecting a small condenser C in parallel with both the condenser C and the inductance L. Obviously we cannot give any constants for this circuit inasmuch as they will vary according to the work at hand and according to the wave-length to which the original circuit will tune.

Some experimenters prefer to use an untuned antenna circuit in a radio receiving set inasmuch as they find that it increases selectivity. This, however, is not always possible or practicable because of the construction of the antenna coil. In such an event, the effect of an untuned primary can be obtained as shown in Fig. 3. A small fixed condenser C having a capacity of about .0001 mf. is connected in series with the antenna and the inductance L. This is usually found far superior as far as selectivity goes to connecting the antenna directly to the grid end of the coil. It is seldom that any noticeable reduction in signal strength is found when this method of reducing the effective wave-length of the antenna circuit is employed. The writer has used this system on several home-made sets and finds it very good. In fact, the same system is now being applied to a good many manufactured sets and is being recommended by several kit manufacturers.



"A" BAT.

FIG. 7

In sets employing a potentiometer for controlling the grid bias of radio frequency amplifying tubes, it is often found of advantage to by-pass the potentiometer by connecting the condenser from the center arm to one side of the potentiometer winding. This is shown in Fig. 4. C is a capacity that is not critical in size and may vary anywhere from .005 to 1 mf. It is usually stated that the larger this condenser, the better the results will be. In any event, the use of such a condenser will reduce the losses in the R. F. circuit and will usually result in more stable operation and somewhat louder signals.

Another variation of the capacity coupled scheme shown in Fig. 3 is illustrated in Fig. 5. Here the fixed condenser is connected in series with the ground lead but this system is not as effective as the one shown in Fig. 3. It is illustrated here for comparison's sake and to make this symposium complete.

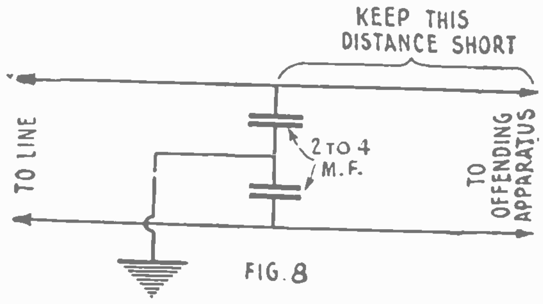


FIG. 8

Where tuned primary circuits are employed, as where a variocoupler operates to tune the antenna circuit, it is often found that with a long antenna the receiver will not respond to the shorter waves. This can be remedied by connecting a fixed condenser C in series with the tuned inductance L as in Fig. 6. In case you want a little more flexibility, it is entirely possible to use two or three fixed condensers with a switch as shown in Fig. 6A. Here the condensers, C_1, C_2 and C_3 should be of various sizes and should be connected to the switch S as shown. The set can then be adapted to various sizes of antennas with the least possible trouble.

Very frequently it is convenient to place the various batteries operating a radio receiving set in the cellar of a house or in a closet so as to get away from the unsightly effect that is created when they are placed in full view right near the receiver. When this is done it is often found that the selectivity of the set is decreased and that the set is more noisy in operation than before the change. This is usually due to the fact that the long connecting wires are acting as collectors and are picking up the external noises. Also they are increasing the radio frequency resistance of the various circuits and so broadening the tuning. This difficulty can be overcome by by-passing the various batteries with fixed condensers connected across the wires directly at the receiving set. Do not place these condensers near the batteries as this will defeat the purpose for which they are employed. These condensers may all be of the same size and should have a capacity in the neighborhood of ½ mf. Even 1 mf. will not be too large. The method of connecting the condensers and their exact location is shown in the circuit in Fig. 7.

Small electric fans, motors and certain types of battery chargers often create a peculiar buzzing interference that is reproduced by the loud speaker and that is most annoying. This interference can often be reduced and frequently eliminated by using the system shown in Fig. 8. Here two condensers are connected in series and shunted across the line near the apparatus that is causing the interference. The center point or common connection between these two condensers is then grounded as illustrated.

In Fig. 9 we show a complete receiving set less the radio frequency or antenna input inasmuch as these phases have already been discussed. We show about the maximum number of fixed condensers that can be employed but it is not necessary that all of them be used. Only when certain troubles arise which are described below will it be found necessary to use some of these condensers, although there are certain ones that should always be included.

In the circuit C_1 is of course the usual .00025 mf. grid condenser. It is always employed in the detector circuit.

Very frequently it is found that the tickler coil will not cause the circuit to oscillate over its entire tuning range, although it will oscillate at the shorter wave-lengths. When this is found to be true and you do not desire to change the physical and mechanical dimensions of the tickler coil itself, try connecting a .00025 mf. or larger fixed condenser across the coil as at C_2

lowed, this condenser can be eliminated from the set as the by-pass condensers across the "B" battery in Fig. 7 will take its place.

The condensers C_6 and C_7 in Fig. 9 are not always necessary but with certain types of audio frequency transformers they will be found of assistance inasmuch as they will frequently flatten out the characteristic curve of the audio frequency transformer so that it will respond to various frequencies with a maximum of amplification. Often, however, the effect is just the opposite and it will therefore be necessary to experiment with this point until it is determined whether or not your particular transformers need these condensers. They should be on the order of .0005 mf. capacity. These statements apply in particular to the fixed condenser C_5 but very often the one shown at C_7 will serve another purpose. It is frequently found that a high pitched whistle is present in the loud speaker and this is due to the audio frequency amplifier. It can frequently be eliminated by the use of a .0005 mf. condenser shunted across the secondary as at C_7. The condenser C_6, if of the same capacity will frequently accomplish the same purpose and when a whistle is found, condensers should be tried across both coils

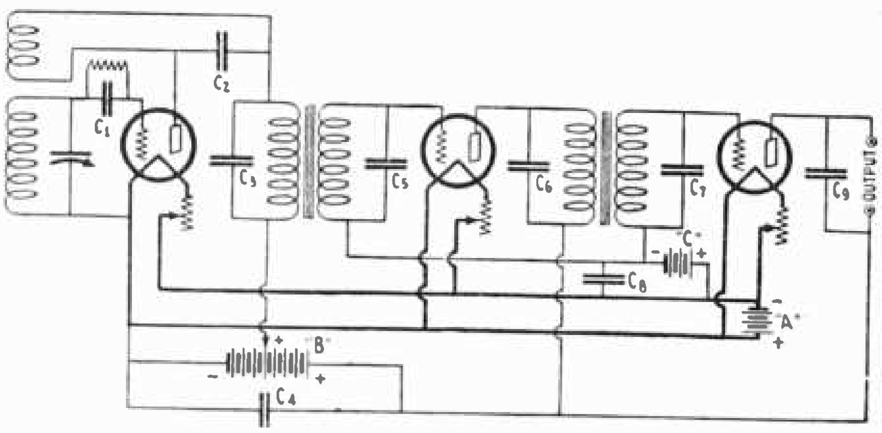


FIG. 9

This will frequently cause the set to oscillate smoothly over its entire tuning range.

In the case of receivers using tickler feed-back regeneration, it is always necessary to by-pass the first audio frequency transformer with a fixed condenser C_3. This should have a value of .0005 mf. or .001 mf. Usually the larger size will be found more effective in operation.

Although it is a mooted question that "B" batteries cause noise in radio receiving sets still it is very frequently found that connecting a fixed condenser, C_4, with a capacity of ½ to 1 mf. across the "B" battery as shown will reduce noises heard in the loud speaker. Whether or not this is due to the filtering action of a fluctuating "B" battery current or not will not be discussed here. It is sufficient to say that this condenser is very often of assistance and it is recommended that it always be placed in the circuit. If, however, the scheme outlined in Fig. 7 for remote supply installations is followed,

until the trouble is eliminated. Sometimes it may even be possible to help this trouble by means of the condenser C_5.

Where "C" batteries are employed in radio receiving sets, it is sometimes found of advantage to shunt or by-pass them by means of a fixed condenser as indicated at C_8. This is more particularly true where "C" batteries are used in radio frequency amplifiers and in such an event, the by-pass condenser should have a capacity of 1 mf. In the audio frequency amplifier this condenser is not so necessary and can often be eliminated without any decrease in results.

The shunting of the output or loud speaker terminals by means of a condenser as at C_9 will frequently aid in enabling the loud speaker to reproduce all of the various frequencies. This condenser should not be of too large a capacity as this will tend to give the reproduced music a hollow unnatural tone. Usually nothing larger than .001 mf.

(Continued on page 167)

The Radio Broadcast "Aristocrat"

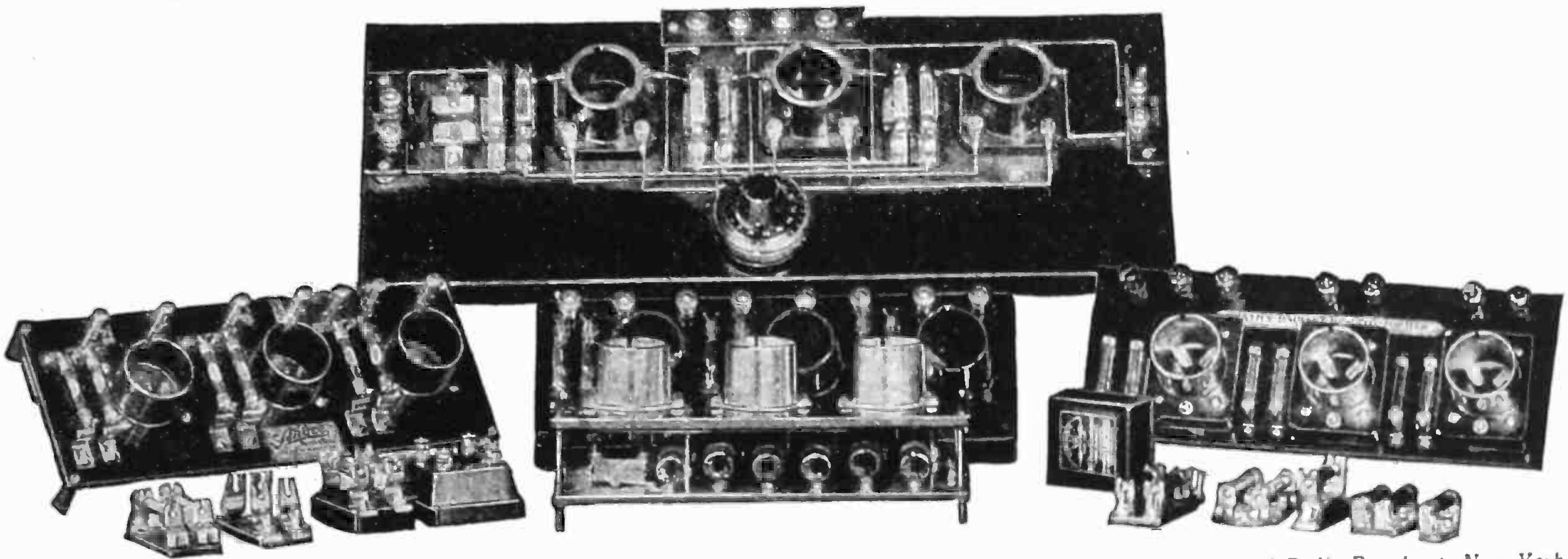
How to Build a Five-Tube Receiver Which Has Extremely Fine Tone Quality

THE word "efficient" can be applied with truth to the radio receiving set designed and described below by *Arthur H. Lynch*. This set combines the distance-getting features of the superheterodyne with extremely economical operation. Its simplicity of tuning, however, places it in a class by itself. The superior tone quality of this set is due partly to the resistance coupled amplification and partly to the improved circuit design, which results in a set well worthy of the name "Aristocrat." Mr. Lynch tells of the advent of this set in *Radio Broadcast* magazine as follows:

For a very long time we had been looking for the kind of receiver that would be easy to build, easy to operate, and at the same time be comparatively economical. In the receiver described here, we found what we consider a solution to the problem. There is but one main tuning control which makes the finding of stations so simple that the most inexperienced can secure surprising results. In an actual demonstration, we have been able to show that by means of this single control and no other adjustments whatever we were able to hear sixteen stations in less than three minutes, with a single turn of the tuning dial. When other adjustments were made—and where is the DX fan who will not want to be certain that he is getting the last drop of energy out of his set?—we have been able to procure distance with volume, which few receivers other than a super-heterodyne could have accomplished. And above all we have been able to secure tone quality which has been characterized by many of the radio designers and enthusiasts who have come to Garden City to witness the performance of our new outfit, as being far superior to most receivers they have seen or heard. We believe this receiver will do much to endear radio to those music lovers who up to the present time have felt that radio reproduction was not sufficiently free from flaws to reproduce with fidelity the music they love.

What the Receiver Is

In combing over the possible circuits of real worth to the home builder we have come to the conclusion that there are but three that possess the merits we sought, namely: the super-heterodyne, the neutrodyne in many of its advanced models, and the combination of a stage of tuned, neutralized radio frequency amplification in combination with a regenerative detector and some more than ordinarily good system of audio frequency amplification. After considerable thought to each of these we decided in favor of the last, not because we thought the others less valuable but because the combination of price, distribution, ease of building, operating, and low upkeep cost seemed



Illustrations by courtesy of Radio Broadcast, New York

Fig. 1. Here are a few of the resistance units tried out in conjunction with the development of the Radio Broadcast "Aristocrat."

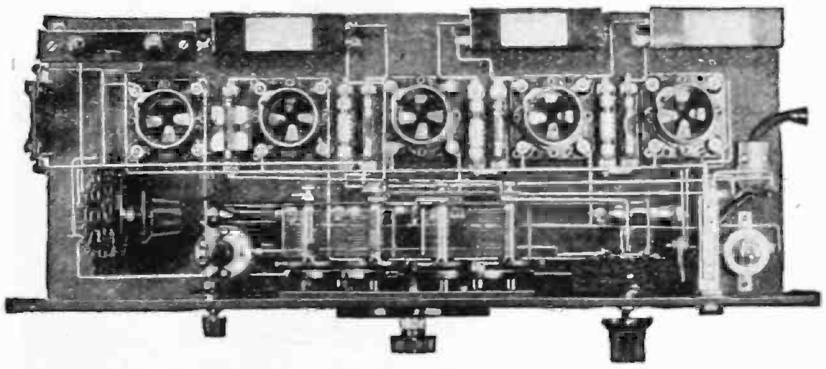


Fig. 2. In this assembly each unit is made with individual mounting. The antenna switch is behind the panel and .5 mfd. condensers are used in the resistance-coupled amplifier, and a short-circuiting switch is used on the ballast for the last tube to allow for use of either 5 or 6 volt tubes at will. The regeneration is controlled by a variable resistance across the tickler. A Cabelug is used for the battery wiring. For the experimenter who wishes to make frequency changes in his circuit this arrangement is just about ideal.

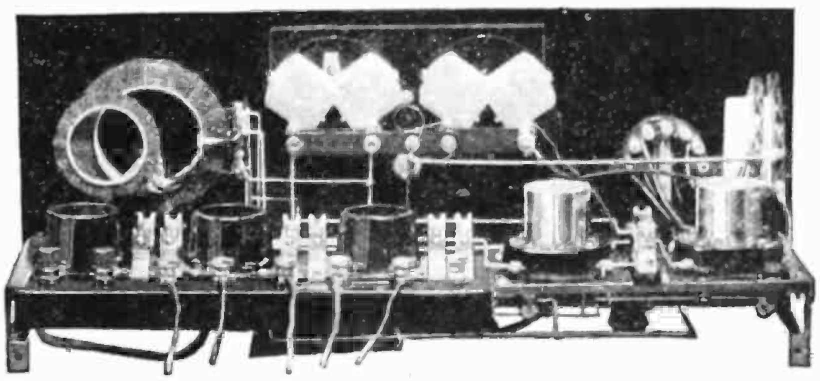


Fig. 3. This receiver was made on a 7 x 18" panel and is intended to illustrate the method of using a complete resistance-coupled amplifier unit in connection with two additional tubes for the complete assembly. When 6 volt tubes such as Daven Mu-20, and Mu-6 are used, there is no need of making any alteration in the filament circuit of the amplifier, and the wiring is thus materially simplified. In this receiver we have used the regular Sickles Knockout coils. The ballast resistors for the first two tubes are beneath the sub-panel.

to be best carried out in the receiver we are now to describe.

So, in the Radio Broadcast "Aristocrat," we have one stage of tuned, neutralized, radio frequency amplification, a regenerative detector, and three stages of resistance coupled amplification. Before going further let it be said that the resistance coupled amplification we are using should not be confused with similar systems described in the past because it is now possible to maintain tone quality, for which this type of amplifier is famous, together with great volume, because of the foresightedness of some of the tube manufacturers who are now marketing what are known as high-Mu tubes. These tubes are designed for resistance coupled amplification. The amplification per stage that is obtainable with them is far greater than has heretofore been generally possible.

Then, too, in the "Aristocrat" there are no rheostats whatever and the number of binding posts has been reduced to a minimum. In order to make the design, building, and operation of this type of receiver quite clear, and in order to demonstrate the variations that may be incorporated in it at the discretion of the home builder, we will describe at length but one of the group we have made, and will point out the differences between it and the others by means of the captions under the illustrations.

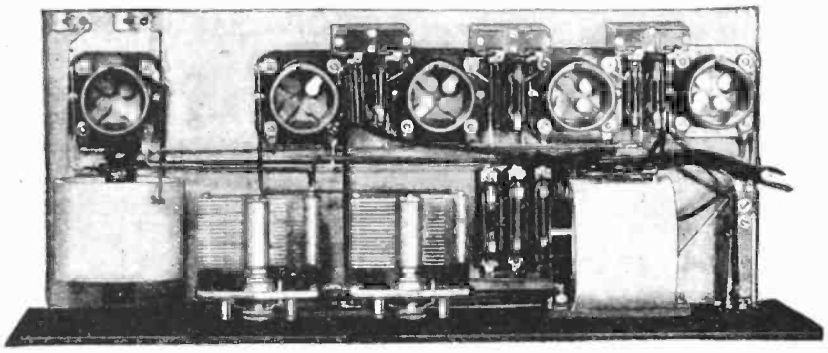


Fig. 4. Mr. McMurdo Silver built this receiver from the ground up in less than four hours. It is his version of the Radio Broadcast "Aristocrat." The single control feature is accomplished by belting two of his condensers together with fish line, letting one dial do all the moving.

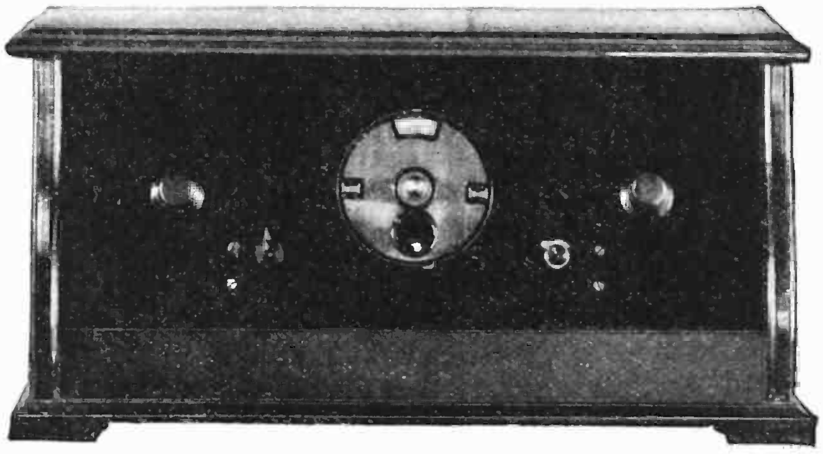


Fig. 5. Front view of Radio Broadcast's "Aristocrat" made to fit in a cabinet providing for a 7 x 18" slanting panel. In this receiver, as the accompanying article will show, we have gone a long way afield and produced what we believe is a true departure from conventional design electrically, artistically, and mechanically.

The Design and Assembly

By referring to Fig. 5, it will be observed that there is but a single dial, in the center of the panel. This dial is used to govern a Hanscom single control unit and is the main tuning control. It is a unique arrangement of two Remler condensers geared together in a manner that makes tuning of the antenna and radio frequency circuits simultaneous. The small knob below and to the left of the main dial is the vernier which is used to compensate for any slight variations between the windings of the circuits tuned by the two condensers. The knob below and to the right of the tuning dial is the filament switch. By referring to the circuit diagram, it will be observed that the filament switch is placed in a position in the circuit that cuts out the by-pass condensers across

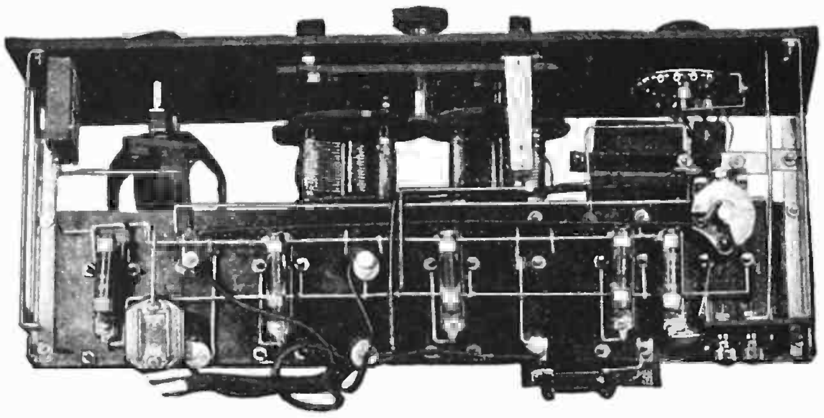
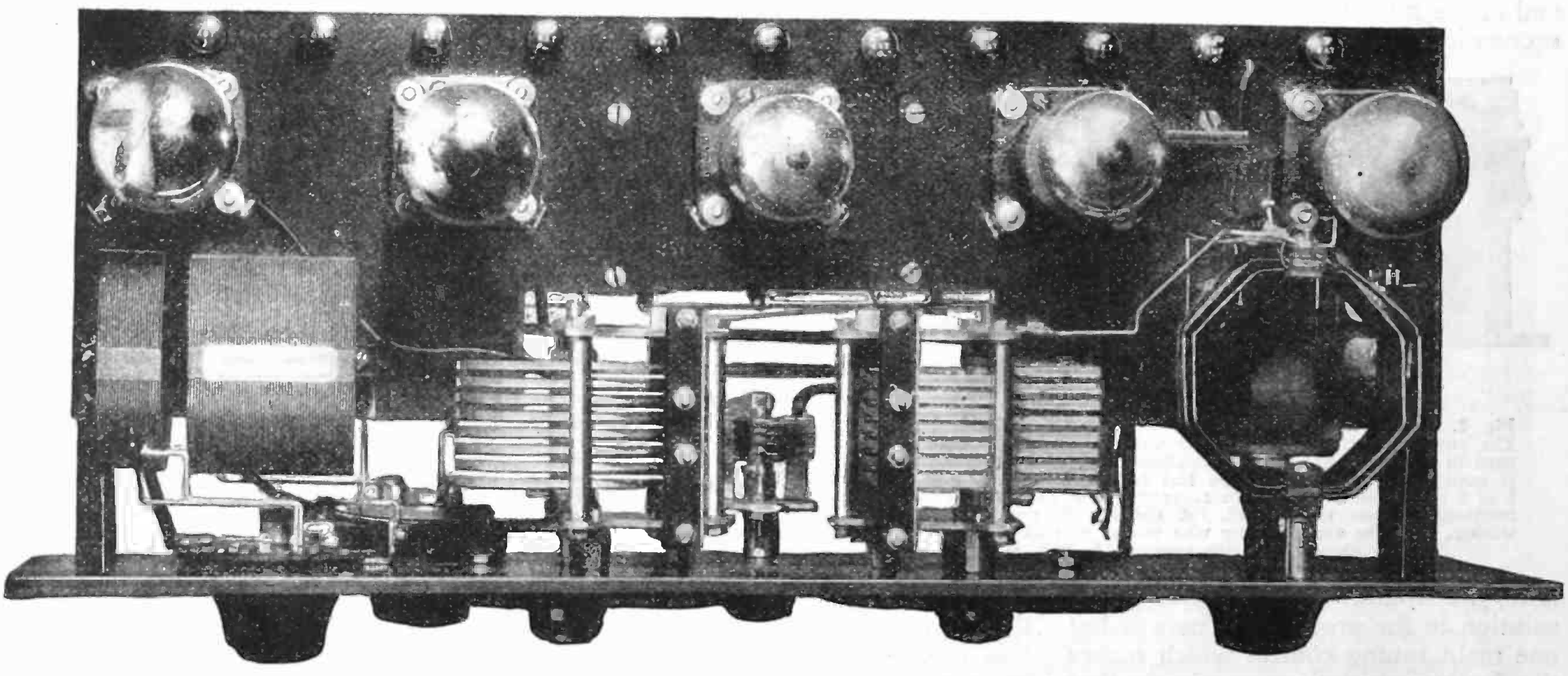


Fig. 6. A bottom view of the "Aristocrat" receiver showing how the filament ballast and other parts are mounted on the sub-panel. This set is one which employs a single control twin condenser. See top view on page 112.



Of the set shown above, the layout above the sub-base, and the freedom from visible wiring this form of construction makes possible, is distinctly shown. The use of the Cardwell SLF condensers and Eastern Coils, resulted in both dials reading the same for any given station throughout the broadcast range. Benjamin cushioned sockets for UX-base tubes were found very satisfactory. In this receiver Dubilier fixed condensers were used.

the batteries, which would ordinarily form a high resistance leak and result in a drain on them even when the receiver was not actually in operation. The small knob at the left of the panel is used for the tap switch, connected to the primary of the antenna coupler, to compensate for antennas of different lengths. Once this switch has been set for a given antenna it need not be touched, except for ultra-fine tuning, when extreme selectivity or extremely long distance is desired. The knob on the right controls the regeneration, and may be considered a volume control.

Before passing on to the consideration of the remainder of the receiver it would be well to look over the accompanying illustrations and observe the variations that have been made in the panel design, the layout of the apparatus, and the different systems of tuning and regeneration control. There is very little difference in the actual performance of any of the models we have made and the selection you make may well be considered from a convenience standpoint rather than one of net results obtainable.

Bear this in mind, however: you cannot expect to get the results we are getting if you buy your parts on nothing but a price basis. We have spared no expense in attempting to bring only the best to your attention and suggest that you make an attempt to get the best—not necessarily the most expensive. And when you are all through getting the best of parts and have done a thorough job in your building don't blame poor reception on the receiver if you hook some poor loud speaker to it.

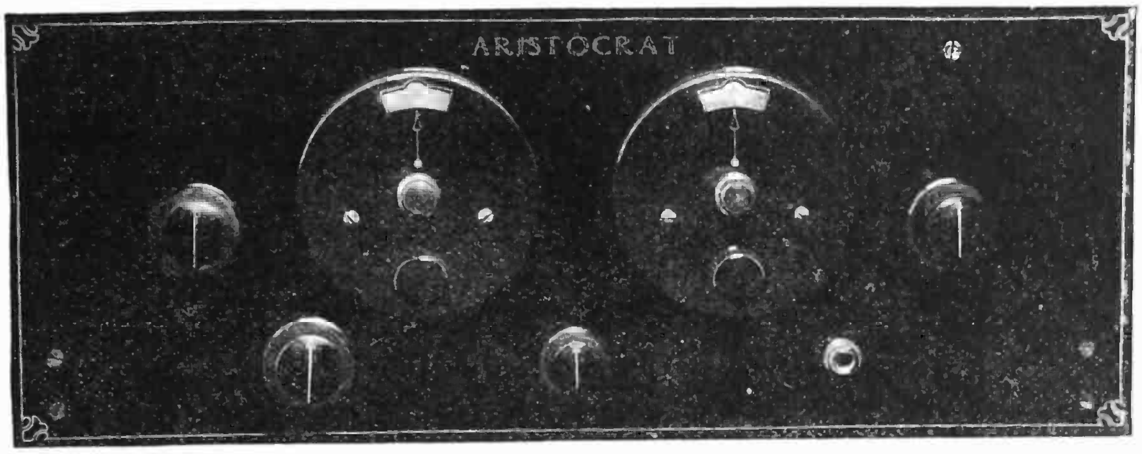
But to continue, we may as well point out some of the other important points in the actual construction of this receiver. The panel of what we may consider our main model is 7 x 18 inches and there is plenty of room on it for all the equipment necessary, when a sub-base is employed. In this model we have used large-size inductances, in order to illustrate how the entire assembly may be housed in a standard cabinet. When other types of inductances are employed, as in the case in some of the other models, there will be a little more room in the cabinet.

It will be observed that the tuning inductances and the variable condenser assembly, antenna switch and battery switch are mounted on the main panel, while all the remaining equipment is either on the top or bottom of the 2½ x 17½-inch sub-panel, which is suspended from the main panel by means of Benjamin No. 8629 brackets.

On the upper side of the sub-panel will be found the five-tube sockets, the three resistance couplers, the grid condenser and leak mounting, and the variable neutralizing condenser. It is also possible to find room for all the binding posts, including those for the three connections for the C battery.

On the under side of the sub-panel there are five mountings which are used for the filament ballast resistors.

When they are to be taken out of the circuit, as explained a little later on, it is but necessary to make a direct connection between the two spring clips of the mounting by means of a bent piece of bus wire.

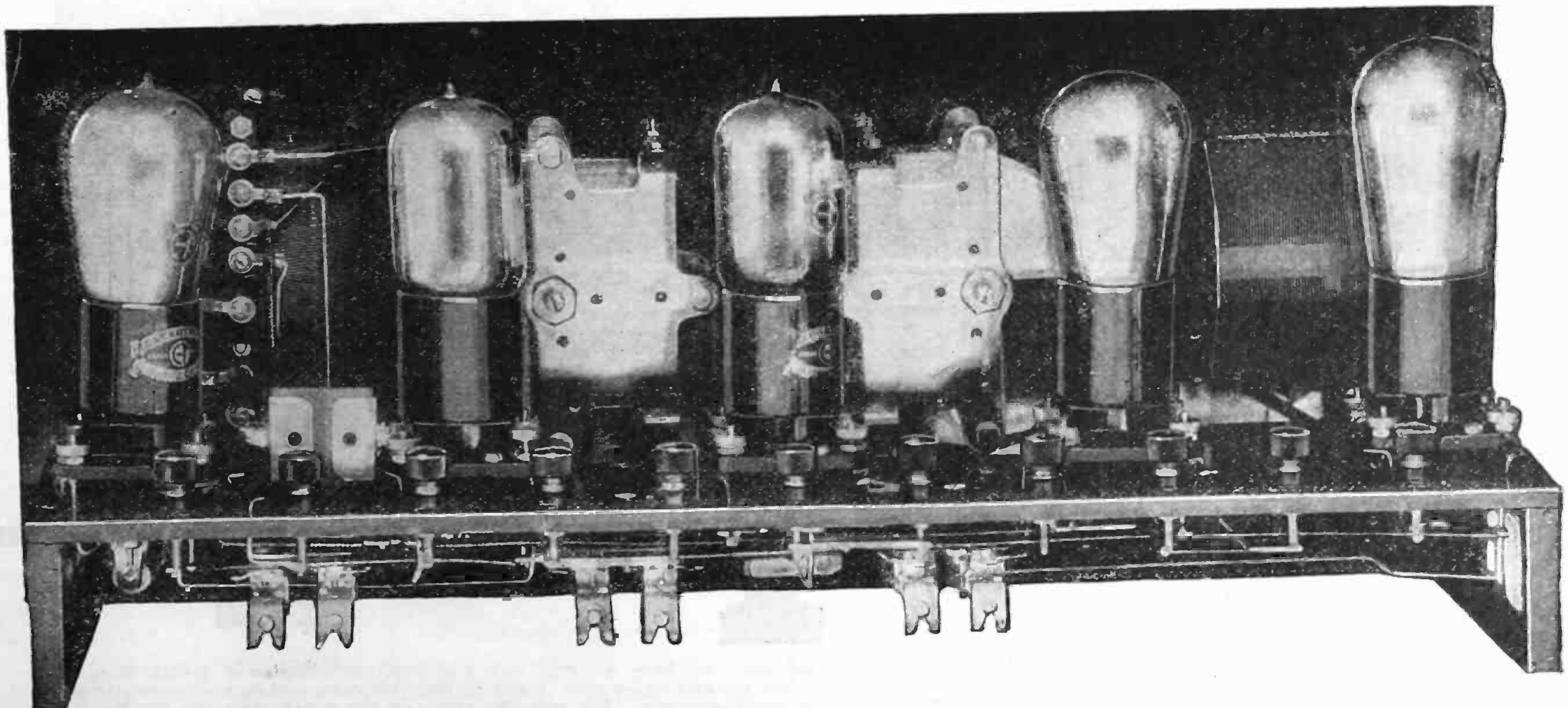


In this model the layout is altered somewhat by the use of a sub-base. This receiver is identical to the original Radio Broadcast "Aristocrat" for which working drawings in blueprint form are available. Amsco vernier dials, whether black, silver, or gold, show up nicely on the Insuline panel. The other knobs, left to right, are Carter antenna switch, Royalty r.f. rheostat, Hammarlund neutralizing condenser, and Eastern tickler control.

List of Parts

The list of parts used in the model we are considering is as follows: The variation in material that is possible is indicated in the accompanying illustrations.

1—7 x 18-inch panel, 1—2½ x 17½-inch sub-panel, Hanscom S. C. Condenser Unit, 1 set Eastern Knockout Coils, 1 Carter filament switch, 2 Apex knobs, 5 Benjamin sockets, 3 resistance couplers with 3—1 megohm resistors and 1 each, 1 meg., 5 meg., and .25 meg. resistors, 1 Hammarlund neutralizing condenser. 2—.004 Sangamo fixed condensers. 1 Dubilier .5 microfarad by-pass condenser. 6



Furnishing a general idea of the complete assembly. The tubes, left to right, are Cleartron CT-201-A Detector; two Cleartron Hi-Constron CT-101-A high-mu amplifier tubes; UX-112 Radiotron power tube; and UX-201-A radio-frequency amplifier. In this layout the resisto-couplers are hung below the sub-base rather than mounted on it as shown in some of the original models.

mountings for filament ballasts and grid leak. 1 grid leak and condenser. 5 Ballast Resistors. (The value of these resistors depends on the type of the tube used and the values for various tubes are given in that part of this article which deals with the circuit and its characteristics.) 1 Belden Standard Color, five wire, cable. 2 Benjamin No. 8629 brackets, 2 to 6 Eby binding posts. 2 dozen 6 or 8-32 round head, brass machine screws, 3/4 inch long. About 6 two-foot lengths of bus bar.

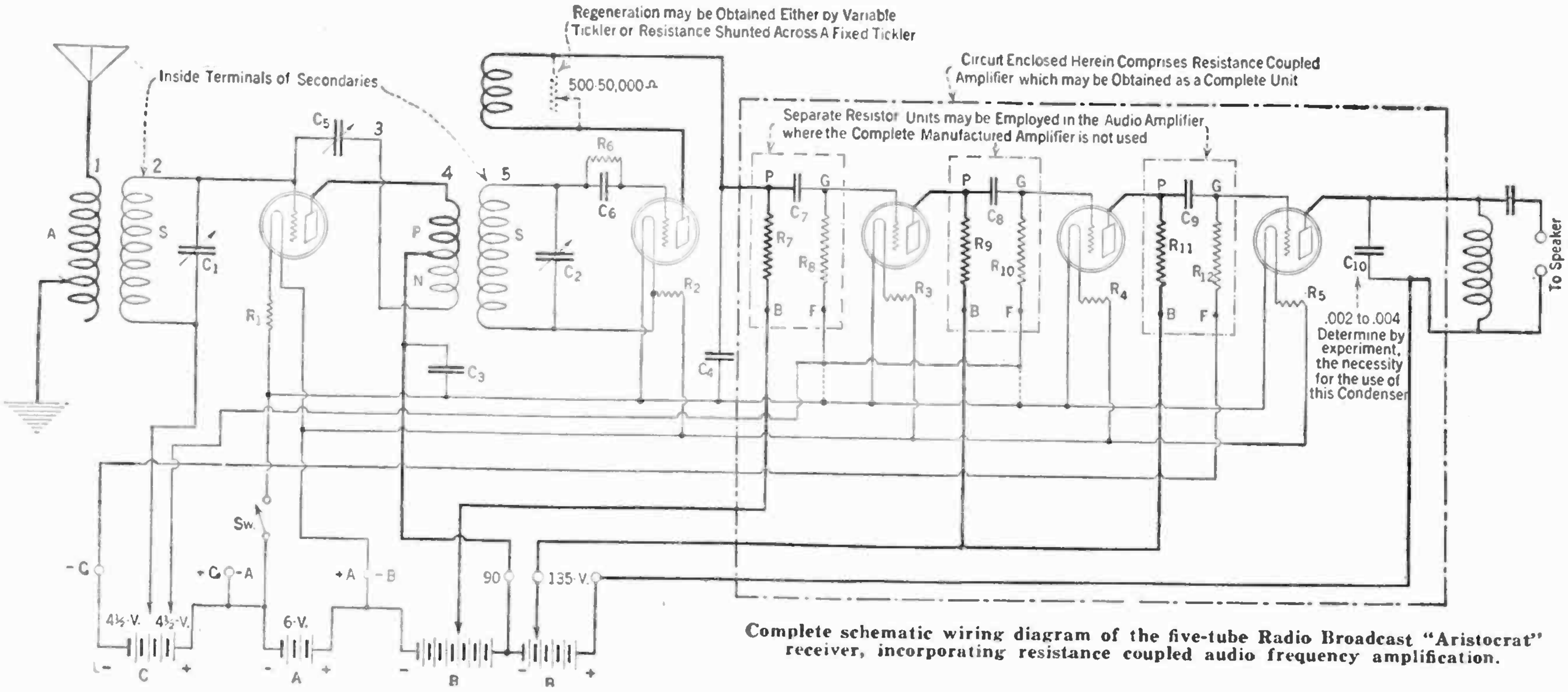
The Circuit and Its Characteristics

In designing this receiver we have attempted to keep in mind the difficulties encountered by some of our readers, who sometimes find that their local dealer does not carry a stock of a particular item, for use in a receiver, whatever kind it may be, and for this reason have endeavored to indicate what we believe to be intelligent substitution and variation in design to accommodate units of different size without materially altering the performance of the circuit. By referring to the circuit diagram and the illustrations of the models we have made, you will be able to see how the various units may be made to fit in whatever space you have available and how they will conform to whatever type of construction you may prefer. If we go over the entire circuit and consider each unit individually, this may be a little more comprehensive. So we may as well start with the antenna coupler.

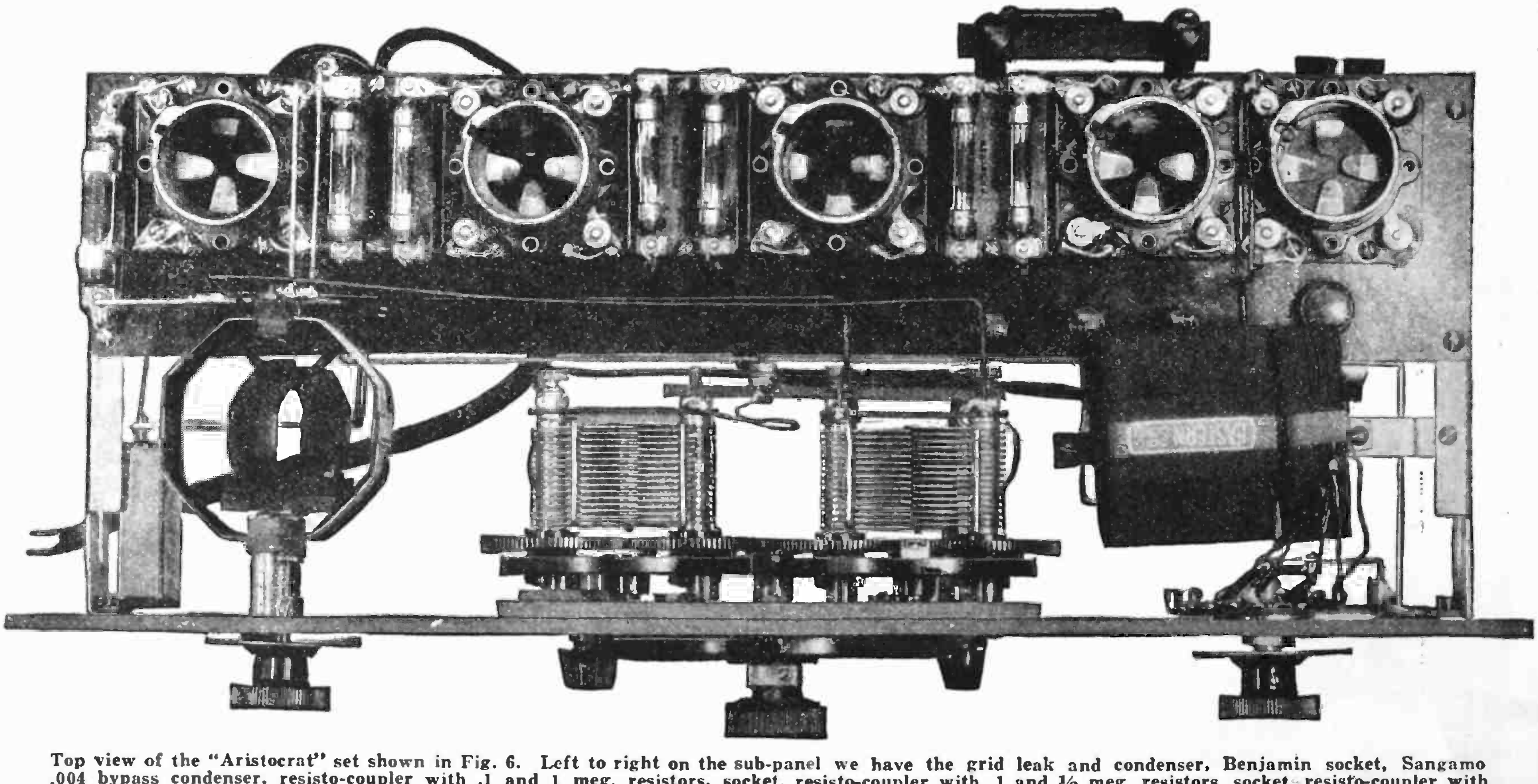
There are now many sets of coils on the market, designed for use in the series of Knockout Receivers, which have been described in Radio Broadcast Magazine. Any of these coils may be used in the "Aristocrat."

The tuning condensers used do not by any means have to be those we have chosen to use. Any good pair of .0005 mfd. variables will do, but what we wanted was single control, and in the "Aristocrat" we have it in a very practical manner. The only remaining requisites are the ballast resistors and

(*Continued on page* 156)



Complete schematic wiring diagram of the five-tube Radio Broadcast "Aristocrat" receiver, incorporating resistance coupled audio frequency amplification.



Top view of the "Aristocrat" set shown in Fig. 6. Left to right on the sub-panel we have the grid leak and condenser, Benjamin socket, Sangamo .004 bypass condenser, resisto-coupler with .1 and 1 meg. resistors, socket, resisto-coupler with .1 and ½ meg. resistors, socket, resisto-coupler with .1 and .25 meg. resistors, socket. The .1 mfd. condensers are within the resisto-couplers. The two Eby posts on the upper strip are for the loud speaker. The three posts on the lower side are for the C battery and the small knob is for the Hammarlund variable neutralizing condenser. Left to right on the main panel are the Benjamin bracket, Dubilier .5 bypass condenser, Eastern Knockout r. f. coupler with Apex knob, Hanscom single control unit with Marco dial, Yaxley filament switch, Eastern Knockout antenna coupler with Carter antenna switch and another bracket.

Two Efficient Short Wave Sets

Plug-In Inductances Used for Reception of Waves Between 37 and 150 Meters

THE increasing interest in short wave work has created an insistent demand from the amateur radio constructors for articles such as the one herewith described. *Elmer M. Wakefield*, in the *New York Herald Tribune,* shows how to build two very efficient short wave receiving sets, one utilizing the familiar Reinartz circuit, the other using a modification of this circuit. Both sets, of course, employ regeneration. The description of these sets follows:

During the present era of radio we generally consider that broadcasting takes place only on wave lengths between 200 and 550 meters. However, during the last two years or more commercial companies have been experimenting with short waves with the expressed purpose of discovering their peculiarities and their possible application to broadcasting and commercial communication.

Transmitting amateurs—the pioneers of short wave communication — too, have been experimenting and it is they who have contributed probably the greatest amount of knowledge of high frequency phenomena. The writer might relate a long story about what they have done to develop short waves, but that would be aside from the subjecf of this article, inasmuch as we are going to describe the construction of two different short wave receivers.

When building a high frequency (short wave) receiver there are five essential qualifications to be taken into consideration in order to keep the efficiency of the set as high as possible. They are as follows:

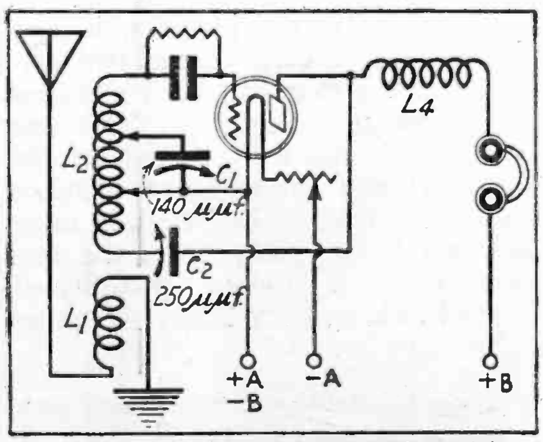
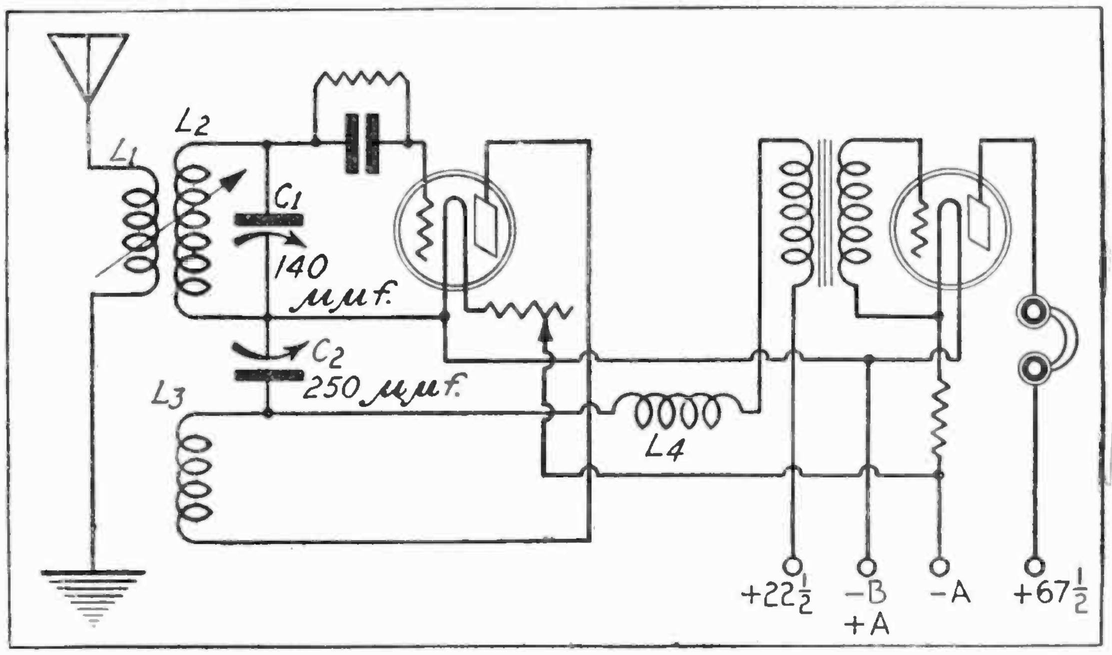


Fig. 3. The Reinartz short wave receiving circuit.

1. It should not have any "body capacity" effect when the hand or any other movable body is brought close to the apparatus.
2. It should cover the desired wave range with a little overlap on either side of the tuning dial scale.
3. The regeneration control should not have any effect on the tuning of the set.
4. It should oscillate smoothly.
5. Last, but not least, it should be extremely sensitive on distant signals and it should be selective on all signals.



Illustrations by courtesy of N. Y. Herald-Tribune

Fig 2. The wiring diagram of a two-tube modified Reinartz short wave set.

The receiver shown in Fig. 1 has been designed to cover wave length range from 15 to 130 meters by a system of interchangeable coils. The circuit is shown in Fig. 2. This set was built with the idea, as nearly as possible, of including all the above factors.

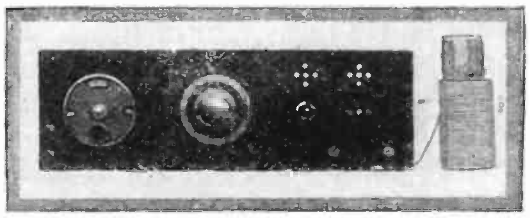


Fig. 1. Short wave set designed to cover 15 to 130 meters.

L_1 is, of course, the antenna coil and has ten turns wound on a two and three-quarter-inch form. The same primary coil is used for all wave bands. This is inductively coupled to the filament end of L_2, the secondary, by an ingenious arrangement. The coil is supported by a composition clamp which is hinged on the base.

The coupling between L_1 and L_2 may be varied by moving it backward and forward. The coupling feature on a short wave receiver facilitates one of the fore-mentioned qualities of a good set, namely, selectivity, because the further the primary is from the secondary coil the sharper the tuning. This is termed "loose coupling."

The secondary circuit is the tuning circuit and therefore requires the greatest amount of attention. It is in this circuit where the losses should be at a minimum, the inductances or coils of best construction and the connecting wires between the various pieces of apparatus as short and direct as possible. We will dwell more comprehensively on the wiring later.

For covering the wave band between 15 and 130 meters three secondary and tickler coils are necessary. Between 15 and 35 meters coil L_2 has three turns and coil L_3 has two turns. For the band between 30 and 60 meters, coil L_2 has eight turns and coil L_3 has four turns. For the band between 55 and 130 meters, L_2 has nineteen turns and L_3 has six turns. These wave length ranges are covered when using a five plate straight line frequency variable condenser (C_1) having a maximum capacity of 140 micromicrofarads across the secondary. This small capacity is used so as to spread the wave length band over as much of the dial scale as possible. This feature facilitates easier tuning.

Each of the three coils is wound with No. 18 B. & S. gauge bare copper wire on a three-inch practically self-supporting composition form. The turns are spaced the diameter of the wire. The wire of the tickler coils is wound on the filament end of the secondary coils, inside the form, making it about one-half inch less in diameter than the secondary. The wire used for the tickler (L_3) is number 30 D. C. C. The primary, secondary and tickler are all wound in the same direction.

Each of the coils has four plugs set in the base—two for the secondary and

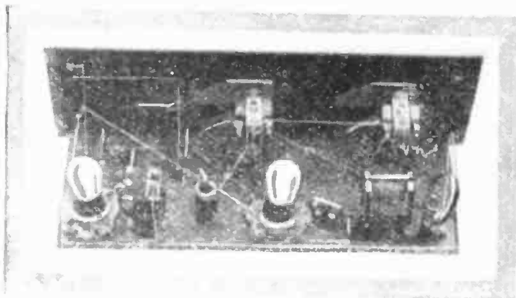
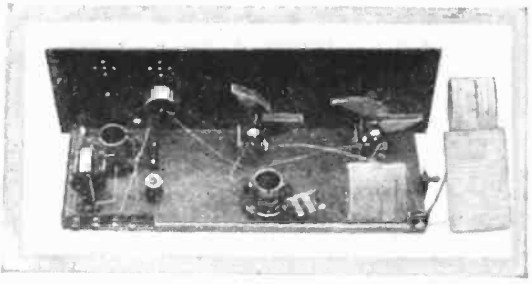


Photo showing a rear view of the set using the circuit in Fig. 2.

two for the tickler. The grid plug is placed a considerable distance from the others so as to reduce dielectric losses. The desired coil is merely plugged in the mounting. This affords a rapid and easy change-over from one wave band to another.



Back panel view of the set shown in Fig. 1.

Feed-back action is actuated by a 250 micromicrofarad variable condenser (C_2). This system is termed "capacity feed-back" and has been found to give the easiest and smoothest control on short wave lengths. With the tickler coil at the filament end of the secondary, varying the regenerative control will have least effect on the tuning. This is desirable.

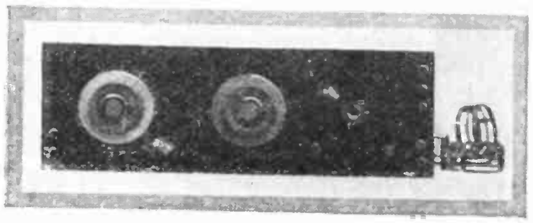
The short wave receiver shown in Fig. 3 is much similar in construction to the set just described, varying only in that it employs the Reinartz circuit with the tickler coil directly connected to the secondary coil. Unless the set has been carefully wired, when using this system, the feed-back condenser (C_2) is apt to have a slight effect on the tuning.

Like the first receiver mentioned the Reinartz was designed to cover wave lengths between 15 and 130 meters with three interchangeable coils. Unlike the first set, however, the primary coils vary in number of turns with the size of the secondary coil. Fixed coupling is used in this particular set in order to eliminate one control.

For the 20 meter wave band the coil L_1 has five turns and the secondary coil L_2 nine turns, tapped at the third and sixth turns. For the 40 meter band L_1 has six turns and L_2 eighteen, tapped at the sixth and twelfth turns. The primary (L_1) of the 80 meter coil has ten turns and the secondary (L_2) thirty-six, tapped at the twelfth and twenty-fourth turns. In each case the tuning condenser (C_1) of 140 micromicrofarads is connected across the tapped portion of the coil. The windings of each are made with No. 16 B. & S. gauge wire wound on a three-inch form and spaced the diameter of the wire. These particular coils happen to have been wound by a patent process on a form five thousandths of an inch thick. This affords an electrically efficient coil.

The hook-ups employed in each of these two sets have three distinct circuits. That is, they have an untuned primary circuit, a secondary circuit and a plate circuit. The efficiency of the antenna circuit is of little importance, and likewise the plate circuit. When we consider that we have either a primary of an audio-frequency transformer, having in the neighborhood of 500 ohms resistance, or a pair of telephone receivers with 2,000 ohms resistance connected in series with the plate, a few additional ohms in the plate coil and the rest of the circuit will not have any detrimental effect on the efficiency of the tuner. However, in the secondary or grid circuit, efficiency is of greater importance and without careful design the set will not function up to expectations.

Bearing this and the requirements of a good receiver mentioned in the forepart of this article in mind, the construction of a simple yet effiicient short wave set is not a difficult problem. In the first place, and probably most important, the grid lead from the inductance to the grid leak and vacuum tube should be as short as possible. The grid condenser should be of the best obtainable construction and the grid leak of the proper value to facilitate stable operation and regeneration.



Front panel view of the short wave set.

It will be found that when receiving continuous wave signals on short waves a grid leak having a value in the neighborhood of ten megohms will be required to obtain the best heterodyne effect. The exact value will vary with the detector tube employed, and different values should be substituted until one is found to work superior to the others.

Likewise, the leads to the secondary condenser (C_1) should be as short as possible. If a condenser of the grounded rotor type is employed, such as used by the writer, the stationary plates should be connected to the grid of the detector tube. The apparatus should be mounted as far as possible out of the electro-magnetic and electro-static fields of the other component parts used in the set. By doing this it will aid to further reduce body capacity and induction effects between each piece of apparatus.

By examining the pictures, it may be seen that in each of the two sets the detector socket has been mounted close to the secondary coil. This was done to keep down the length of the grid lead; still precaution was taken to place the tube sockets slightly more than two inches away from the secondary coils. The close proximity of the grid leak and condenser has practically no effect.

Another view of the set in diagram, Fig. 2.

In a short wave receiver, using the capacity method of feed-back, it is necessary to employ some means of keeping the radio frequency currents out

(*Continued on page* 162)

PARTS REQUIRED FOR THE SETS

The various pieces of apparatus listed below were actually selected by the writer and employed in the construction of the two short-wave receivers described in this article. This does not imply their superiority over equally efficient parts of other manufacture which may be substituted with discretion.—Editor.

The following parts were used in the receiver illustrated in Fig. 3:

1—Set of Hammarlund space wound coils L_1, L_2)
1—140 Mmfd. Hammarlund variable condenser (C_1)
1—250 Mmfd. Hammarlund variable condenser (C_2)
1—Hammarlund choke coil (L_4)
2—Sockets (R. C. A.)
1—.00025 Mfd. Micadon grid condenser
1—10 megohm Durham grid leak
1—Rheostat for detector tube
1—AmerTran transformer
1—Amperite for amplifier tube
1—Mar-co dial (for tuning condenser)
1—7x21 inch Radion panel
Baseboard, binding posts, bus-bar and other fixtures.

The following parts were used in the receiver illustrated in Figs. 1 and 2:

1—Set of Aero Products Coils (L_1, L_2, L_3)
1—140 Mmfd. Hammarlund variable condenser (C_1)
1—250 Mmfd. Hammarlund variable condenser (C_2)
1—Hammarlund choke coil (L_4)
2—Garod-Pryex sockets
1—.00025 mfd. Micadon grid condenser
1—10 megohm Durham grid leak
1—Rheostat for detector
1—Federal transformer
1—Amperite for amplifier tube
2—Accuratune dials
1—7x21 Radion panel
Baseboard, binding posts, bus-bar and other fixtures.

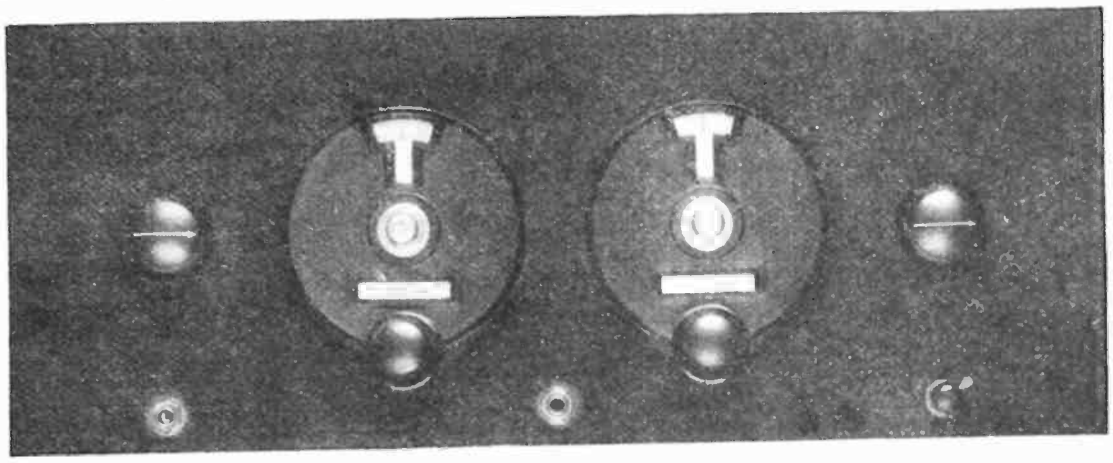
The Silver Long Wave Receiver

By Mc MURDO SILVER, A. I. R. E.

DURING the past few seasons practically all of the average radio enthusiasts' attention has been given to broadcast reception on the regular wave-length band of from 200 to 550 meters, with what little was to spare devoted to the shorter waves which have rapidly been gaining in favor for transmission purposes. Practically no thought at all has been given to the longer waves of from 5,000 meters up except by inveterate experimenters—those individuals who at present consume the major portion of the parts output of American manufacturers.

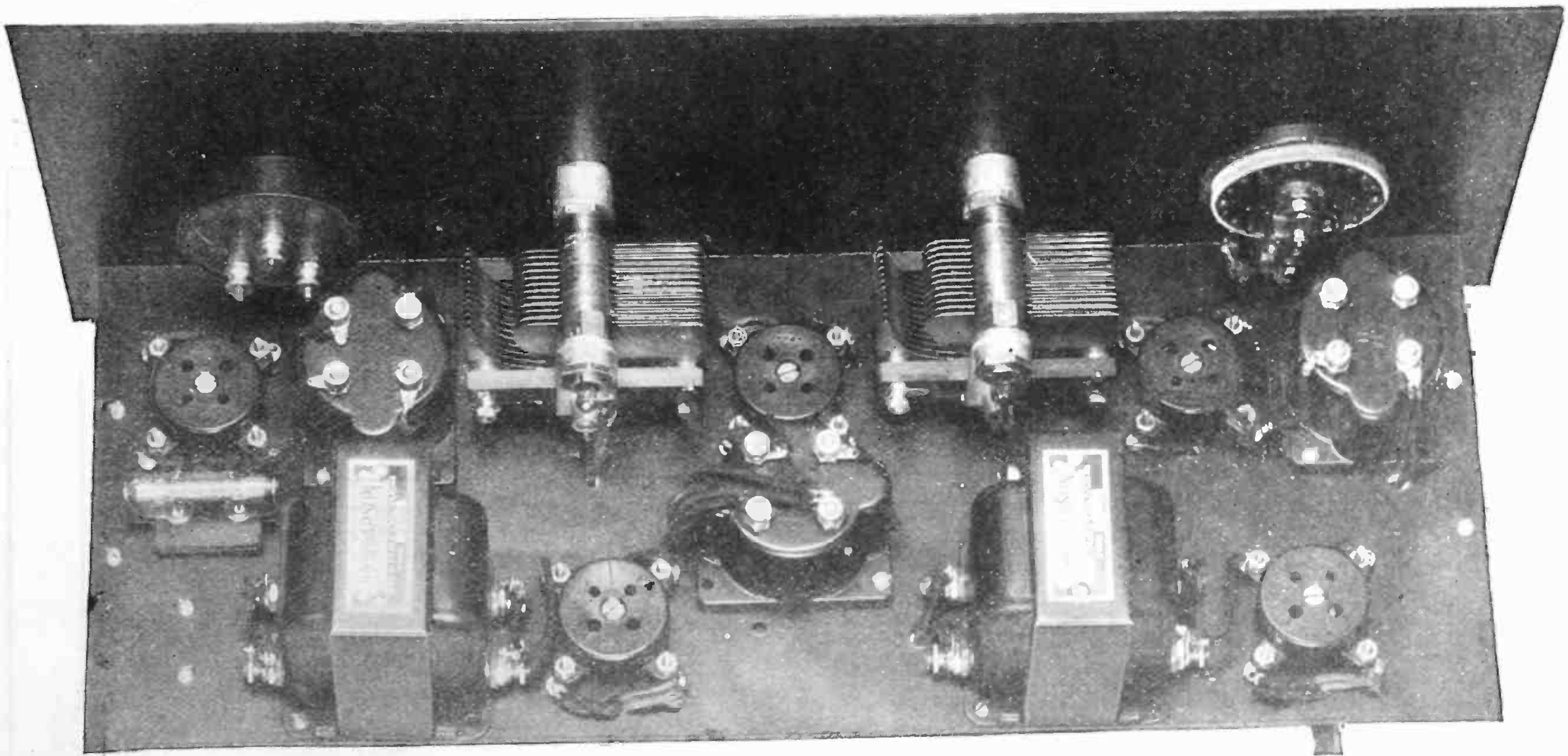
For some time past, however, very interesting experiments have been conducted in trans-oceanic telephony on waves in the neighborhood of 5,000 to 6,000 meters. Within the past few weeks mention of these experiments has been given prominence in the newspapers of the land, with the result that many fans not heretofore familiar with them, becoming interested, desire to construct receivers suitable for this class of reception.

In the accompanying photos an extremely satisfactory type of long wave receiver of comparatively original design is illustrated, capable of covering a wave-length range of 4,500 to 15,000 meters. This receiver consists of one stage of tuned radio frequency amplification, one stage of untuned amplification, a detector and two stages of audio amplification. Standard parts easily procurable upon the open market are used thruout, with the result that the set may be constructed in a very short time by the interested fan.



A front panel view of the long wave set. Note the especially well balanced layout of the tuning controls and rheostats, etc.

The circuit of the receiver is shown in figure three, from an examination of which certain things will become evident. A standard sharply tuned long wave transformer is used to couple the antenna to the input of the first tube. The secondary of this transformer is tuned by a .00035 straight line frequency condenser of approved design, while the primary remains untuned. Coupling the first and second R. F. amplifier tubes is a second transformer of the same type, tuned by a similar condenser. These two tuned transformers will give more than enough selectivity for long wave reception, so the output of the second R. F. amplifier is fed to the detector tube by means of a comparatively broad-band, iron-core transformer, of a type intended for most efficient operation at from 45 to 60 kilocycles, tho capable of amplifying quite effectively other waves as well.



How the set appears from the rear. All parts and their arrangement on the front panel and sub-panel are clearly seen.

The detector tube, rectifying by virtue of a grid condenser and leak is coupled to the first audio amplifying tube thru a special type of transformer designed to transmit with minimum attenuation all frequencies between 30 and 7,000 cycles—those required for for distortionless speech and music reproduction. This tube is in turn coupled thru a similar transformer to the second audio amplifying tube. Jacks are provided so that either one or both stages of audio amplification may be used at will.

A single rheostat is provided for all five tubes, which may be either dry cell or storage battery types, the UV201A's are recommended for best results. A 500,000 ohm resistance is connected in the plate circuit of the two R. F. amplifiers, to stabilize them and control oscillation. This resistance is also quite effective as a volume regulator.

The entire assembly is mounted upon a 6½ x 17 x ⅛" sub-panel and a 7 x 18 x ⅛" front panel, of bakelite. No dimensions are given, as the instrument locations can be very easily determined from the photos, and each individual constructor will wish to exercise his own ideas in the assembly of the receiver.

The parts necessary to construct the receiver are listed below. While the parts recommended need not of necessity be employed—others of the same mechanical and electrical characteristics being satisfactory—it is suggested that in the case of the long wave transformers substitution be not indulged in since those specified are particularly suitable for operation over the frequency range involved in the transoceanic telephone tests.

In assembling the receiver, the parts should first be located upon the panels, the necessary holes laid out with scriber and center punch and then drilled to the proper size. The panels may be grained by rubbing in one direction with fine sandpaper and oil and, if desired, engraved, to add to their appearance.

In mounting, all parts should be placed upon the panel that are seen upon it in the photos. Similarly, all parts illustrated upon the baseboard should be mounted upon the smaller bakelite panel with the .05 condenser fastened beneath the base. The two panels may then be joined together by means of the mounting brackets and the wiring put in place.

Wiring may be done using either bus-bar and spaghetti or flexible insulated wire such as Belden hook-up wire. In any case it will be necessary to drill holes through the sub-panel to bring the necessary leads through from

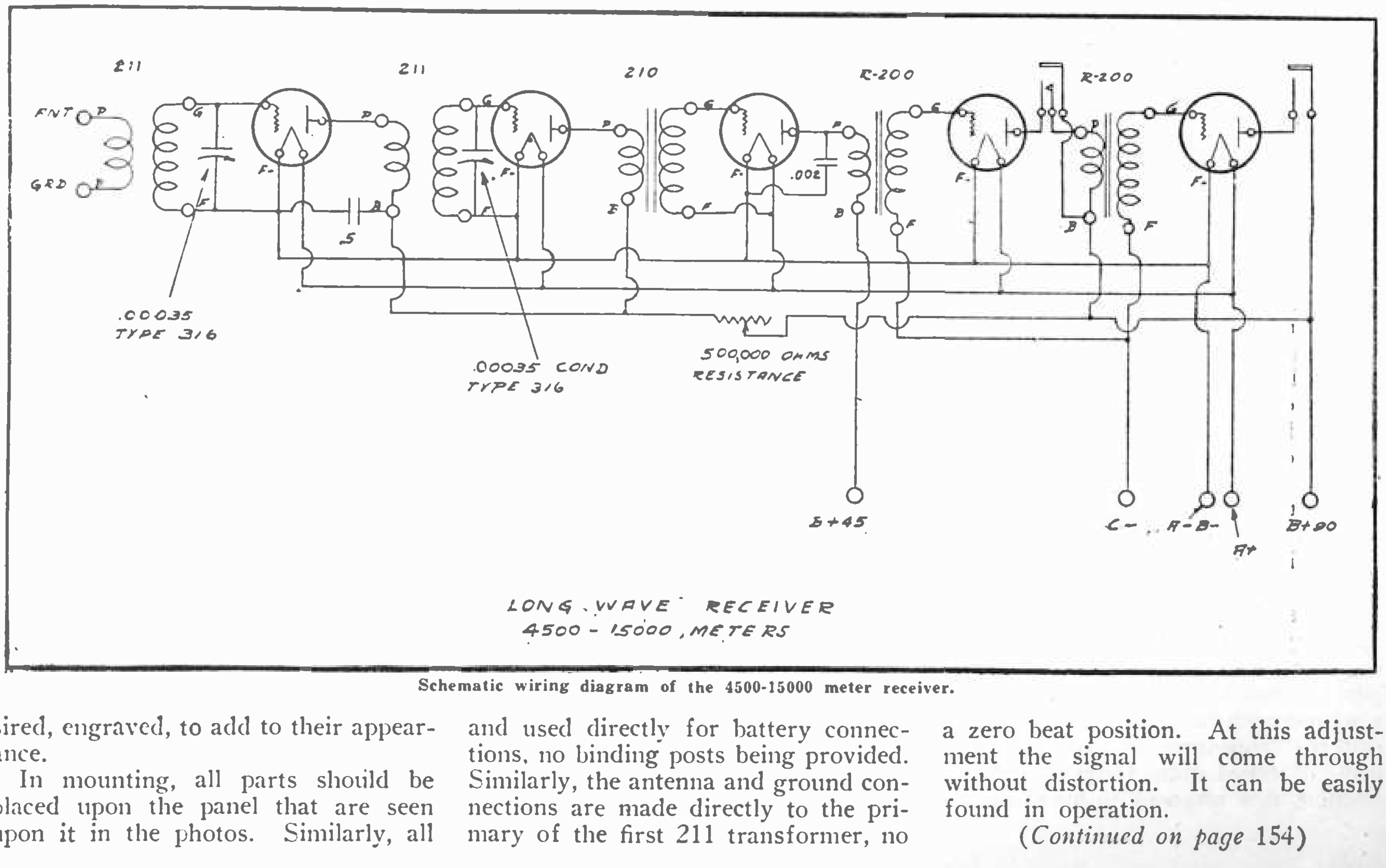
PARTS REQUIRED

- 2 .00035 SLF condensers—S-M type 316
- 2 Vernier Dials—S-M type 801
- 2 Tuned long wave transformers—S-M type 211
- 1 Iron-core long wave transformer—S-M type 210
- 5 UX tube sockets—S-M type 510
- 2 Audio transformers—Thordarson R-200
- 1 3 ohm rheostat—Yaxley No. 13K
- 1 500,000 ohm resistance — Centralab Modulator
- 1 1-spring Jack—Yaxley No. 1
- 1 2-spring Jack—Yaxley No. 2A
- 1 Battery Switch—Yaxley No. 10
- 1 Grid Condenser with clips—.00025—Polymet
- 1 .002 condenser—Polymet
- 1 .05 condenser—Tobe
- 1 pair mounting brackets—S-M type 540
- 1 7x18x⅛" bakelite front panel
- 1 6½x17x⅛" bakelite sub-panel
- Miscellaneous wire, screws, nuts, solder, etc.

the jacks, switch, etc. It is suggested that the wiring be continued in the form of five leads to extend a distance of four or five feet beyond the set. These leads may be braided together and used directly for battery connections, no binding posts being provided. Similarly, the antenna and ground connections are made directly to the primary of the first 211 transformer, no unnecessary wiring or binding posts being employed.

The testing of the receiver is extremely simple—being similar in all respects to the test of an ordinary tuned RF receiver.

In operation, however, there are one or two points to be observed. Transoceanic telephony is generally effected by means of single side band transmission. This means that the wave transmitted from the transmitting station is minus one set of side bands which are unnecessary in transmission as well as the carrier which has also been eliminated. Obviously, for satisfactory reception, a local carrier must be provided by the receiving station. This is accomplished very simply by causing the RF amplifier to oscillate. This adjustment is in turn effected by cutting out resistances in the centralab modulator until squeals can be heard as the receiver is tuned. It will be noticed that these squeals in most cases, instead of varying in pitch or being steady as in the regular broadcast frequency spectrum, will be broken up into dots and dashes. These squeals indicate that some of the longer wave telegraph stations are being received, and if the operator is acquainted with the continental code he may interpret these signals quite easily. When a long wave radiophone station is encountered, the squeal received will vary in pitch or will be perfectly steady. It will not appear and disappear periodically, however. In the case of suppressed side band and carrier transmission where only one side band is radiated, it will be necessary to adjust the receiver in an oscillating condition to a zero beat position. At this adjustment the signal will come through without distortion. It can be easily found in operation.



Schematic wiring diagram of the 4500-15000 meter receiver.

(*Continued on page* 154)

"Vegetables Grown in Your Own Garden Taste Best"

By ARNOLD E. PFEIFFER

NOTWITHSTANDING the terrible onslaught of 5-tube tuned R.F. regenerative, and other circuits, the tried regenerative circuit lifts its head "bloody but unbowed." After all there is always a certain public who know what they want regardless of the machinations of advertising writers, publicity plasterers, and, most subtle influence of all, "the vogue."

One is truly surprised upon making inquiries among ones friends at the number who possess and swear by the regenerative receiver. Still more surprising is the fact that almost without exception the receiver they favor is one that is not manufactured as a unit, but one that must be made from standard parts.

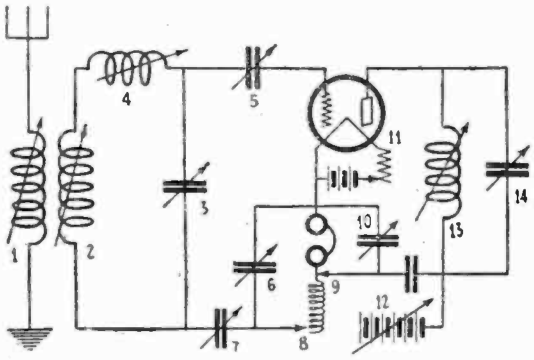


Fig. 1. The original Armstrong circuit in which a number of controls are employed to perform various actions.

What is the reason for the continued popularity of the regenerative receiver? I asked Bill Jones coming down in the train one morning. Bill is a typically representative American—lives in the suburbs, commutes to and from his office every day, and is just about living within his income.

"Well"—Bill spoke with conviction—"I'll tell you why I like my little three tuber, if that will help you any. You see, long about the time I became interested in radio, the radio magazines and the newspapers were all het up over these 5 and 8 tube circuits. Now I didn't know anything about radio—could string up an electric bell and plug in the vacuum cleaner—but I sort of figured that I could get a lot of fun out of making the thing myself, only those five and eight tube hook-ups scared me. Besides that, they'd put an awful dent in the bankroll when it came to buying parts.

"Well, one day, coming home from the office I started talking to a young chap in the smoker and naturally I brought up the subject of radio, that being in my mind. He was very much interested and talked as tho he knew a lot about it, which later proved to be a fact for I found out that he was an engineer.

"I then got my trouble up to him, at

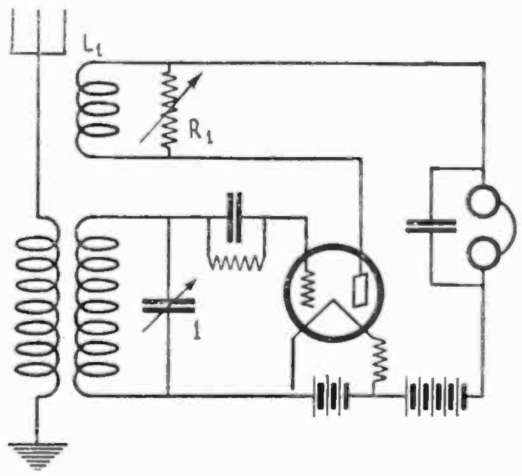


Fig. 3. An improved Armstrong regenerative circuit with only two controls.

which he laughed and told me not to believe all I'd heard about five and eight tube sets—that he'd give me a three tube circuit that'd do anything a five tube would do, and a lot of the eight's for that matter. He proved to be a very decent chap for before the train pulled into my station I had a diagram, a list of parts, and his telephone number—he lived only one station farther.

"The circuit he gave me was one known as the triple circuit feed-back, a circuit that used a simplified three circuit tuner, and I want to tell you that the whole thing was so simple and easy to build that I didn't have to call up for help once."

"But, Bill," I queried, rising, for the train was approaching the first stop, "factory made five tube sets are very cheap now. Why do you continue depending on a three tuber for your entertainment when you could get a big set cheap—that's what I want to know?"

"Cheap is right," snorted Bill. "Some of my neighbors have 'em and they don't come up to my little outfit even when they're working, which is seldom. Don't forget that my little three tuber is made up of the best parts I could get, while their five tubes have got to work with the Lord only

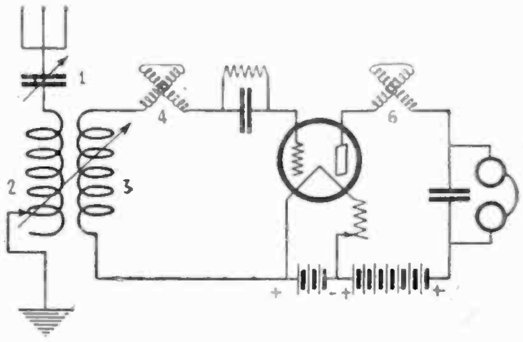


Fig. 2. A later development of the Armstrong circuit, using six controls.

knows what kind of junk. Besides I get a lot more satisfaction pulling in a distant station with a 3."

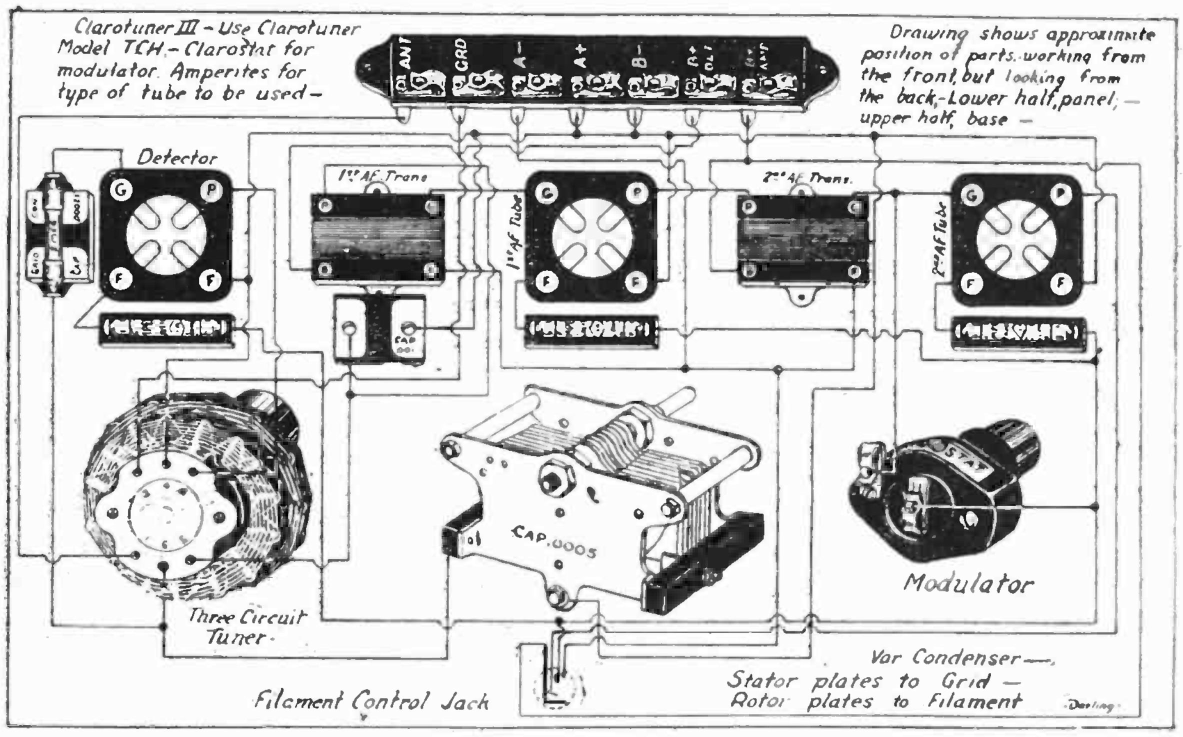


Fig. 4. A typical layout and wiring diagram of a regenerative set employing the Clarotuner and Clarostat units.

"So that's why you like your little three tuber," I mused.

"Yes," went on Bill, "and because I

(*Continued on page* 160)

Short Wave Broadcasting and How to Receive It

By GEO. F. KOENIG

MUCH has been said and written about receivers that will function on the present broadcast band which ranges approximately from 202 meters to 545 meters, but recently such wonderful work has been done with the extremely short waves below 100 meters that it is thought timely to describe two efficient types of receivers which are easily constructed and will enable this short wave broadcasting to be received.

Recently all radio listeners who have short wave receivers and who were interested in the progress of broadcasting were asked to cooperate with the engineers of the General Electric Company at Schenectady, N. Y., who were conducting a series of tests in wave propagation on 32.79 and 65.5 meters. Special telegraph tests were also made on 15, 26.4 and 50.2 meters.

The ways of the longer waves, particularly those in the present broadcast band, are familiar to the engineers, but much remains to be learned of the characteristics of shorter wave-lengths, and it was for the purpose of accumulating a vast fund of information that the engineers were transmitting and asking reports on these particular wave-lengths.

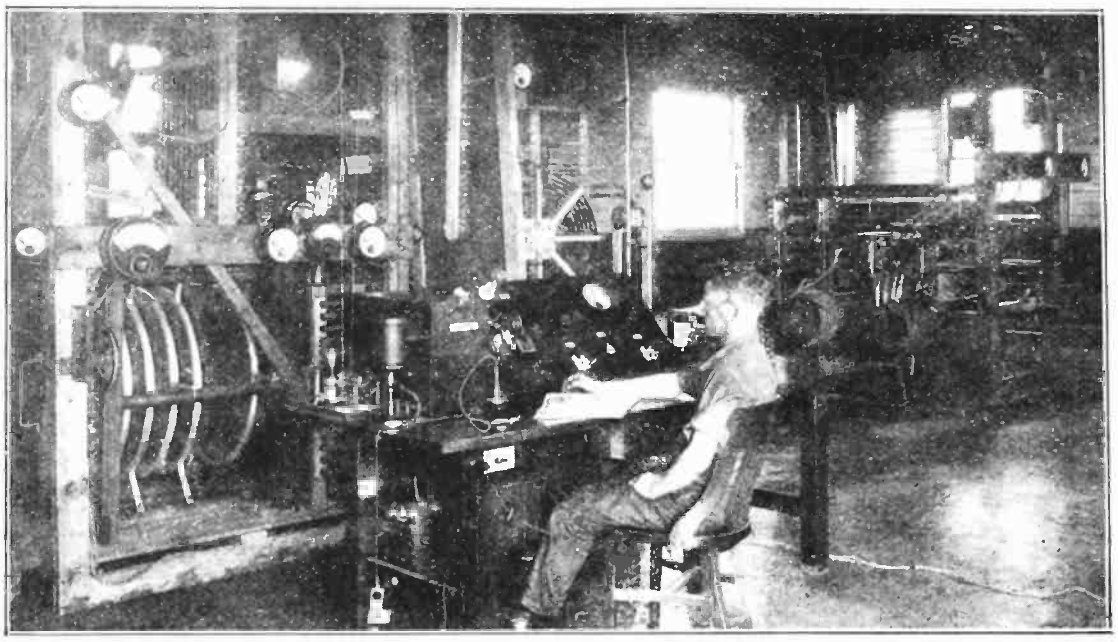
During these transmissions on the short wave-lengths the WGY programs were broadcast through 2-XAF, operating on 32.79 meters, and 2-XK on 65.5 meters. In addition to 2-XAF on 32.79 meters, and 2-XK on 65.5 meters, the following transmitters were also active:

2-XAW at 15 meters or 20,000 kilocycles.

2-XAD at 26.4 meters or 11,370 kilocycles.

2-XAC at 50.2 meters or 5970 kilocycles.

These are experimental stations of the General Electric Company at South Schenectady, N. Y.



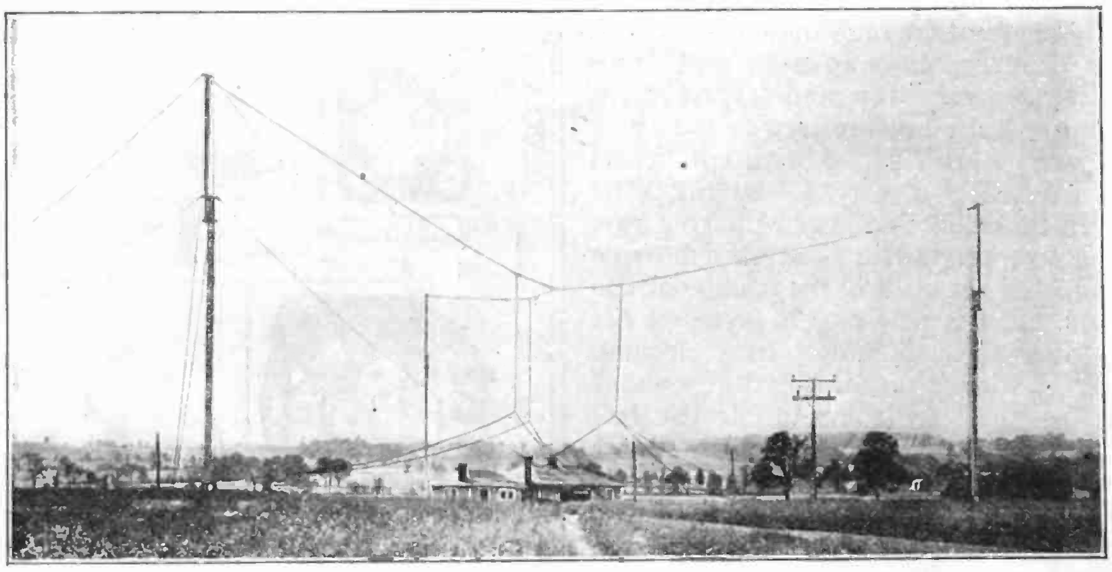
65.5 Meter transmitter (2XK) at transmitter development laboratory of General Electric Co., South Schenectady, N. Y.

As indicative of the importance which these engineers attached to the assistance of listeners, all who could co-operate with them during those tests were asked to send their names to the radio department of the General Electric Company so that special report forms could be supplied to them.

Research in radio transmission calls for extensive observation at a great many points, over a considerable period of time and under a great variety of conditions. It is impossible for a small group of men to accomplish this adequately and for that reason the General Electric Company invited the co-operation of everyone equipped with short wave receivers to report.

A large number of experimenters in this country and abroad volunteered their services and contributed to the data at hand. Listeners in the United States and Canada, in Europe, South Africa and the islands in the Pacific assisted. Members of the American Radio Relay League (a large and powerful organization of radio amateurs) were particularly active and performed a great service in reporting on reception and in intercepting messages from abroad, reporting in code, the results of their observations.

Experimental transmitter work, except in the field of observation, is beyond the scope of the amateur and the average individual experimenter because of the space and equipment required, and the almost prohibitive cost of establishing and maintaining a great laboratory. With its developmental station at South Schenectady, with many different types of antennas and many transmitters, the General Electric Company has the facilities to inaugurate these tests. The illustrations herewith



Triple "T" antenna used with 65.5 meter transmitter shown above.

show the various short wave transmitters used by the General Electric Co. and the aerials in conjunction therewith.

To a small extent engineers of the company have been able to make reception tests but their work is only a fraction of what is necessary to arrive at any definite conclusion. Within the past few months observer engineers traveled by truck north, east, south and west from Schenectady, N. Y., recording the characteristics of the short waves as they get farther and farther away from the station. The tests carried them as far south as Jacksonville, Fla., by land and on the return trip they made their observation by water. Simultaneously with the work of these two men, a special agent was detailed to travel by boat to Panama.

Those who were willing to assist in making observations were asked to make careful statements of signal strength, quality, fading and static. Quality was to be judged from the standpoint of the broadcast listener, that is, was the signal capable of giving pleasing reproduction of a whole program? How did it compare with the local station?

The frequencies of both transmitters, that is the 32.79 and 65.5 meter sets, are accurately determined and are held constant by crystal quartz control.

For several months the engineers experimented with a wave of 41.9 meters and then changed to 35 meters and later to 32.79 meters.

On one night the signals on 32.79 meters were rebroadcast by a Johannesburg, South Africa, station, located approximately 8,000 miles away. The signal of 2-XAF was reported at full loud speaker volume and the relay transmission was exceptional. The power used by 2-XAF at the time was 10,000 Watts.

The value of the short waves from 30 to 35 meters was demonstrated two days earlier when KNX of Los Angeles, Cal., rebroadcast 2-XAF which was then using 35 meters.

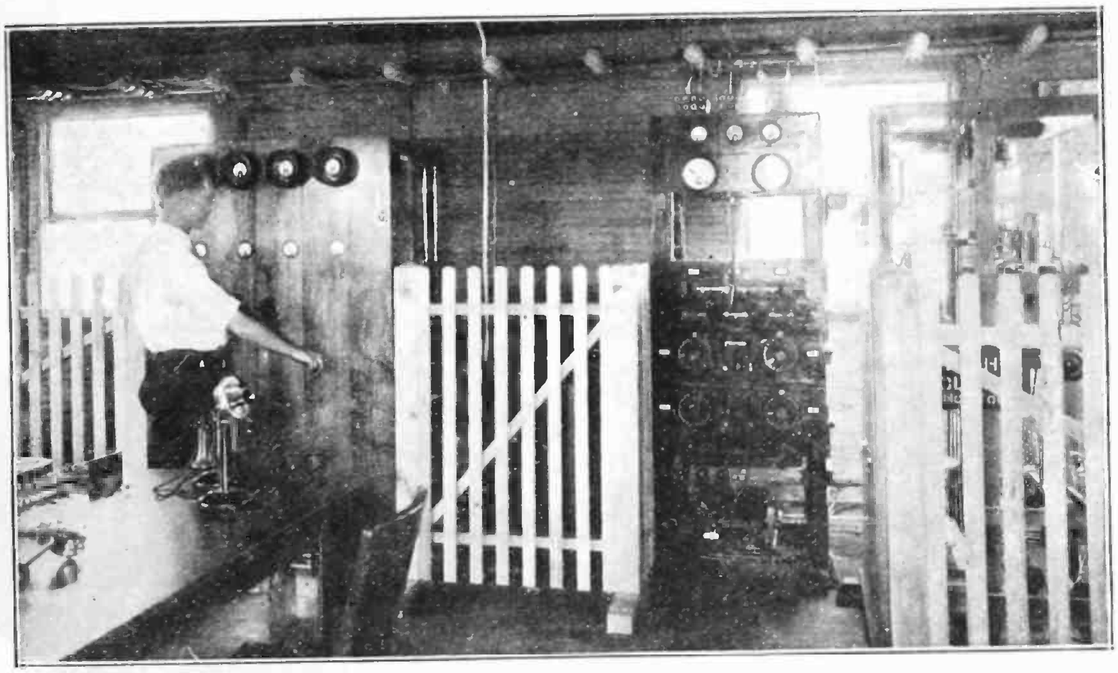
There are several other broadcast stations experimenting on the low waves within the tuning range of these receivers, but as their schedules, wave-lengths, power, etc., are so variable no data can be given as to their activities, although they may be picked up practically every night.

In addition to this short wave broadcasting there is a tremendous amount of code transmission on these waves, and it is a comparatively simple matter for the broadcast listener to master the Continental code which is used exclusively in radio, and thus have the pleasure of understanding this traffic.

We are giving below a table showing the present short wave-length assignments and the service for which they are used:

Wave-length in Meters	*Service*
109–105	Relay broadcasting only.
105–85.7	Public toll service, Government mobile, and point-to-point communication by electric power supply utilities, and point-to-point and multiple address message service by press organizations only.
85.7 –75.0	Amateur, Army mobile, naval aircraft, and naval vessels working aircraft only.
75.0 –66.3	Public toll service, mobile, Government point-to-point and point-to-point public utilities.
66.3 –60.0	Relay broadcasting only.
60.0 –54.5	Public toll service only.
54.5 –52.6	Relay broadcasting only.
52.6 –42.8	Point-to-point only.
42.8 –37.5	Amateur and Army mobile only.
37.5 –33.1	Public toll service, mobile, Government point-to-point, and point-to-point public service utilities.
33.1 –30.0	Relay broadcasting only.
30.0 –27.3	Public toll service only.
27.3 –26.3	Relay broadcasting only.
26.3 –21.4	Public service, mobile, and Government point-to-point.
21.4 –18.7	Amateur only.
18.7 –16.6	Public toll service, mobile and Government point-to-point.
16.6 – 5.35	Experimental.
5.35 – 4.69	Amateur.
4.69 – 0.7496	Experimental.
0.7496– 0.7477	Amateur.

Now that we have given the reader an idea of the tremendous activity on waves which are far below the range of present day broadcast receivers, we can proceed to explain in detail the construction of a receiver with a range of approximately 15 to 110 meters.



32.79 Meter transmitter at the development station of the General Electric Company at South Schenectady, N. Y.

This receiver employs the well known regenerative principle and uses a system of interchangeable coils, one coil being known as the grid coil and the other as the plate or tickler feed-back coil.

In Fig. 1 is given the schematic diagram of this receiver with one stage of audio frequency amplification, which has been found to make an ideal combination. The various parts are identified by symbols in this diagram and the several values thereof are given herewith.

List of Parts

L¹ and L² are interchangeable coils, the construction of which is described later on.

C_1 is a small adjustable condenser which consists of two ¾ inch copper discs soldered on the ends of two short pieces of No. 12 bare copper wire. This No. 12 wire is supported by two binding posts and the capac-

Vertical antenna used with the 32.79 meter transmitter illustrated below.

ity of this condenser is varied by changing the distance between these two copper discs. The correct separation must be determined by experiment as it is governed entirely by the size of the aerial to which connected. Generally the larger the aerial the less will be the degree of coupling necessary to bring in the desired signal. A fixed condenser with a capacity of .0001 mfd. may be substituted for the copper discs and will function very well.

C_2. This is a variable condenser of any standard make, preferably of the straight line frequency type, and should consist of three stationary plates and two movable plates. In order to avoid hand-capacity (i. e., throwing the set out of tune when the hand is removed from the dial of this condenser) the stationary plates of this condenser must be connected to the lead from the grid condenser to the top of the grid coil and stationary plates of aerial condenser.

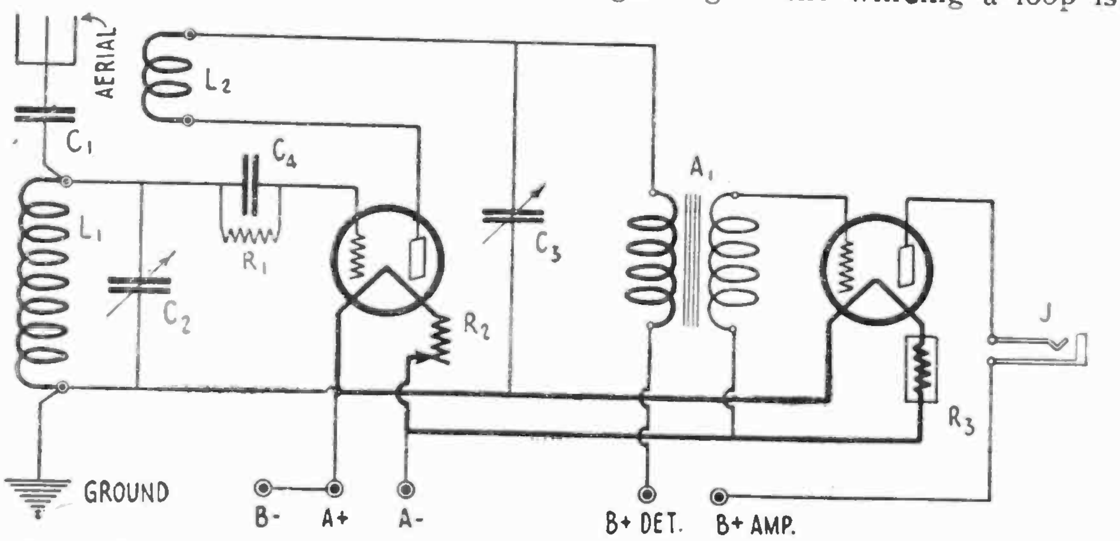


Fig. 1. Schematic diagram of the short wave interchangeable coil regenerative receiver shown in Figs. 5 and 5A.

The movable plates go to the bottom of the grid coil, to ground, and to the "B—A+" as shown in Fig. 1.

C_3 is a variable condenser of any low loss type and should have a capacity of .00025 mfd.

C_4 is a mica grid condenser of a capacity of .00025 mfd.

R_1 is a grid leak and the correct value depends upon the tube used, although it is generally from 5 to 9 megohms.

R_2 is the detector rheostat and here again the resistance depends upon the type of tube used as a detector. If a 199 type is used the resistance should be 30 ohms; for a 11 or 12 type tube 6 ohms; for a 201-A or 301-A tube approximately 15 ohms.

R_3 is an automatic filament resistance such as the Amperite, etc., and the resistance thereof also depends upon the tube used as the audio amplifier.

A_1 indicates the audio frequency transformer, which should have a ratio of 3½ to 1 or 5 to 1, but not greater than the latter. Any good make will give satisfactory results.

Tube sockets should be either glass or bakelite.

J is an open circuit phone jack.

Necessary bus bar, binding posts, screws, etc.

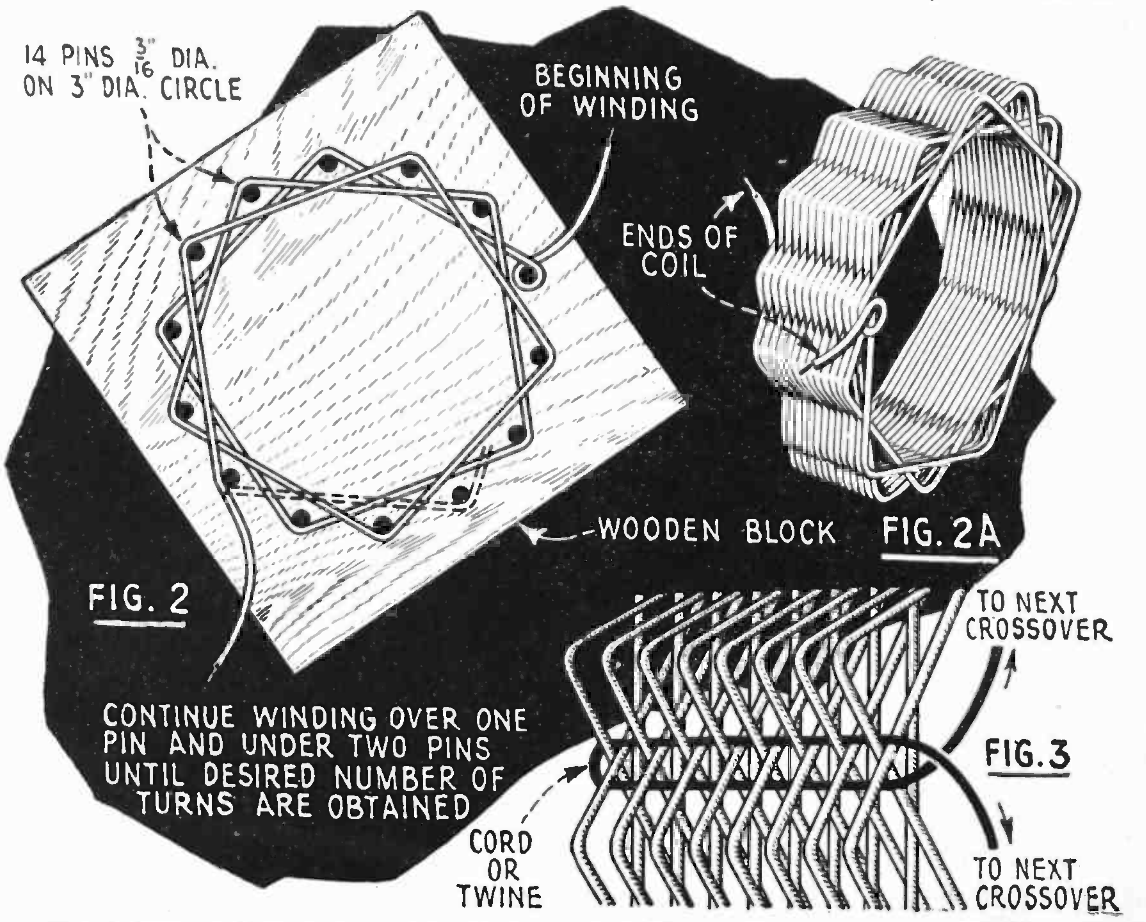


Fig. 2 shows the form used to wind coils L_1 and L_2 in Fig. 1. Fig. 2A is a view of the completed coil, and Fig. 3 gives the method of tying the coils to keep the turns securely in place.

Construction of Grid and Plate Coils

The construction of the grid and plate coils L_1 and L_2 respectively will now be taken up; for identification purposes the three sets of two coils each will be called the 20, 40 and 80 meter coils.

These coils are of the well-known Lorenz type. Upon a piece of board approximately 6 inches square take your compass and inscribe a circle three inches in diameter. Now divide this circle in 14 equal parts and at each such division drill a hole and securely fasten therein a 3-16 inch wooden pin, or a headless nail may be used. Either should be three inches long. Number 16 D.C.C. copper wire is used and at the beginning of the winding a loop is made around any one peg and the wire is then wound under two pegs and over one peg, as shown in Fig. 2, until the required number of turns according the table below have been wound on. These coils are then tied with cord as indicated in Fig. 3 to prevent them from coming apart. The table of coil winding is as follows:

Meters	Grid Coil	Plate Coil
20	3 turns	4 turns
40	8 "	5 "
80	18 "	10 "

Range of Coils

The range of these coils is as follows: The "20 Meter Coil" has a range of 15 to 25 meters; "40 Meter Coil" from 28 meters to 50 meters; and the "80 Meter Coil" from 55 to approximately 110 meters. If it is desired to make these coil combinations interlap it will be necessary to add another movable plate and one stationary plate to the five-plate variable condenser, but this will make tuning more difficult as the same degree of movement of the dial with the added plates will cause a greater wave-length change and accordingly make the condenser more difficult to tune, but a vernier attachment will go far toward overcoming this.

If desired, the 5 coil unit shown in Fig. 3A may be purchased instead of winding the coils, changing the coil mounting base accordingly.

Construction of the Set

The panel of this set should be 7 by 14 inches. The two variable condensers and the rheostat should be placed on a line midway between top and bottom and should be equally spaced from each other. The phone jack may be placed directly underneath the rheostat as shown in the illustration, Fig. 4. The five plate condenser which controls the wave-length should be placed on the left. The aerial and ground binding posts are placed on the left and the battery binding posts on the right side of the panel.

The baseboard should be either kiln dried wood or preferably hard rubber or bakelite. It should be about an inch shorter than the panel, and should be so attached to the panel as to allow the panel to overlap the baseboard a half inch at each end. This is to enable the set to be easily placed in a cabinet. The width of the base is governed entirely by the depth of the cabinet in which it will be mounted.

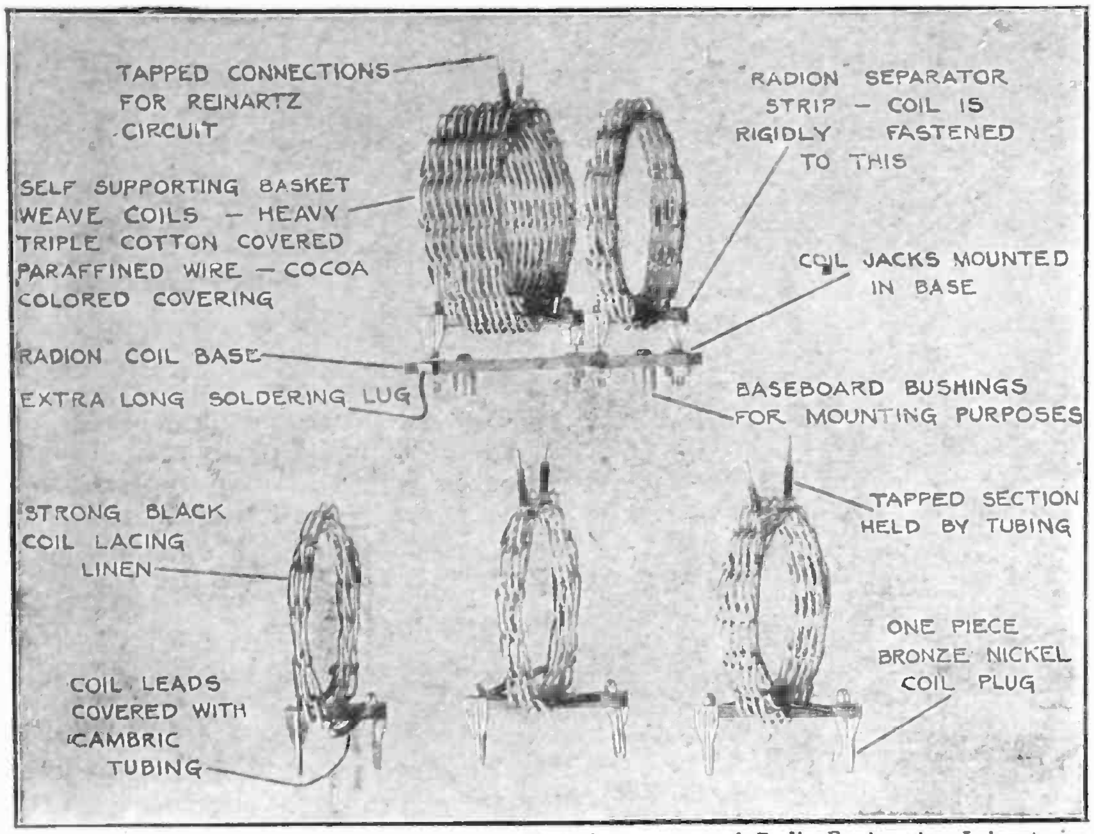


Photo by courtesy of Radio Engineering Laboratories

Fig. 3A. This set of 5 coils, and base mounting can be purchased completely assembled and works very well in place of L_1 and L_2 in Fig. 1. The tapped coils are used in place of L_1. Taps not used.

The plate and grid coils should be placed on the left of the base and mounted on bakelite or hard rubber strips as shown in Fig. 5. When the set is completed and the proper distance of separation between these coils has been determined by experiment, such point being where regeneration is best controlled, if it is desired to preserve this setting, several lengths of glass rod may be inserted through the loops from one coil to the other, and the coils held securely thereon with a few drops of collodion. The two coils can then be removed as a single unit.

The placing of the remainder of the apparatus can be clearly seen in Fig. 5A and need not be gone into in detail.

Operating the Set

After the tube filament is lighted and the rheostat adjusted for proper voltage across the detector tube, the oscillation control condenser (the variable one with .00025 mfd capacity) should be set a few degrees above the point where the oscillations begin. The tuning condenser (5 plates) is then varied until signals are tuned in. The shorter the wavelength the more sharp the signals will seem to be, and the last adjustment of the beat note can be easily found by changing the setting of the oscillation control condenser a few degrees one way or the other. If the code signal is very weak the setting of this oscillation control condenser should be kept very close to the point where oscillations cease. This is just the reverse of the condition for maximum signal strength when receiving voice or music, which is at a maximum just before the circuit goes into oscillation, and is generally called the point of maximum regeneration.

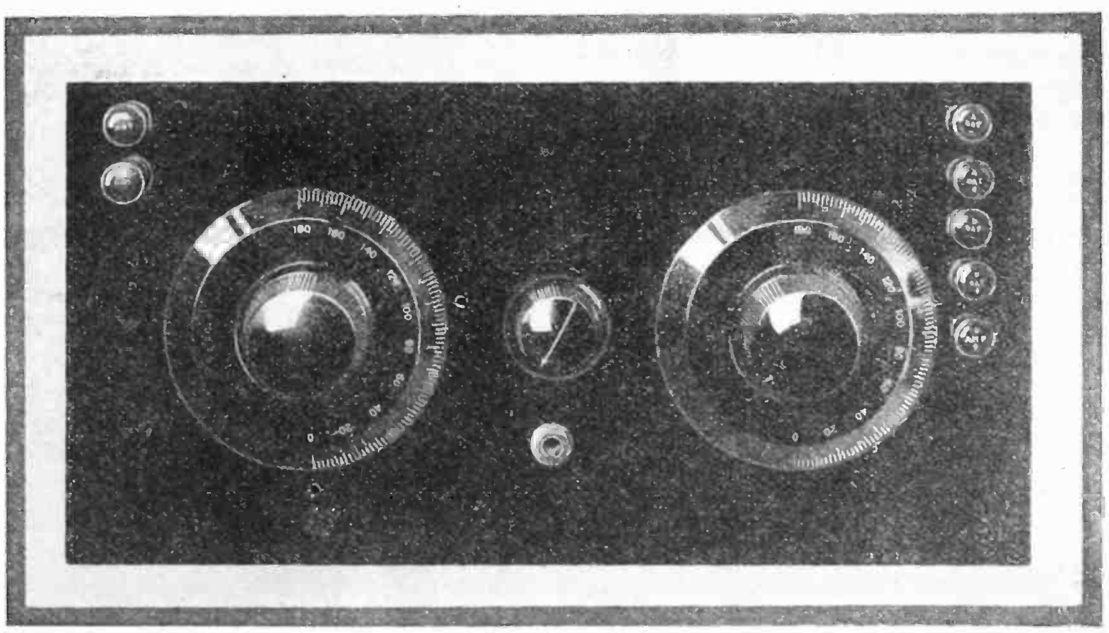


Fig. 4. Panel layout of set shown in Fig. 1.

Precaution Against Irregular Action

All contacts should be perfect, especially the tube prongs and the movable plates of the variable condensers. The connection to the movable plates of the variable condensers should be through a "pigtail" rather than through the bearings. Any friction here will result in noise in the set.

All connections should be securely soldered, but care must be taken that too much flux is not used, and that the solder flows freely into the joint, insuring a perfect connection.

Both "A" and "B" batteries should be always maintained up to the required voltage. Run down batteries cause a hissing or frying noise in the set which is frequently mistaken for static. If this develops simply disconnect the aerial and ground as a test. If the noise does not stop it is safe to assume that the trouble is with the batteries and the test for voltage should be then made. If the battery is of the dry cell type and has dropped to two-thirds of its rated voltage it should be discarded. Storage batteries should be frequently tested with the hydrometer and recharged whenever necessary.

A variable grid leak may assist in making the set oscillate on all waves.

It has been frequently noticed that the ignition systems of automobiles generate and radiate waves of radio frequency which are most noticeable on the 20 and 40 meter bands. Nothing can be done with the set to eliminate this, but it seldom causes much annoyance unless a car stops close to your receiver and allows the motor to run while so standing.

Care should be taken to purchase only the best of parts. All condensers should be of the low loss type, the tube sockets preferably of glass, and condensers of mica. It is advisable to use vernier dials as an aid to close tuning.

If this set is carefully constructed it will prove well worth all that it cost in time and materials, as it opens up a field of exploration which is most fascinating.

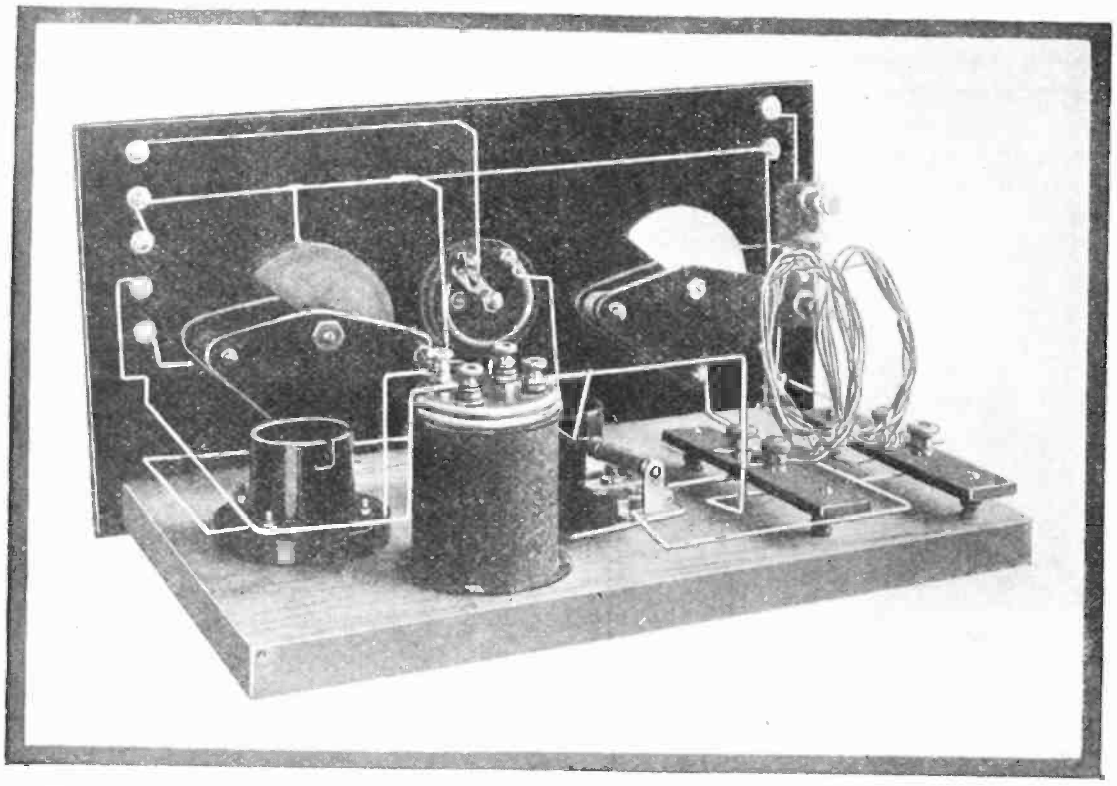


Fig. 5. The method of mounting the plate and grid coils (L_1 and L_2 in Fig. 1) is clearly illustrated in this photo. The mounting strips are 5 inches long and 1 inch wide.

For the benefit of those who do not desire such an elaborate set using interchangeable coils, audio amplification, etc. we will describe a different type of short wave receiver which uses the conventional three circuit tuner in a regenerative circuit. This set is much easier to construct, and the results therefrom are remarkable, amateur stations in Europe and short wave code stations in the Hawaiian Islands having been tuned in on such a set at the author's home just north of New York City.

In Figure 6 we give the schematic diagram of this set, and it will be seen that there is nothing new in the circuit, this same circuit having been used for years on the regular broadcast band. However when such a circuit is used on the short waves the values of the various parts must be correspondingly reduced.

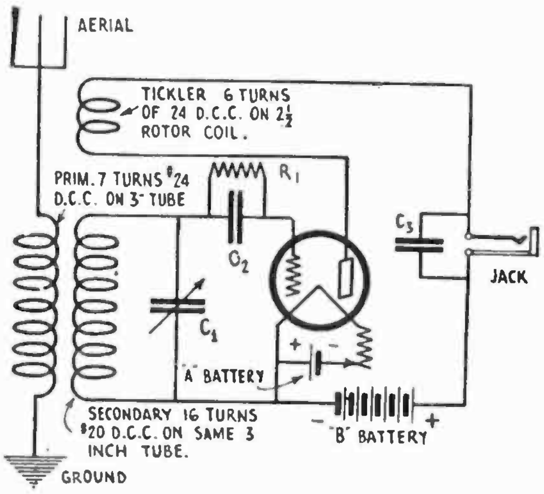


Fig. 6. Schematic diagram of 3-circuit short wave regenerative receiver shown in Fig 8.

The first step toward the construction of this receiver is to lay out the panel for balance. The three circuit tuner should be mounted midway

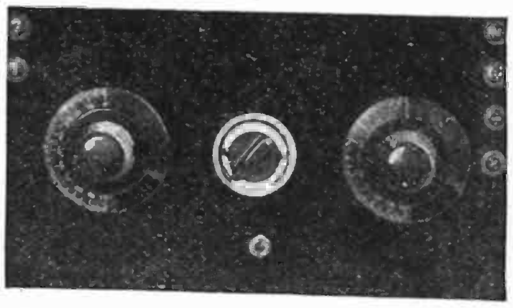


Fig. 7. Panel layout of set shown in Fig. 8.

between top and bottom of the panel and near the left hand side of the panel. The five plate variable condenser should be mounted on a line with the three circuit tuner, but on the right hand side of the panel. The rheostat is exactly in the middle of the panel between the three circuit tuner and the variable condenser, directly beneath the rheostat should be phone jack. Fig. 7 shows the panel layout.

The baseboard should be approximately one inch shorter than the panel so as to allow the set to be more easily inserted in a cabinet.

In the set illustrated in Fig. 8 the tuner was a Bremer-Tully product, but if the reader will be governed by the following specifications he will be able to construct a tuner which will tune from approximately 50 meters to 100 meters, with a 150 mmf. variable condenser across the secondary winding.

PARTS REQUIRED

In the construction of this type of receiver the following parts are required:

1—Short wave three circuit tuner as described.
1—5 plate variable condenser, capacity approximately 150 mmf.
1—.00025 mfd. fixed condenser across 'phones.
1—Variable grid leak.
1—.00025 grid condenser.
1—Tube socket.
1—Rheostat.
1—Phone jack (open circuit).
1—Panel 7 by 12 inches.
6—Lettered binding posts.
1—Baseboard.
Necessary screws, bus bar, etc.

Procure a tube of either bakelite or cardboard, bakelite preferably, 3 inches in diameter and about 3½ or 4 inches long and space wind thereon 16 turns of No. 20 D.C.C. copper wire for the secondary. By space wound we mean winding the wire and a cord on side by side at the same time and after the winding is completed, remove the cord and the wire will, of course, be separated by the thickness of the cord just removed. Skip ⅜ of an inch and then

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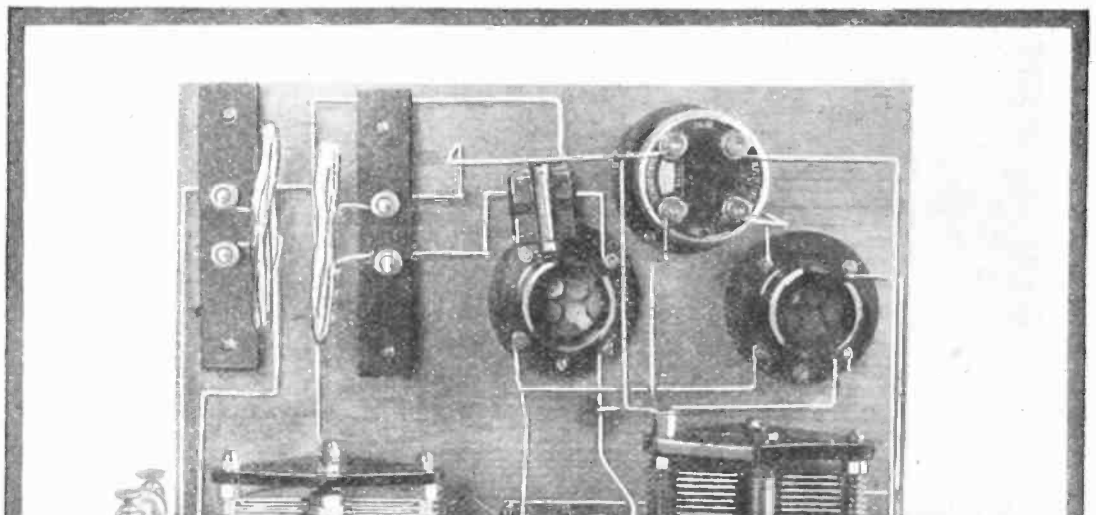


Fig. 5A. The placing of the apparatus is shown clearly in this view. The tubes in this set were connected in parallel, but they may be connected as shown in Fig. 1, and an automatic rheostat used to control the audio amplifier tube. The coupling condenser C_1 is shown at the extreme left

The Silver-Cockaday Receiver

By McMURDO SILVER, A. I. R. E.

WERE one to review the successful radio receiver developments of past seasons, a single outstanding fact seldom considered would be evident—that practically every popular circuit design has been the result of the work of a single engineer, or at best, that of the engineering staff of a single concern—generally engaged in the manufacture of highly specialized parts.

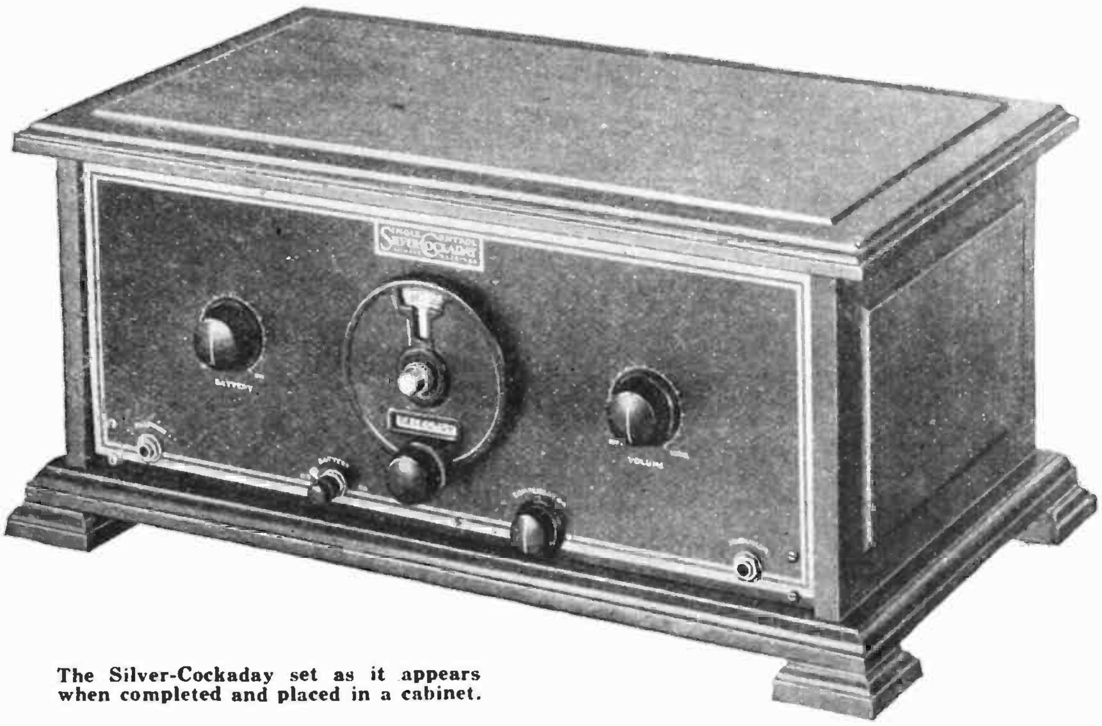
That there have been many successful and popular circuits developed in this fashion indicates that the individuals responsible had a keen insight into, and appreciation of the requirements of broadcast receiver design.

Let us consider an analogy—the automobile. Here, no single man or concern designs a complete car. A good car represents the endeavors of a number of specialists, each highly trained in a particular line. Thus the carbureter, ignition system, bearings, body, power plant, braking system—each individual part represents, even in the finest cars, the work of many organizations—each one fully appreciative of the true value of the watchword of the era—co-operation.

The S-C Receiver is the result of the application of this idea of co-operation and specialization to receiver design, put into operation by two men, aided by the sales and engineering staffs of a number of large manufacturers. Every man—every department of these organizations was closely in contact not only with each other section, but even more important, in direct personal communication with the army of radio fans whose desires had to be satisfied.

This, briefly outlines the idea behind the S-C receiver—an idea of combining the best efforts of highly specialized organizations to produce in a single receiver the answer to insistent public demand—a set in which no single feature had been slighted, but a design wherein each tiny detail had been subjected to the scrutinizing inquiry not of an engineer versed in fundamentals only, but rather by a staff trained in fundamentals, plus specialized application of these fundamentals over a period of many years.

Thus, the S-C receiver is the result of the combined efforts of Lawrence M. Cockaday, designer of the famous four circuit tuner, seven prominent and capable engineering staffs—the pick of the industry—and the author, in an endeavor to develop a thoroughly satisfactory set which would adequately meet certain requirements considered necessary to an ideal receiver—features such as have not been found in receivers developed prior to the S-C circuit. Just how these efforts have succeeded, is left for the reader to decide.



The Silver-Cockaday set as it appears when completed and placed in a cabinet.

Short or Long Waves on One Receiver

At the outset, one of the first conditions imposed was that of wave-length flexibility, in order that the system, which consists of a stage of tuned radio frequency amplification, a regenerative detector and two stages of audio amplification, might operate satisfactorily at any wave-length from 50 to 1800 meters, thus taking in all American and most foreign broadcasting stations. Actually, through the use of plug-in inductances, the range of the S-C receiver is almost unlimited. By using two standard "A" type inductances, the wave-length range is from 190 to 550 meters, while with two "B" type inductances, the range is from 90 to 210 meters. Again changing to a set of two "C" type coils, gives a range of 50 to 110 meters. "D" or "E" type coils allow adaption to foreign broadcasting on waves up to 1800 meters without difficulty. Due to the design of these coils, which are wound upon ribbed Bakelite tubing, the losses are extremely low. Further, the selectivity of the receiver and its adaptability to different antenna lengths and locations is within easy control—by merely adjusting a small coupling coil located in the antenna inductance. The reader will realize that it is seldom indeed that an all-wave design is practical, yet in this particular receiver it has not only been made practical, but the tuning of different circuits has been simplified down to a point where but a single control is required.

Single Control

A single dial controls all wave-length adjustment or tuning, thus simplifying the operation of the receiver to a point where an absolute novice can operate it with the assurance of far more than average results. This feature is accomplished through the use of two standard condensers so designed that they lock into each other and thus permit of control from a single dial. Their design must be extremely accurate in order that any circuit variations will not affect the tuning of the receiver throughout its wave-length range other than to an extent which may be compensated for by the small condenser provided for this purpose—not with an adjustment for each new station tuned in, but rather with a single adjustment for practically the entire wave-length range.

These condensers possess a substantially straight line frequency curve resulting in extremely easy tuning since low wave stations can be easily separated, yet with no sacrifice in selectivity on the longer wave stations.

An exceptional bit of engineering work is evident in the audio amplifier on the part of the transformer designers. A new type of special power transformer, heretofore available only in receivers costing from $500 to $2,500 or more, is used, possessing a practically straight line frequency curve from 30 to 7,000 cycles. While this curve is not absolutely flat, it is so straight that its slight minor variations are not perceptible to even the best trained human ear—as compared with average resistance coupled amplifiers—and there is little difference in quality between transformer and resistance coupling using these particular transformers. Yet the amplification obtainable from the two transformer coupled stages which are, incidentally, designed for the handling of comparatively high powers, is considerably greater than that obtained from the average resistance coupled amplifier, with a consequent decided increase in efficiency.

PARTS REQUIRED

P—1 Bakelite front panel, 7 x 18 x 1/8"
Q—1 Bakelite sub-panel, 6½ x 17 x 1/8"
U—1 Belden S-C wiring harness, complete with all leads
C—D—2 Thordarson power transformers, No. R200
E—F—2 Silver-Marshall .00035 SLF condensers, No. 316
A—B—1 each Silver-Marshall 110A and 114A coils (190-550 meters)
A—B—2 sockets for above coils, No. 515
O—1 Centralab Radiohm, 25,-.000 ohm, No. 25 MSR
R1—R2—R3—R4 —4 Silver-Marshall UX tube sockets, No. 510
E—F—1 Silver-Marshall vernier dial, No. 801
N—1 Silver-Marshall compensating condenser, No. 340 —.000025
S1—S2—1 Silver-Marshall (pair) mounting brackets, No. 540.
K—1 Yaxley 6 ohm rheostat, No. 16K
M1—1 Yaxley 2-spring jack, No. 2A
M2—1 Yaxley 1-spring jack, No. 1
L—1 Yaxley battery switch, No. 10
I—1 Polymet .00015 mica condenser with leak clips
G—1 Polymet .002 mica condenser
H—1 Polymet .005 mica condenser
J—1 Polymet 2 megohm grid leak
12 3/4" 6/32 Roundhead Brass screws
8 1/2" 6/32 Roundhead Brass screws
4 1" 6/32 Flat Head Brass screws
24 6/32 Brass nuts

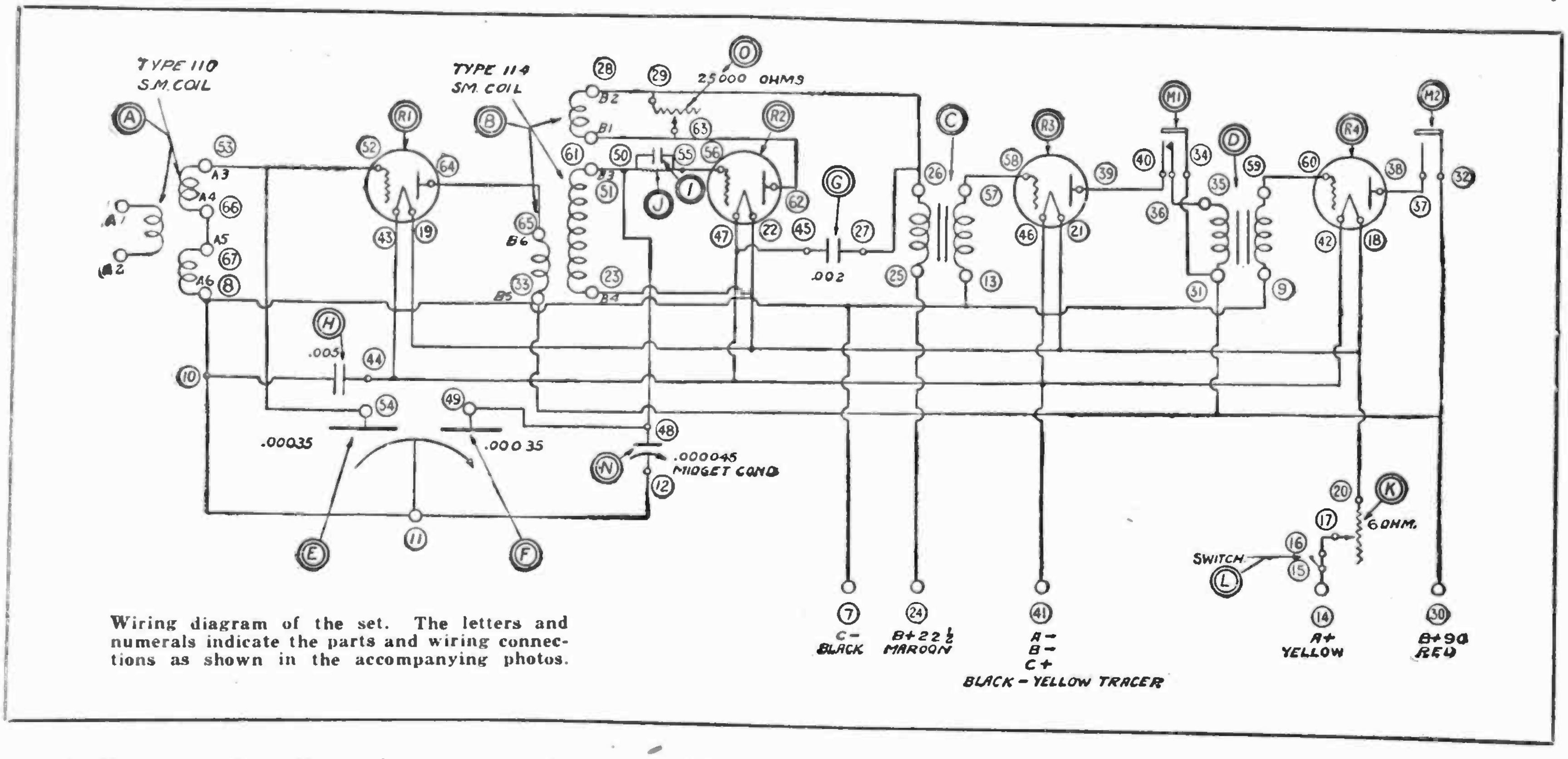
Wiring Previously Prepared

An assembled wiring harness, an almost entirely new feature even in commercial receiver production, simplifies the wiring to a point where anyone except a completely color-blind individual can assemble the receiver in a very few minutes. All low potential leads, including battery connections, are contained in the cable so that it is merely necessary to take it, compare the color of the leads with the diagrams and connect the ones of a given length and projecting from the cable at certain places, to the instrument terminals as marked in the photographs and drawings. The high potential leads for the grid and plate circuits of the RF amplifier and detector are separate from the cable but supplied with it, cut to length with the ends scraped and tinned. Thus the wiring is merely a process of pushing the cable ends through the baseboard and either soldering them to instrument lugs or tightening them under instrument binding post nuts so that soldering is not a vital necessity. The cable method of wiring is extremely efficient in that all low potential leads are grouped in one harness and, as a result, coupling to undesired parts of the circuit is reduced to a practical minimum.

Little need be said of the circuit. It is the standard approved four-tube circuit employing one stage of tuned radio frequency amplification, regenerative detector and two stages of power audio amplification. Little more need be said for it for in a recent survey of the country, it was found to be the most popular in the estimation of the public. This is justly so since the sensitivity, selectivity and quality of this four-tube combination is in excess of that of many five and six-tube receivers now available.

Set Is Portable or Permanent

The general utility of the design, assembled as it is on a 7 by 18-inch Bakelite panel and a 6½ by 17-inch Bakelite sub-base, is astonishing. It may be placed in any type of console cabinet or any other standard enclosure, or, it may even be put in a portable case since the receiver will operate with a very small antenna—or with a very long one with equal selectivity—say, anywhere from 20 to 150 feet.



Wiring diagram of the set. The letters and numerals indicate the parts and wiring connections as shown in the accompanying photos.

Results of Preliminary Tests

On December 28th, 1925, between nine and ten o'clock, some thirty-four stations were logged with the four tubes on a loud speaker, no recourse being had to head-phones. Slightly later, when KFI came on, this station, approximately 2,500 miles away, was brought in to a crowded metropolitan area with sufficient volume to be heard throughout two good-sized rooms. This was at the home of Mr. Cockaday, in a residential section of New York City.

While the S-C receiver does not represent the absolute limit of sensitivity or selectivity that may be realized from a receiver employing twice as many tubes, carefully built in an engineering laboratory, it does represent the best dollar for dollar value available to the home builder since its assembly is simple and positive, its upkeep cost low and its performance equivalent to that obtainable from receivers costing many times its price.

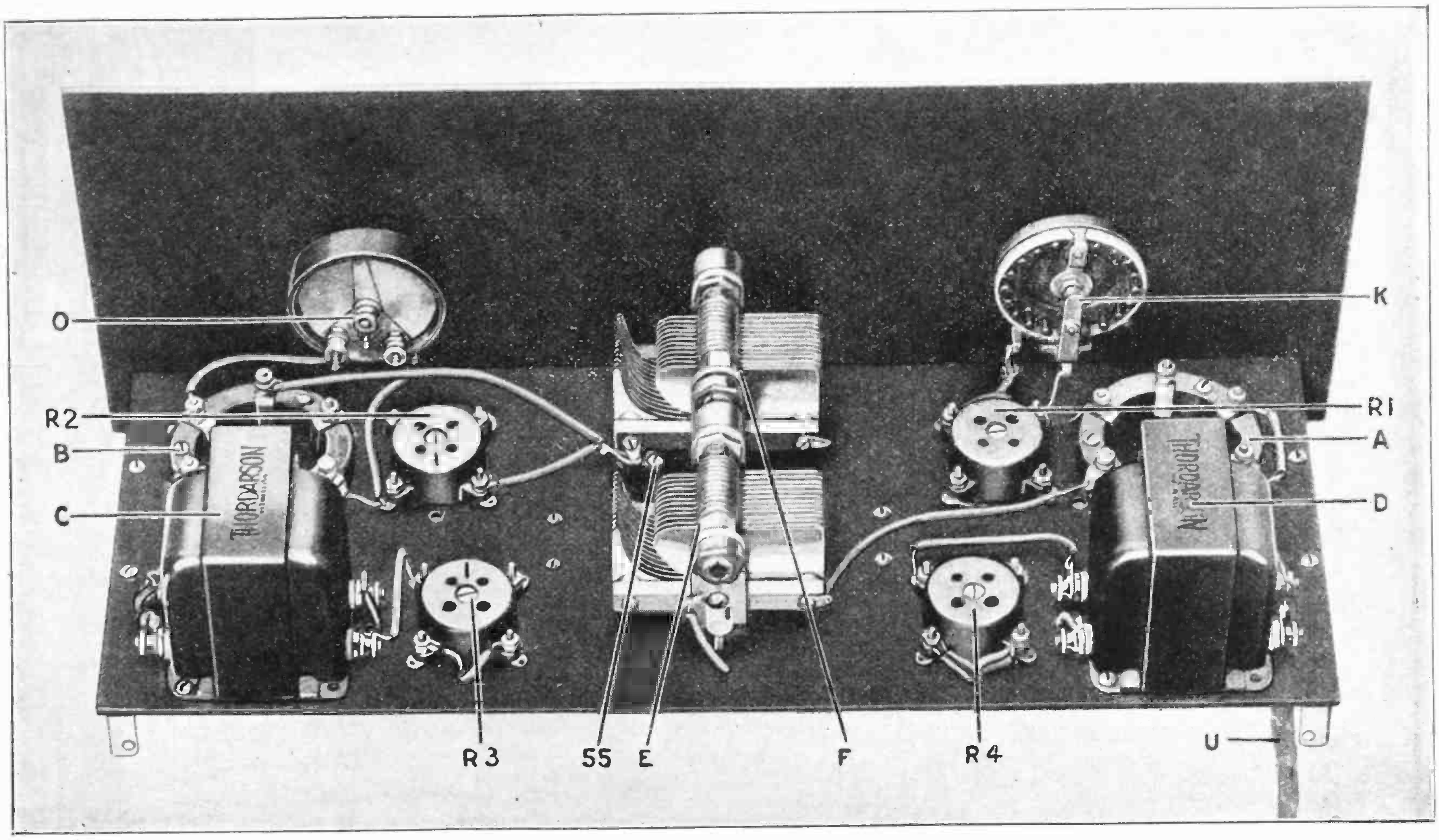
Construction

The work necessary to build the S-C receiver is absurdly simple, considering the results of which the set is capable. All parts used are standard with nationally known manufacturers, and can be procured with little or no effort from the shelves of reliable dealers, or in kit form.

The builder should first procure the necessary parts as listed below from a radio store, bearing in mind that substitution of equally suitable and efficient parts is permissible, although the results obtained will probably be most satisfactory if the exact parts used in the original models are utilized, since they were selected and in many cases designed especially, so that they will correlate properly in operation. Preceding each item in the list is a designating letter by means of which the particular part may be located in the diagrams and photos. The approximate total cost is $59.00.

After the parts have been assembled, each one should be individually inspected to see that it is entirely O.K. Springs on tube and coil sockets should be tested with tubes and coils to insure good contact, and bent up if necessary. Jacks and battery switch should be similarly inspected. Condensers should be examined, and, in general, every item checked closely in order that no trouble may be encountered further on in the assembly and testing.

If plain panels have been procured, they will have to be drilled to take the instruments, and finished to suit the builder. It is suggested, however, that drilled and processed panels be purchased at the start, as the appearance of the set as a whole will be tremendously enhanced by the use of an attractively decorated front panel, and the connecting harness will not allow of variations in layout.



Rear view of the four tube Silver-Cockaday receiver with all parts indicated. See wiring diagram.

Mounting the Parts

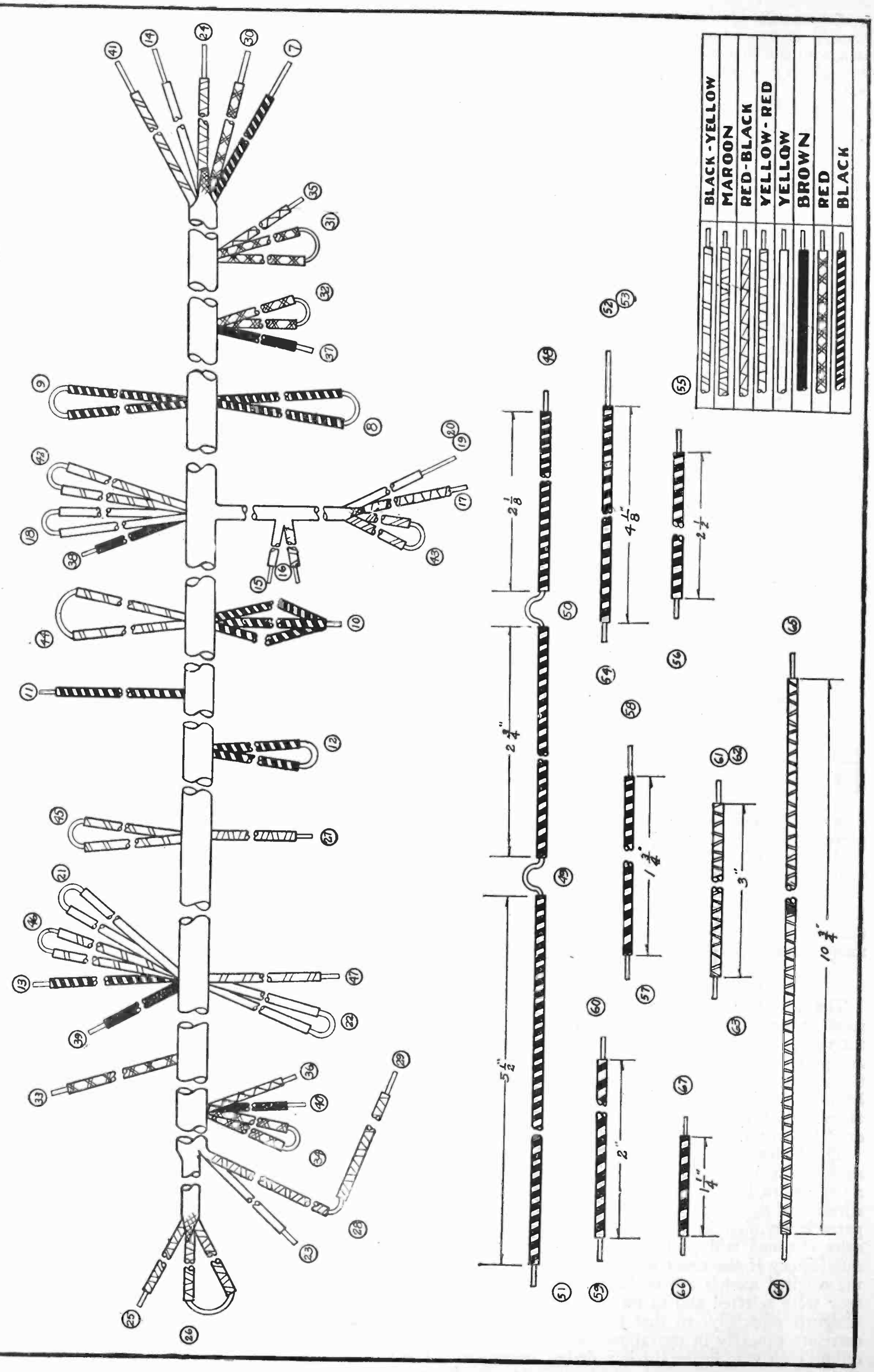
If the photos are carefully studied, the builder can easily fasten the various parts to the sub-panel as they appear, taking care to see that the notches in the coil sockets and the terminal markings in general, are arranged exactly in position as shown in the photos on the various instruments.

In mounting the two condensers, which fall one behind the other on the center of the sub-panel, care must be exercised. The shaft of the rear one fits into the rotor plate bushing of the front instrument, and the two are locked together by the three set screws in the rear bushing of the front condenser. Before locking, the plates should be lined up on each one so that when the rotor plate edges are even with the stator plate edges on one condenser, they are also even on the other. Should the adjustment be stiff, this may be remedied by loosening up the rear bearing of the front condenser, held fast by a large nut locked up on it against the rear of the U-shaped die-cast frame. Any slight unevenness of movement, however, will be compensated for by the vernier dial.

The proper parts should be mounted on the front panel, after which the sub-panel is fastened to it by means of the brackets provided for this purpose. The knobs on the rheostat and radiohm should be adjusted so that their arrow heads fall over the arms of the instruments and trace their course on the front of the panel. The knob on the compensating condenser "N," should have its arrow pointing to the right when the plates are entirely interleaved.

The vernier dial should be attached to the shaft of the tuning condensers in such a manner that it will read zero when the plates are all in, and 100 degrees when they are all out. In order to arrange this, it may be necessary to remove the indicator plate from the dial by loosening the center stud which is screwed up tight, and dropping out the indicator disk by pulling the control knob away from the center so the disk will drop out. It may be reassembled in the reverse

Coded Chart of Wiring Harness and Leads for Silver-Cockaday Receiver



manner, after the proper scale has been turned toward the front. In tuning, only the scale from zero to 100 is used, low wave, high frequency stations coming in at 100 on the dial, and high wave, low frequency stations coming in toward zero, in order to realize the SLF tuning qualities of the condensers.

Connecting the Harness

The photos and diagrams should be studied carefully again before putting the harness in place, since they carry the numbers corresponding with the wire ends. If the photo of the bottom of the sub-base is continually referred to in putting in the harness, together with the cable chart, no difficulty should be experienced in hooking the set up. There are eight leads outside the cable clearly visible in the photos. They are the grid and plate leads, some of which could not be included in the cable for reasons of efficiency. They are numbered as is the cable, and as a result should present no undue difficulties even to the man building his first set. After wiring, all connections should be re-checked before testing, for safety.

Soldering is not necessary, though it may be indulged in if desired. The cleaned and tinned wire ends may be fastened to the instrument binding posts under the thumb nuts, which will hold them securely, or, in the case of jacks, condensers, etc., the ends may simply be pushed through holes in the lugs, bent over, and squeezed tight, the lug being crushed upon the wire to make a more positive connection. Thus, only a screw driver and a pair of pliers are required to build this entire set.

Testing and Operation

The accessories needed as listed below will be required to put the set in operation.

- 4 UX201A tubes (3 UX201A and 1 CX112 if desired)
- 2 large 45 volt B batteries
- 1 large 4½ volt C battery
- 1 6 volt, 60 to 100 ampere storage battery
- 1 loud speaker with plug (phone-plug)

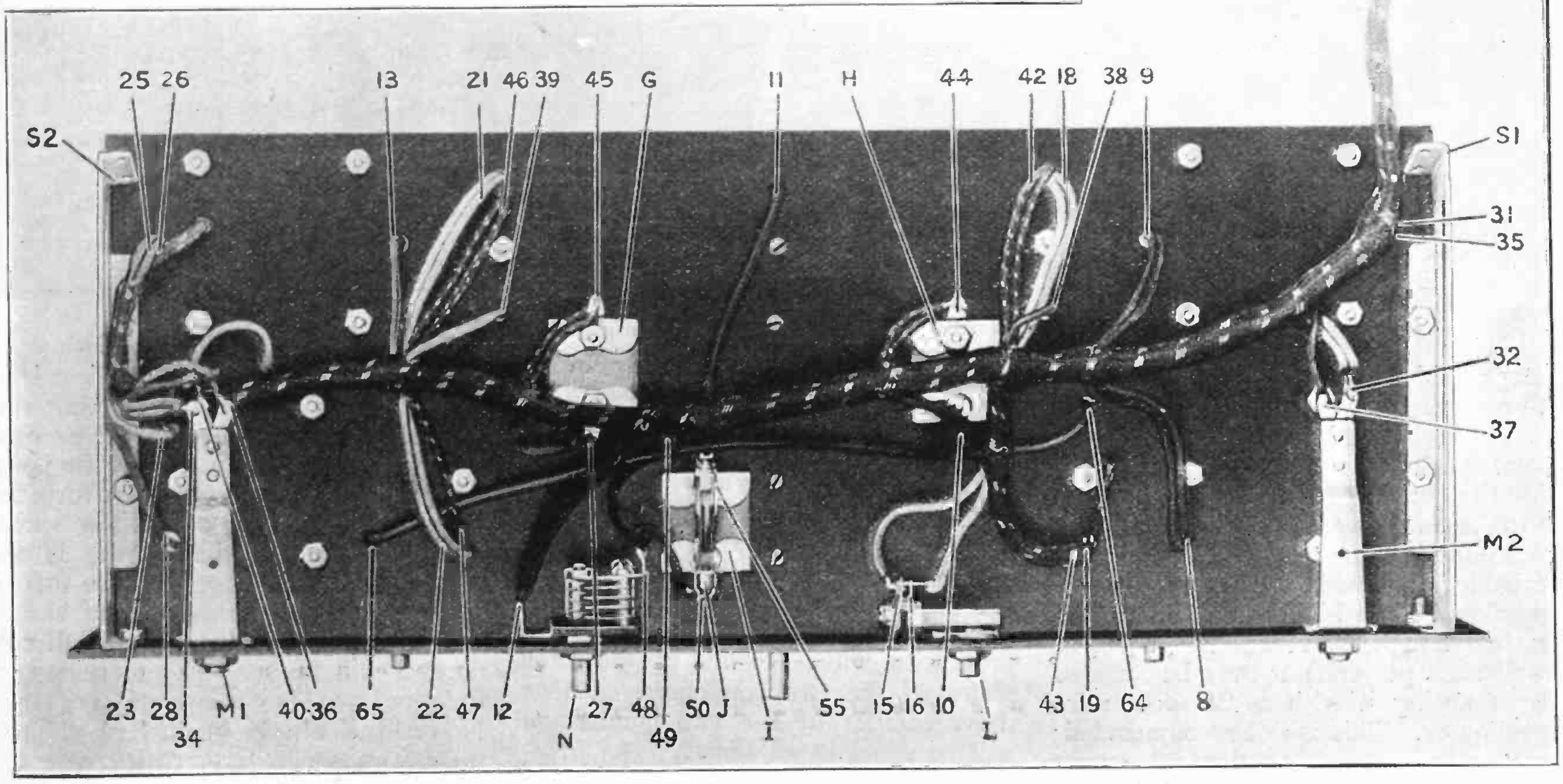
Dry cell tubes may be used with slightly less volume, if the builder prefers, although the sensitivity, selectivity, and quality will remain about the same as though storage battery tubes were used. On extremely strong signals, distortion may be noticed with them, however, due to their lower power handling capacity as compared with UX201A's or UX112A's. If this change is made, the storage battery may be dispensed with and in its place six ordinary dry cells hooked in series parallel may be used for the A battery.

A single tube should be put in a socket, all the batteries having been connected, taking care to see that its pin lines up over the line between the "P" and "G" marks on the socket shell. If the rheostat is turned just barely on, and the battery switch turned to the right, the tube will light if connections are correct.

If the tube lights properly, and its brilliancy varies with adjustment of the rheostat, the three remaining tubes should be put in their sockets. If a power tube—UX112 or UX120—is used, it goes in socket "R4." For UX199 tubes, the rheostat should be just barely turned, while for UX201A's it should have the indicating arrow point to the right. The loud speaker may be plugged into either of the jacks.

The antenna, so far, has been ignored. It should consist of a single wire about 70 to 100 feet long connected to post "A-1" or "A2" of coil socket "A." An indoor antenna can be used, with a decrease in sensitivity, however. The ground, connected to whichever post—"A-1" or "A-2"—was not used for the antenna, should consist of a wire run to a well-scraped water, steam, or gas pipe.

When first trying the set, condenser "N" is set at zero (left,) and the volume knob at zero (left,) then if the selector dial is rotated, local stations,



Bottom view of the sub-panel showing the parts and connections with wiring harness.

if operating, will be heard. The selectivity of the set may be regulated by adjusting with the finger the rotor of coil "A." When its axis is at right angles to that of the outside tube, selectivity will be greatest. Once set, this adjustment may be ignored.

To tune in distant stations, the volume control must be turned to the right nearly all the way. Then, if the selector is rotated, squeals will be heard if stations are operating. If no squeals are heard, the rotor of coil "B" must be adjusted with the fingers. Generally, if the rotor and stator axes coincide, the receiver will oscillate, with consequent squeals when stations are tuned in. This squealing may be stopped by retarding the volume knob to the point where a squeal just ceases and the intelligible signal is heard. This is the most sensitive position of the volume knob, and will vary slightly for the different setting of the selector.

Should, on some fairly weak station, —say, one just giving good loud speaker volume—two points be noticed on the selector dial at which the station may be heard, separated by about a degree or two this condition may be remedied by adjusting "N" in small steps, which will cause the two points to merge.

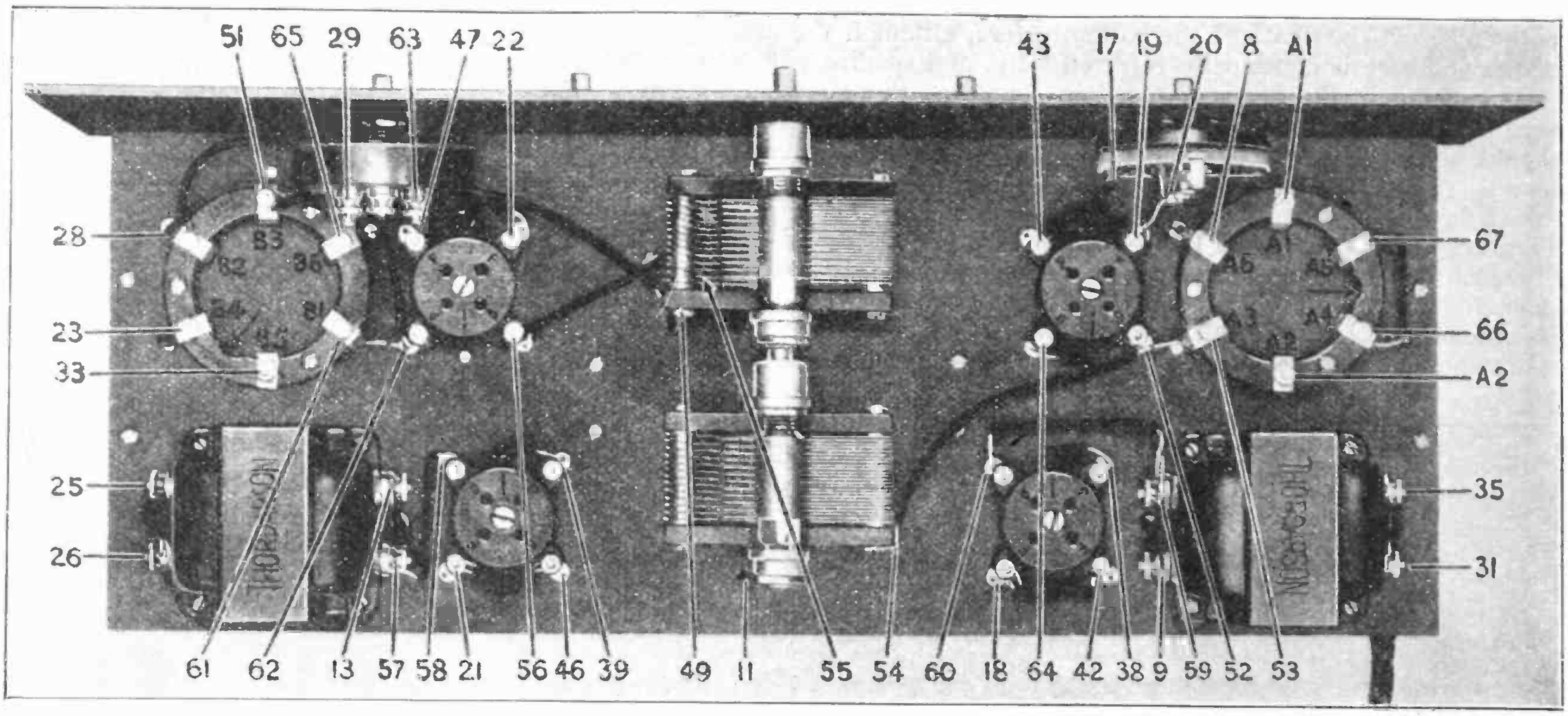
The use of a Western Electric cone loud speaker is fully justified, considering the quality of the receiver, in order to take full advantage of the excellent reproduction of which the system is capable. Should the pitch of the speaker be too high to suit individual taste (though the reproduction will be well nigh perfect,) it may be lowered by shunting it with a .01 fixed mica condenser. This is not recommended; rather it is suggested that the owner endeavor to accustom himself to truly faithful reproduction—something seldom encountered even with resistance coupled amplification.

Notes on Adjusting the Set

The circuit capacity of the two tuned circuits in this receiver are surprisingly equal but it is not possible to construct a "home built" set that will have sufficient uniformity of circuit constants to permit perfect gang control without some means of compensation. The designers of this circuit did not intend that there should be no compensation—in fact, they provided a small compensating variable condenser in parallel with the second tuning unit (the condenser nearest the panel) so that any variation might be balanced out.

Let us consider what is necessary to successfully tune two or more circuits with a gang condenser. Since inductance and capacity are functions of wave-length or frequency (Wave-length $= 1884\sqrt{LC}$) and the inductances (L) and (L_1) are fixed quantities and are equal, it is evident that the condenser capacities (C) and (C_1) must always be equal. Of course, the circuit capacities must either be equal or made equal by means of a compensating condenser. If straight line capacity condensers were used, one condenser could be made to "lead" the other to a sufficient extent to compensate for any variation in circuit capacity or distributed capacity in the coils. However, in this particular case straight-line-frequency condensers are used and the capacity variation per degree is different for each degree of the dial. Since this is the case, the first precaution will be to line up the rotor plates of the two condensers so that the capacities of the two condensers will be equal at all times.

The next step would be to compensate for variations in circuit and distributed capacities in the various circuits. The capacities of these two circuits are so nearly equal that the addition of the small compensating condenser in parallel to the detector variable condenser increases the minimum capacity of the circuit to such an extent that the compensating condenser must be operated with the plates nearly unmeshed. Of course, the ideal method of operating this receiver would be to have the plates of the compensating condenser half meshed so that a maximum variation could be had in either direction should that be necessary. The natural operating point of this condenser may be set at this point by raising the minimum capacity of the radio frequency variable condenser (the one in the rear.) This may be done by connecting about a 12-inch length of double silk covered wire (any size between 30 and 22) to each of the stator and rotor plate terminals of this condenser, and twisting them until the desired result is obtained. The remaining untwisted ends may be cut off and the twisted wire may be coiled up on one's finger and then tucked away underneath the condenser so that the two free ends do not touch each other or any other part of the circuit.



Rear view, looking down at the sub-panel. All parts and connections are clearly indicated to correspond with the wiring diagram.

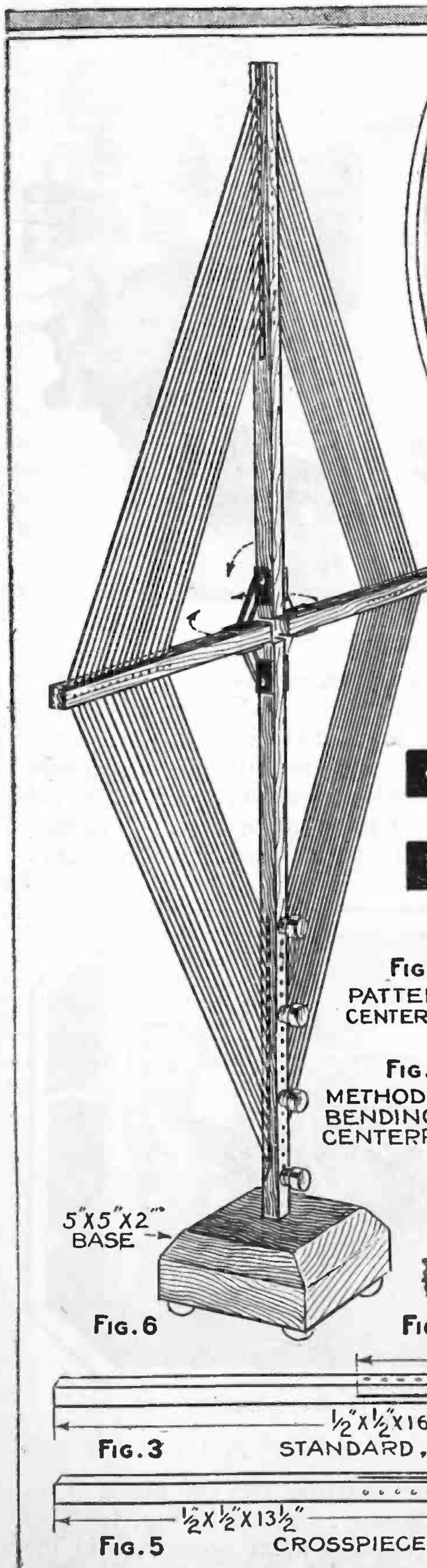
The receiver should be placed in operation and a high wave-length station tuned in. The compensator condenser should be adjusted to the point of maximum intensity. Now turn the large tuning dial so that a low wave-length station may be heard. If the compensator condenser must be turned more than a quarter of a turn before the station is again brought to full volume, it will be necessary to remove a turn or two from one of the coils. If on the above mentioned adjustment it was necessary to increase the capacity of the compensating condenser, it is evidence that the antenna coil has too many turns. If, on the other hand, the volume of the signal was increased by decreasing the capacity of the compensating condenser, it is an indication that the radio frequency coupler has too many turns. These turns should be taken off one at a time and if ultimate results are expected, it may be necessary to make a final adjustment by removing ½ a turn from one of the coils. These adjustments should only be made after the S-C Receiver has been carefully built and adjusted in accordance with the instructions in the booklet describing it. The writer found that it was possible to cover the entire broadcast range of this single control receiver without moving the compensating condenser more than ⅛ of a turn.

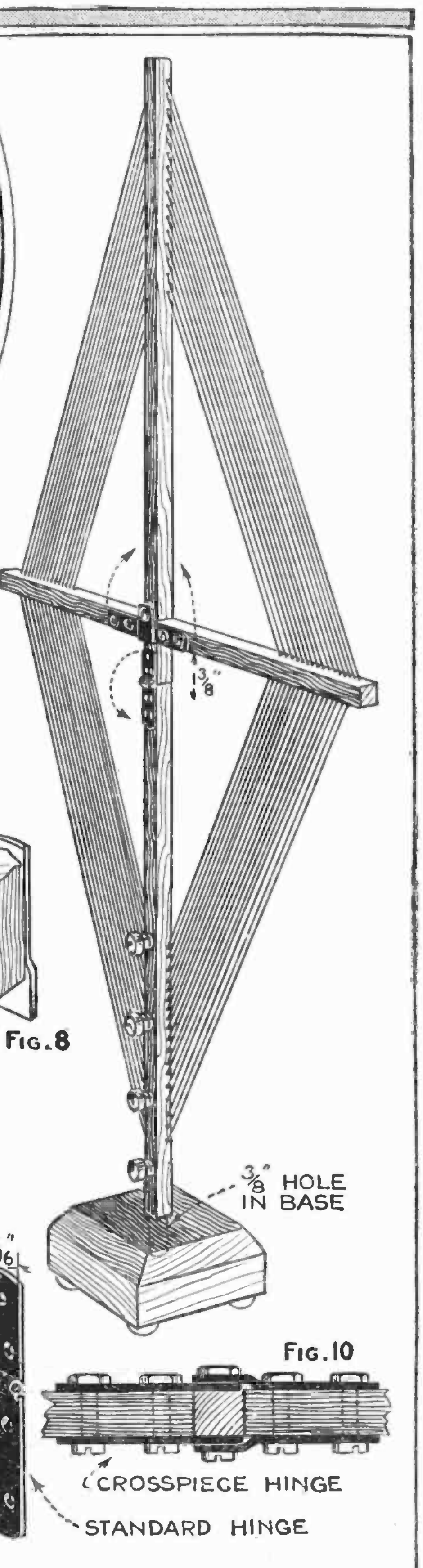
How to Make a Collapsible Loop

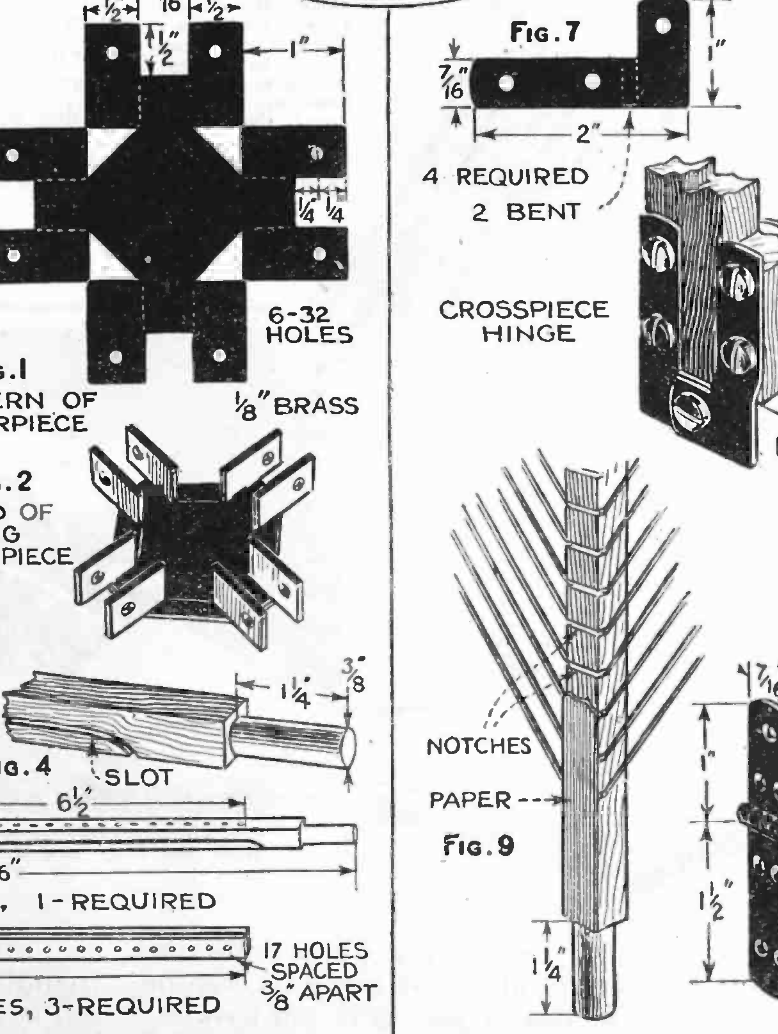
Complete Constructional Details of a Practical Tapped Loop for Your Vacation Set

NOW that we have the Summer months almost upon us a good many radio enthusiasts will want to take their portable sets on vacations. For those who have portable super-heterodynes and other types of sets which can be operated on a loop, the constructional details of a collapsible loop as given in *Popular Mechanics* magazine and presented herewith will be found of particular value. *E. R. Haan*, author of the article, explains the features of this loop and describes it as follows:

After several unsuccessful efforts to increase the selectivity of his 6-tube







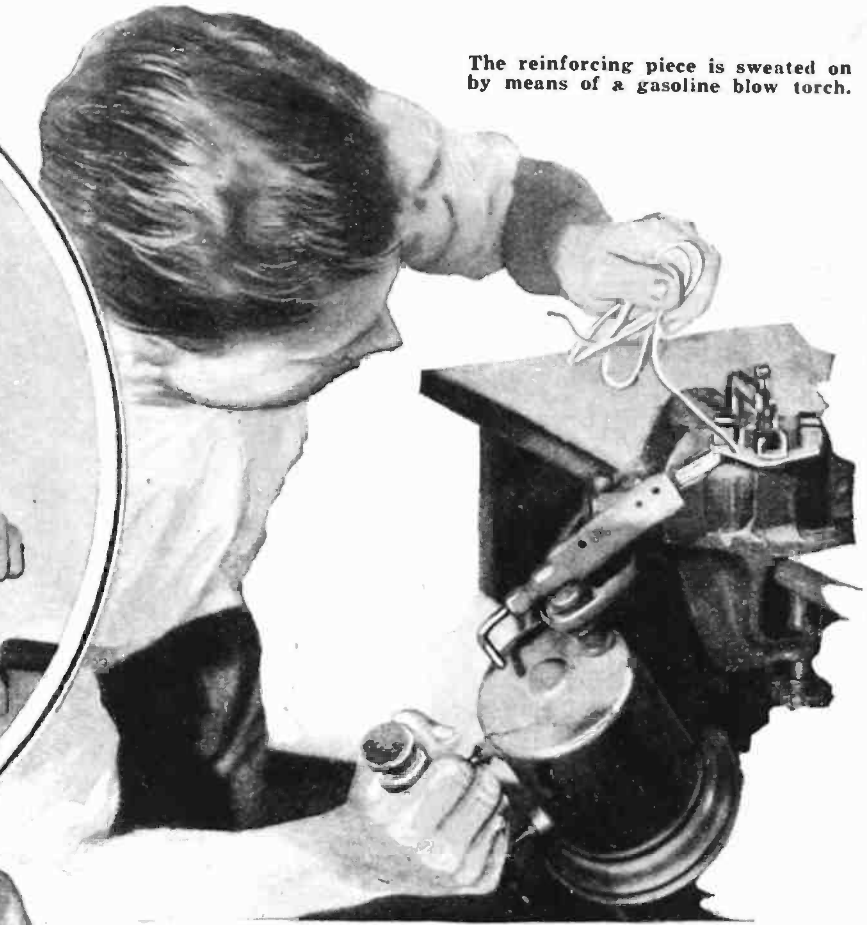
Illustrations by courtesy of Popular Mechanics, Chicago, Ill.

Above, the proper method of opening the Loop; each half of this illustration shows details of a Pancake style Loop with different folding features and method of attaching the wire.

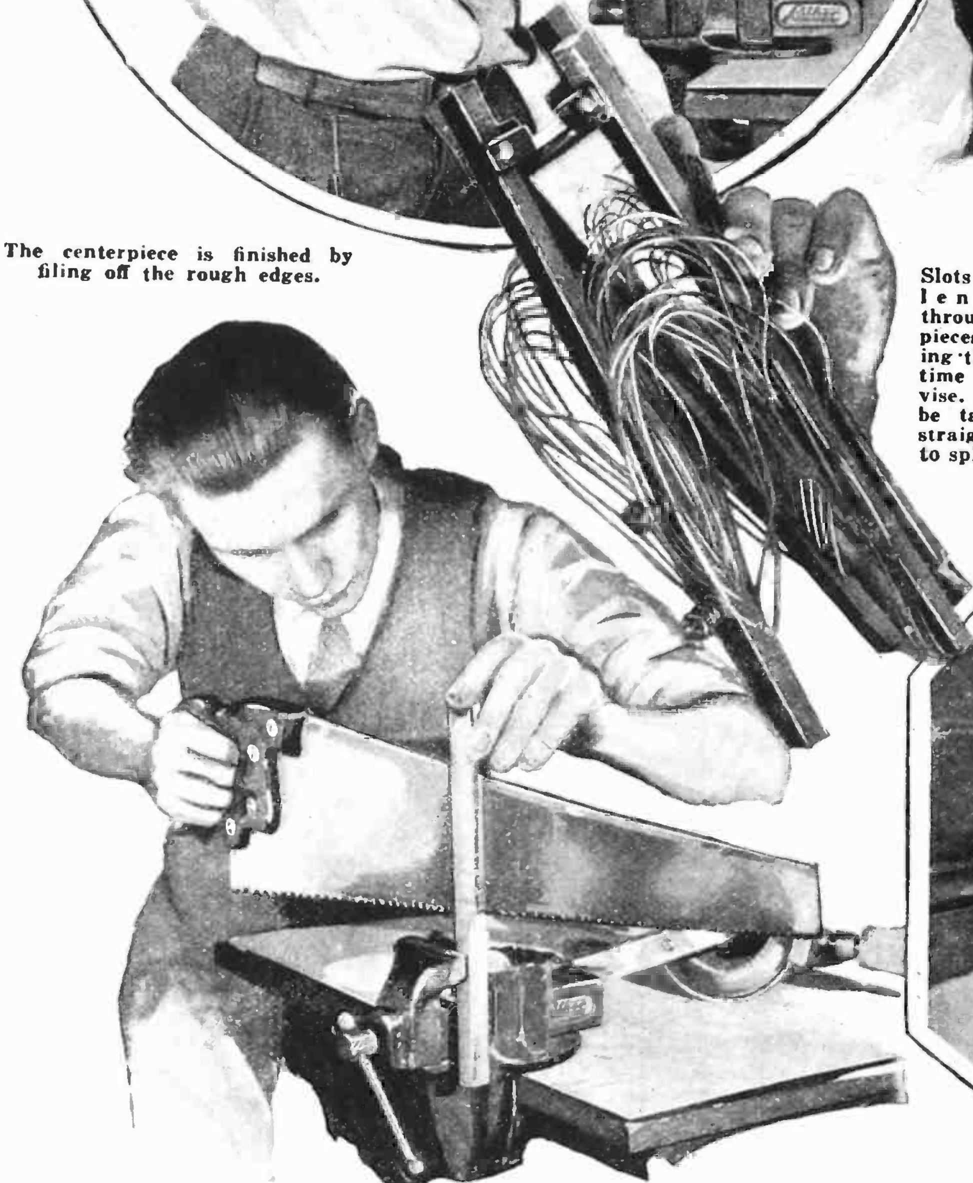
radio-frequency set, located within a mile from two powerful Chicago broadcast stations, both of which could be found all over the dial when in operation, making it impossible to tune in outside stations, the owner resorted to a tapped loop and found that this eliminated all his trouble. With another receiver having one stage r.f. amplification, the stations on lower wave-lengths than 275 meters could not be brought in on the dial when using a loop of standard size. This obviously meant that there was too much inductance. So a tapped loop was used, and it was found that these stations could be brought in near the center of the dial. The effect was that these stations could be separated at points farther apart on the dial than usual when they are brought in on the lower end, which gave a result similar to that obtained with the new straight-line frequency condensers.

These two instances prove the universal usefulness of a tapped loop on sets of these types, so if you have experienced similar troubles, a tapped loop is the remedy. The simplest loop to make is one having a rigid frame on which to wind the wire, but many people desire a loop that can be folded and carried around conveniently with portable sets, and therefore consider it worth the extra trouble to make it collapsible.

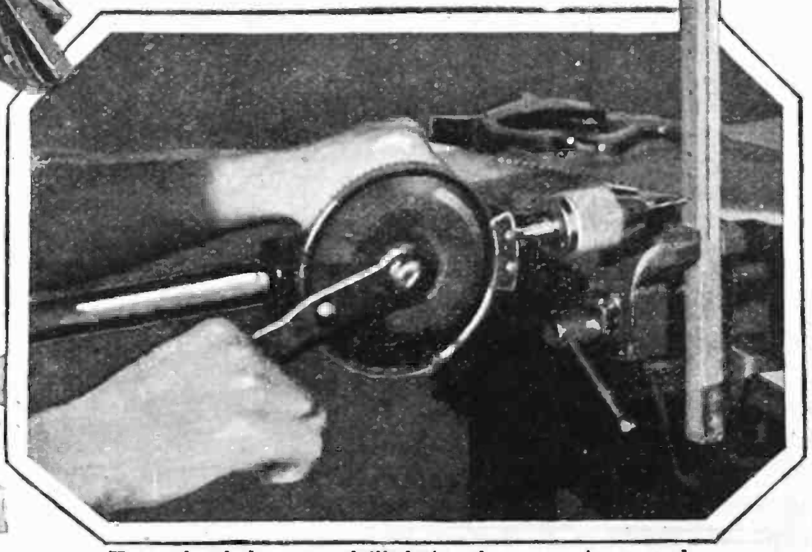
The centerpiece is finished by filing off the rough edges.



The reinforcing piece is sweated on by means of a gasoline blow torch.



Slots are sawed lengthwise through the crosspieces by clamping them one at a time in a bench vise. Care must be taken to saw straight and not to split the pieces.



How the holes are drilled in the crosspieces and standard.

The three crosspieces, Fig. 5, and the standard, Fig. 3, are made of strong ½-in. stock, preferably oak. A distance of 6½ in. is marked off from one end and 17 small holes, spaced about ⅜ in. apart, are drilled through them, care being taken to keep the holes in line. Saw slots, 6½ in. long, are cut in the ends of the crosspieces with a small panel saw, as shown in the lower left-hand photo, and a similar slot is cut in the standard with a keyhole saw, starting the cut about 3 in. from the end, as shown in Fig. 4. This end is rounded to fit accurately in the hole drilled in the base, shown in Fig. 6. The centerpiece is cut from ⅛-in. sheet brass. Cut the pattern exactly according to the dimensions shown in

(*Continued on Page* 158)

The Bodine Radio Frequency Set

An Efficient Five Tube Set Using a New Type of Fieldless Coil—Optional Loop Operation a Feature

By F. L. HILL

THE ever increasing power and number of broadcasting stations in the United States makes selectivity an important factor in the choice of a receiving set. The use of closed field types of coils in tuned radio frequency receivers results in much improved selectivity although in many cases the selectivity is gained at the cost of amplification and sensitiveness. The performance of a tuned radio frequency receiver depends on the efficiency of the radio frequency coils more than on any other piece of apparatus in the set.

The receiver described in this article features the Bodine Twin-Eight Coil, a recent arrival in the ranks ot closed field transformers. This set will give exceptional selectivity with no sacrifice in amplification or distance getting ability. In fact the amplification is higher than can be obtained with the best types of solenoid coils.

The Twin-Eight coil is ingeniously wound in a double figure eight shape as the name indicates. It is entirely self supporting except for a small ¼" hard rubber rod passing through the intersection of the figure eight which serves as a mounting and carries the terminals. Elimination of dielectric material in coil construction is an important factor in the reduction of resistance at radio frequencies. As the winding is continuous from the top to the bottom of the coil, the high potential or grid end of the secondary is as widely separated as possible from the plate terminal, an important feature.

The closed field principal of the Twin-Eight is the same as for the toroid or binocular types. The fields of the two sections of the coil are opposed to each other, thereby tending to concentrate the magnetic field in a ring passing through both barrels of the coil. This concentration of field prevents magnetic coupling between stages, losses caused by linkage with adjacent apparatus in the set and the picking up of undesired strong signals from nearby stations. The coil is wound so as to use the least wire for the maximum inductance and lowest distributed capacity. Therefore the turns are wound close together in a single layer with the primary turns at one end. This arrangement gives tight magnetic coupling between primary and secondary with minimum electrostatic coupling,—a condition necessary for high amplification as shown by the well known Browning-Drake experiments.

A minimum number of parts have been used in the construction of this set, but those used are the best obtainable. The simplicity of the arrangement and wiring is apparent in the illustration and it is a very easy set to construct. Placing the audio circuits at one end of the base board as shown is the safest practice as it eliminates the danger of feedbacks into the radio frequency circuits which often happens when audio transformers and wiring are mixed up with the radio frequency circuits. No stage control switches or jacks are used as volume can be controlled just as effectively by means of the rheostat and the Centralab variable high resistance. The saving of battery current possible by the use of stage control jacks is not appreciable and does not justify the extra cost and work of wiring. No battery switch is used as the rheostat serves just as well to turn off the set. A single bypass condenser is used. More are unnecessary if B batteries are in good condition. If desired additional ½ mf. by-pass condensers may be connected from B-90 and B-45 to A—, but the gain is imperceptible in most cases. The use of a C battery lengthens the life of B batteries but is otherwise unnecessary. If desired it may be connected as indicated in the hookup, and

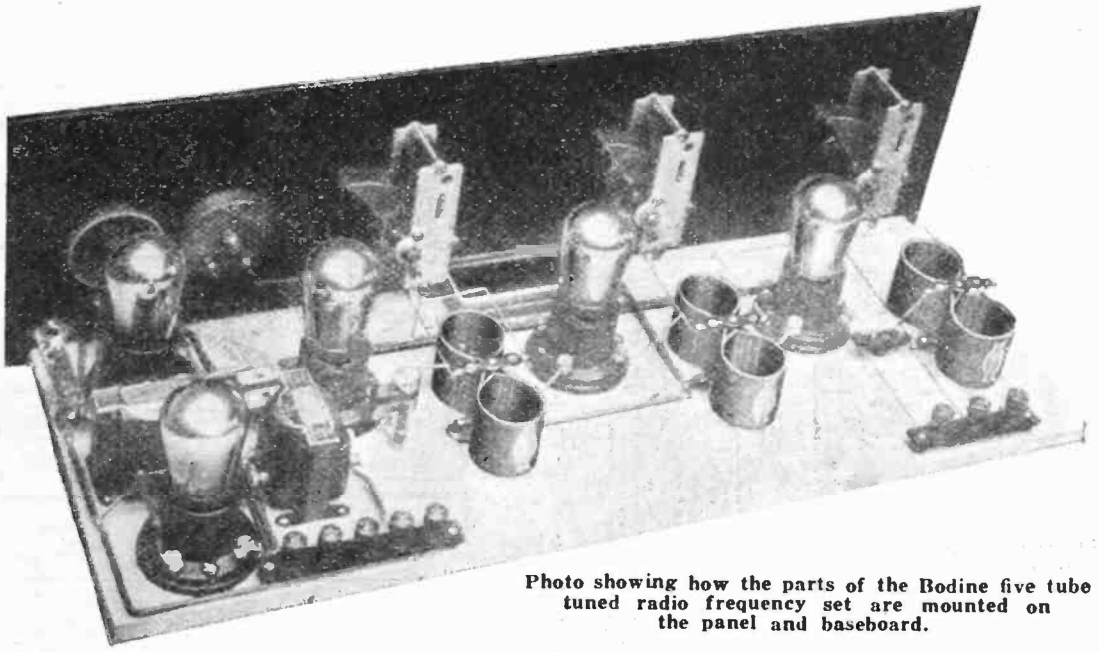


Photo showing how the parts of the Bodine five tube tuned radio frequency set are mounted on the panel and baseboard.

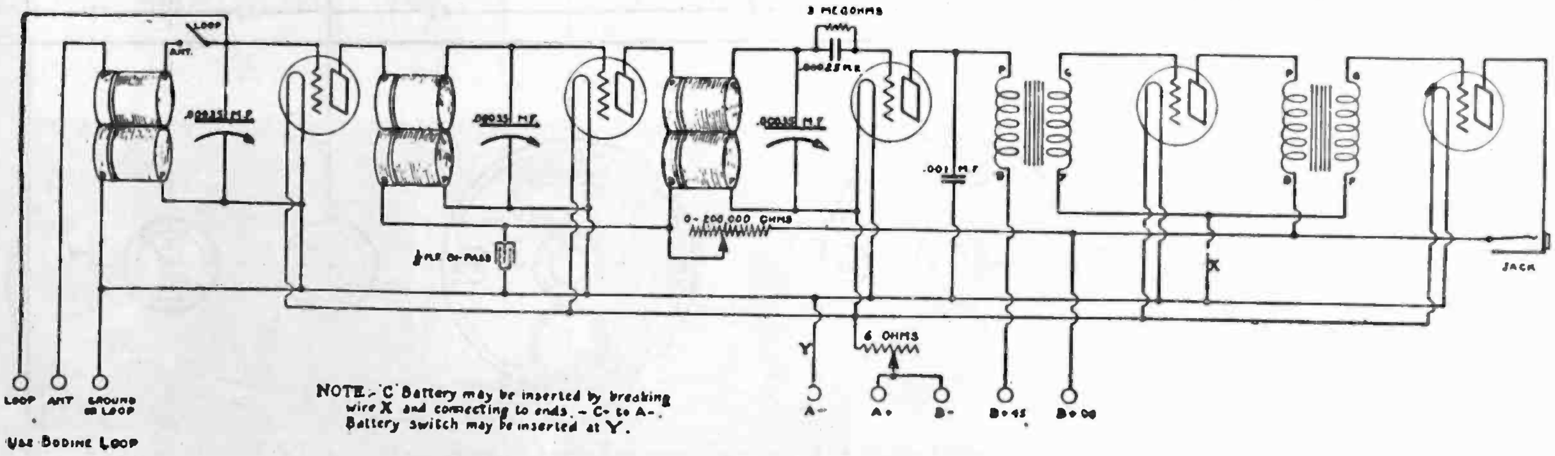


FIG. 1 SCHEMATIC WIRING DIAGRAM.

there is plenty of room on the base board for it so that extra binding posts are not required.

Amsco S.L.F. condensers are used. They are compact with consequent

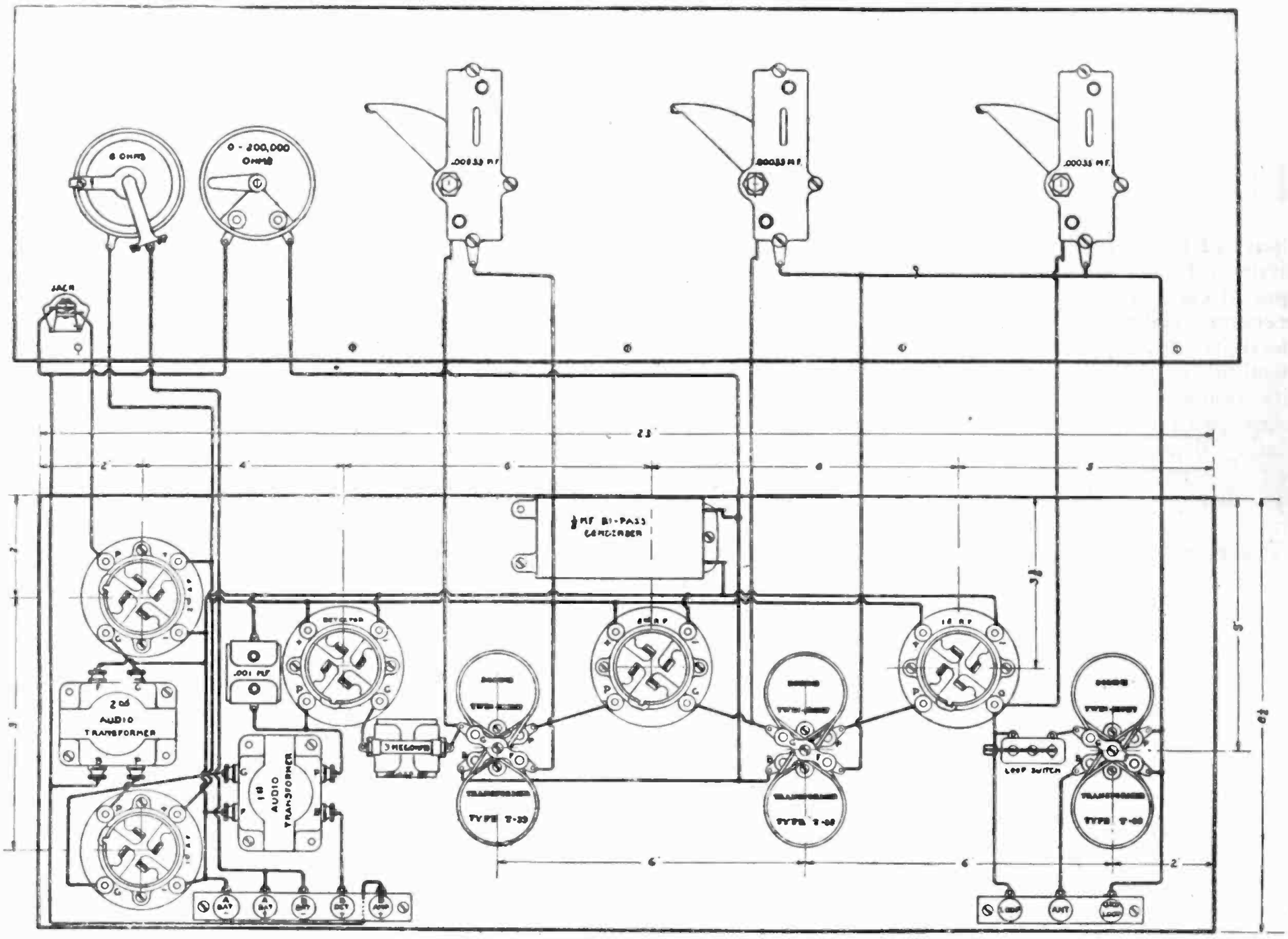


FIG. 2 · REAR VIEW of PANEL & PLAN of BASE BOARD SHOWING ARRANGEMENT & WIRING.

small interstage capacity. They have a good low minimum capacity and tune the Twin-Eight coils nicely, bringing in KSD (545 meters) at about 94 and WSBC (206 meters) at 19 on the

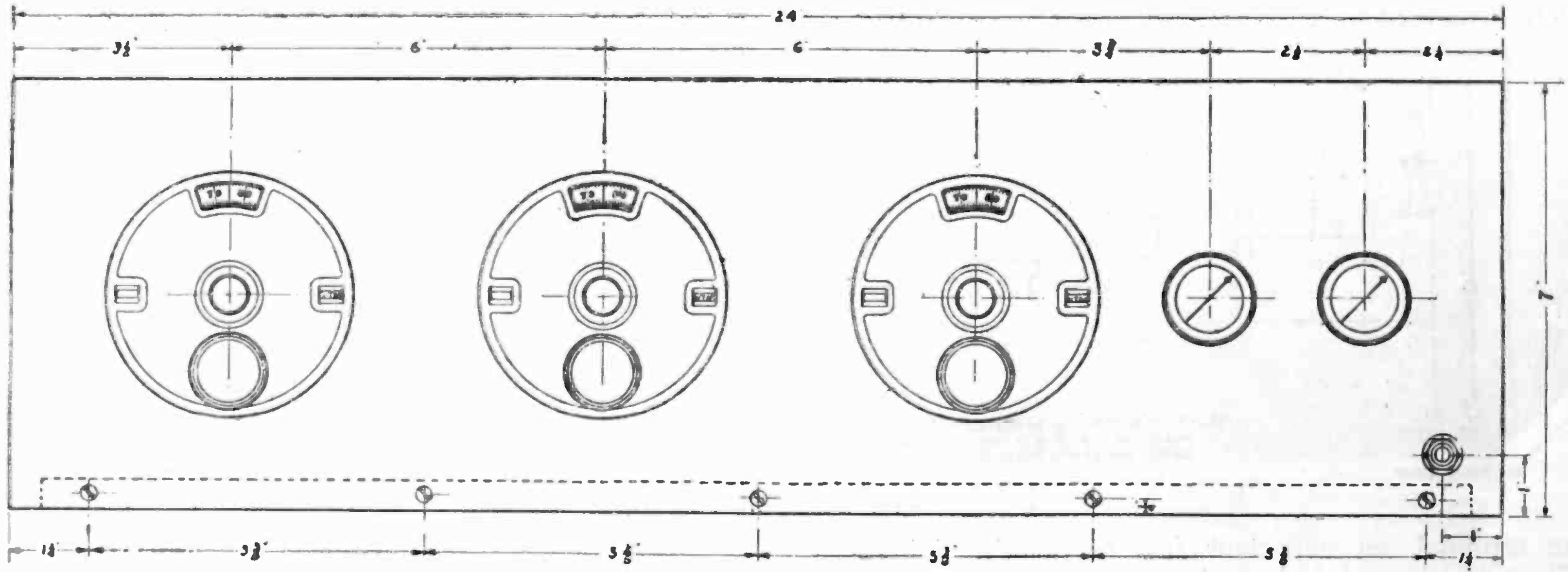


FIG. 3 · FRONT PANEL.

dials. Oscillation is controlled by means of the Centralab 0 to 200,000 ohm non-inductive variable resistance, which also serves as a volume control. Thordarson Audio Transformers are specified as no matter how clear and undistorted the signals come from the detector tube, the tone quality at the loud speaker will be poor unless good audio transformers are used.

A feature of this set is the provision for optional loop operation. While the use of a loop results in a reduction in volume on a 5 tube set, it also reduces interference and greatly improves tone quality when atmospheric conditions are bad. For instance, in testing this set at Chicago on an extremely bad and noisy night, KPRC Houston, Texas; WDAP Fort Worth, and WHO Des Moines were brought in with good volume but with considerable noise due to bloopers and static.

On switching to loop operation, using a Bodine Standard Loop, reception from these stations was much clearer and pleasanter to listen to. Reception from WSMB, KSD and WHAD was also improved by the use of the loop aerial. For local reception with the loop there is no perceptible reduction in volume and selectivity is better, especially when the set is located close to a broadcasting station.

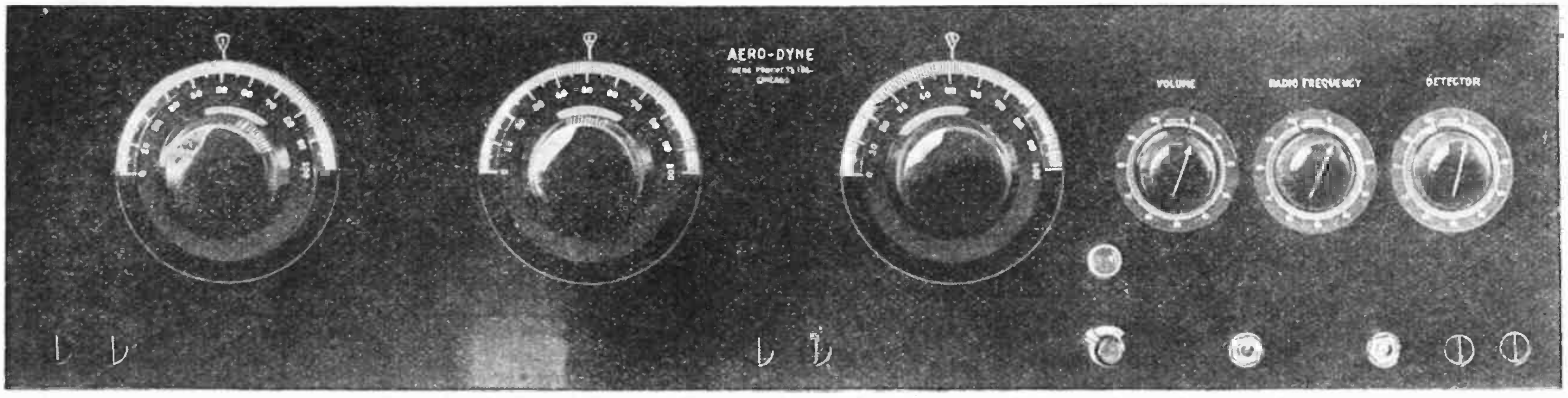
The construction of the set is very simple if the accompanying diagrams and illustrations are carefully studied. As the panel is of standard dimensions the set will fit in a great variety of cabinets which are on the market. A

(*Continued on Page* 164)

Building the Aero-Dyne Receiver

By PETER C. CARDELL

THE effect of losses on the operation of radio receivers has been so thoroughly explained and discussed during the past two seasons that the stages of audio frequency amplification. The latest improvements from the standpoint of volume, selectivity, ease of control in both tuning and regeneration, and tone quality, have been incorporated in its design. Low losses and the correct size of plate coil make for volume; and adjustable primary on



Front panel view of the Aero-Dyne receiver. The three large dials are the tuning controls.

engineer as well as the broadcast listener has become convinced that his set, to rank with the best, must be the ultimate from the "low-loss" standpoint. A prominent eastern engineer, attached to a large research laboratory, has recently published a very complete paper on the subject, proving mathematically, and conclusively, the tremendous effects that a few misplaced ohms of resistance may cause. Therefore, it is not the purpose of this article to repeat what many others have said before, but merely to show the home-builder broadcast listener how he may duplicate and even surpass, in some instances, the results achieved by some of the highest priced, carefully designed radio receivers of 1926.

The Aero-Dyne receiver, so named after its essential parts, the Aero Coils, is a five-tube, tuned radio frequency amplifier system, using two stages of tuned RF, a tuned detector and two

LIST OF PARTS REQUIRED

- 8 binding posts.
- C4-1 .00025 mfd. fixed condenser.
- C5-1 .002 mfd. fixed condenser.
- C6-1 1 mfd. by-pass condenser.
- R1-1 five-megohm grid leak.
- 1 Yaxley battery switch.
- 1 Yaxley open circuit jack type 1.
- 1 Yaxley closed circuit jack, type 2a.
- 12 lengths bus-bar.
- 1 set of T.R.F. 120 matched Aero coils.
- 1 bakelite panel, 7x28x3-16 in.
- 1 bakelite sub-panel 7x27 in.
- C1, C2, C3 — 3 Karas .00037 straight line frequency condensers.
- 3 dials.
- 5 standard tube sockets.
- 1 Yaxley 15 Ohm Rheostat.
- 1 Yaxley 30 Ohm Rheostat.
- 10-200,000 Ohm Radiohm. (Made by Central Radio Laboratories, Milwaukee).
- 2 Thordarson Ratio 3½ to 1 audio transformers.
- 1½ Ampere ballast resistance.

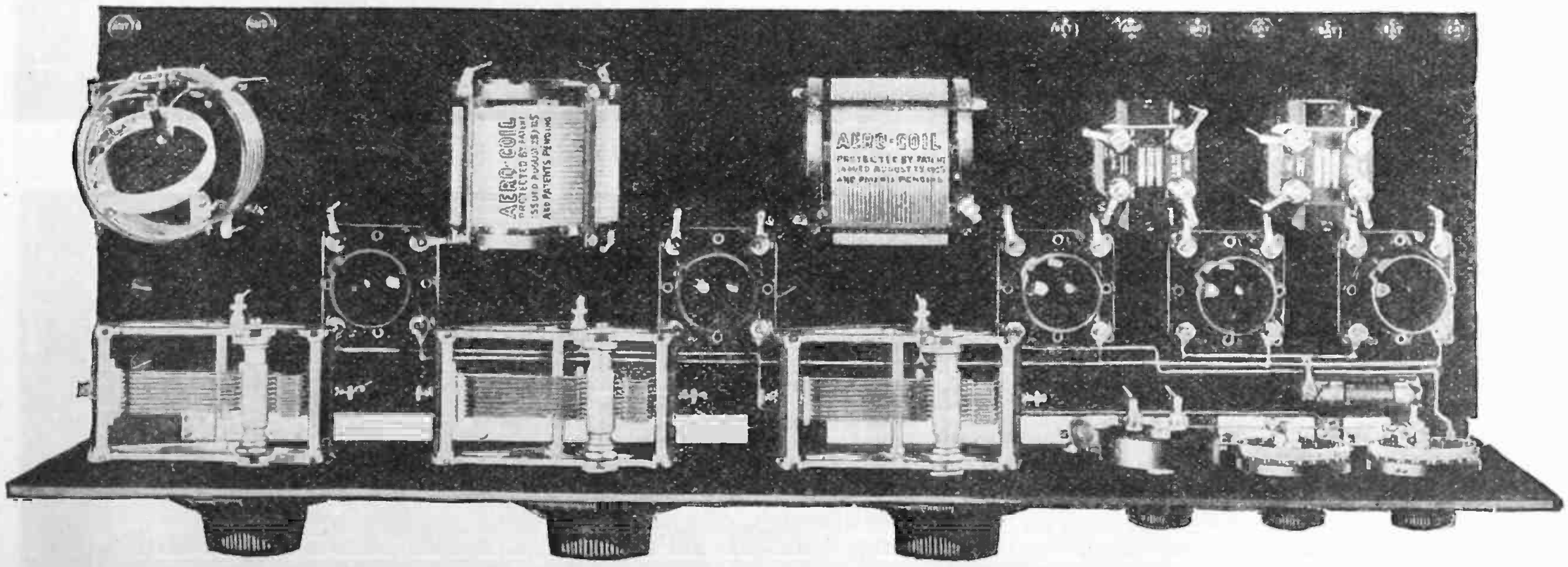
the antenna coupler to compensate for different sized aerials gives selectivity; ease of control is assured by straight line frequency condensers and a variable oscillation control which is foolproof; and tone quality is obtained through careful selection of audio transformers and correct bias of the grids.

The list of parts required to build the Aero-Dyne is given herewith.

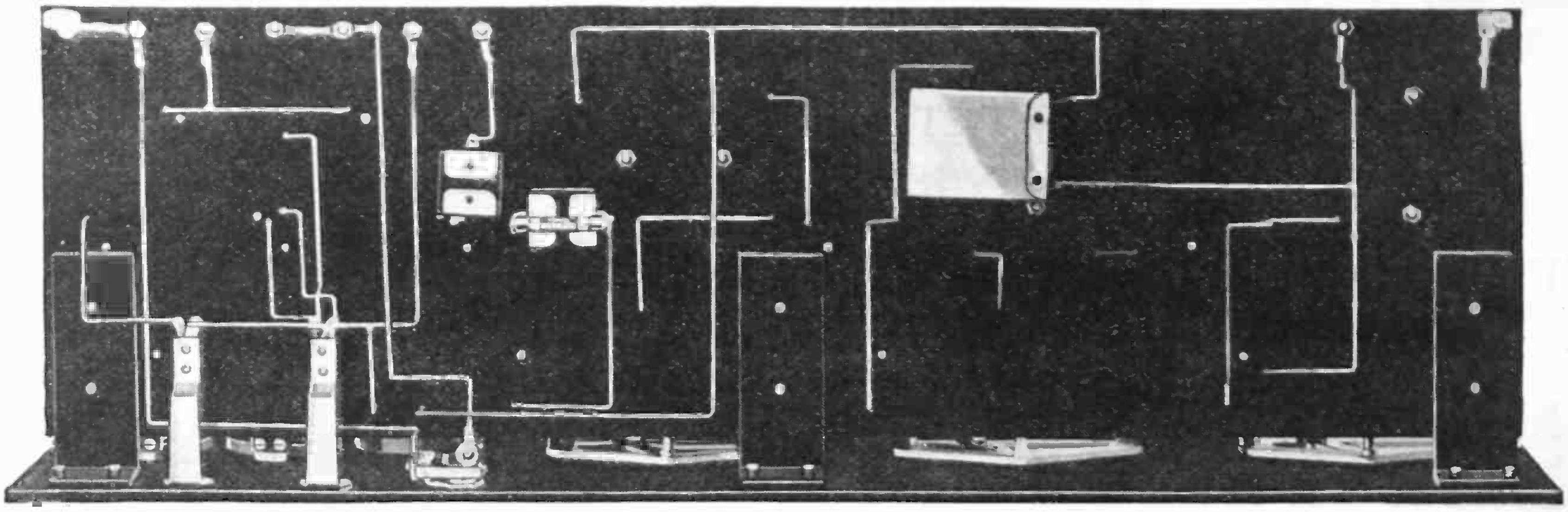
The user should be extremely cautious in the substitution of other parts that he may have in his possession, to be certain that the quality is as good and the manufacturers reputation irreproachable.

The accompanying photographs and drawings make the details of construction clear. It is seen that a bakelite panel and sub-base are used, the essential apparatus being mounted on them and the low-potential (battery and audio leads) wiring done under-

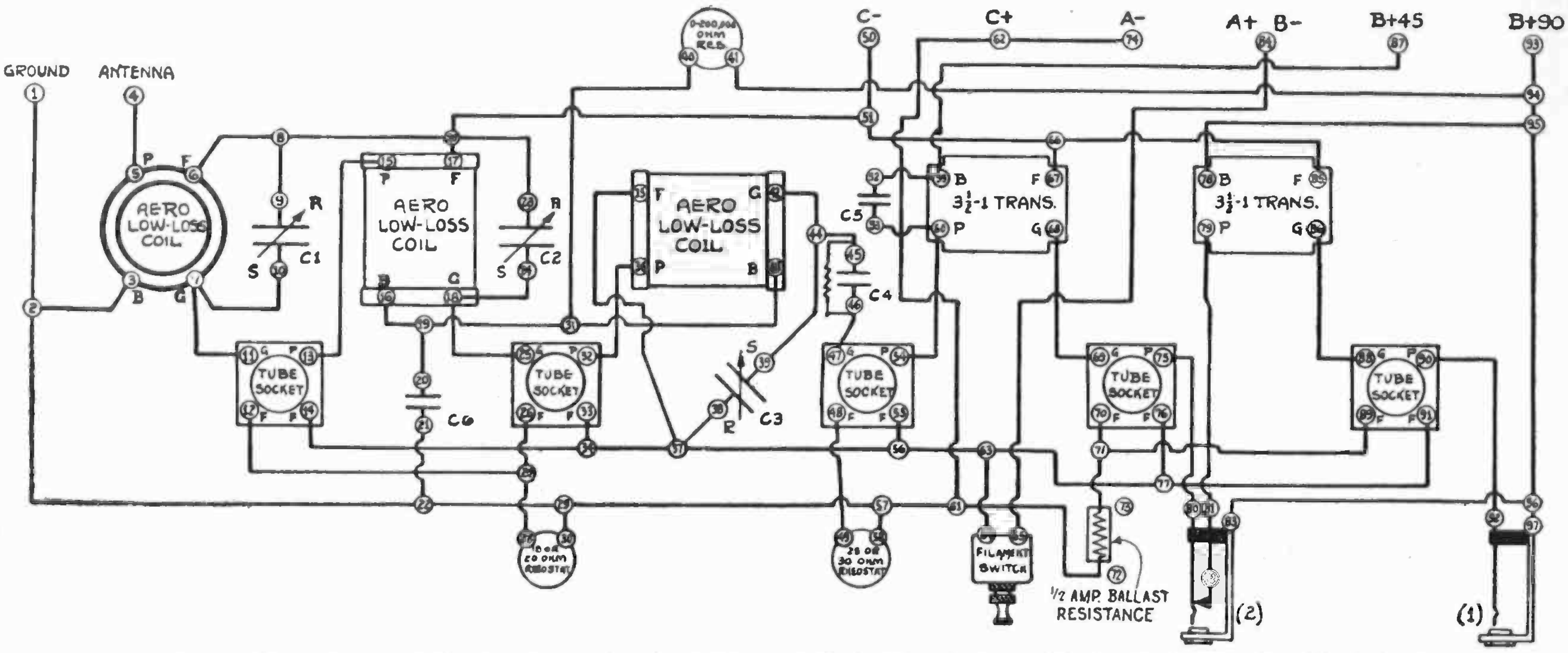
(Continued on Page 169)



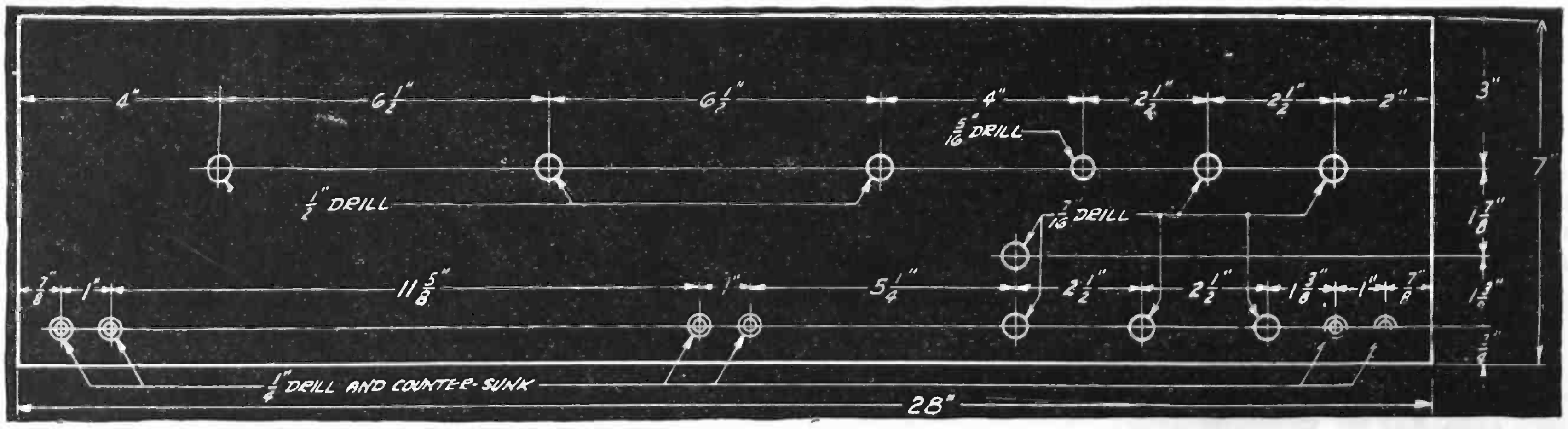
Looking down on the sub-panel of the Aero-Dyne receiver from the rear. Note that practically all wiring to the various parts pass through holes in the sub-panel.



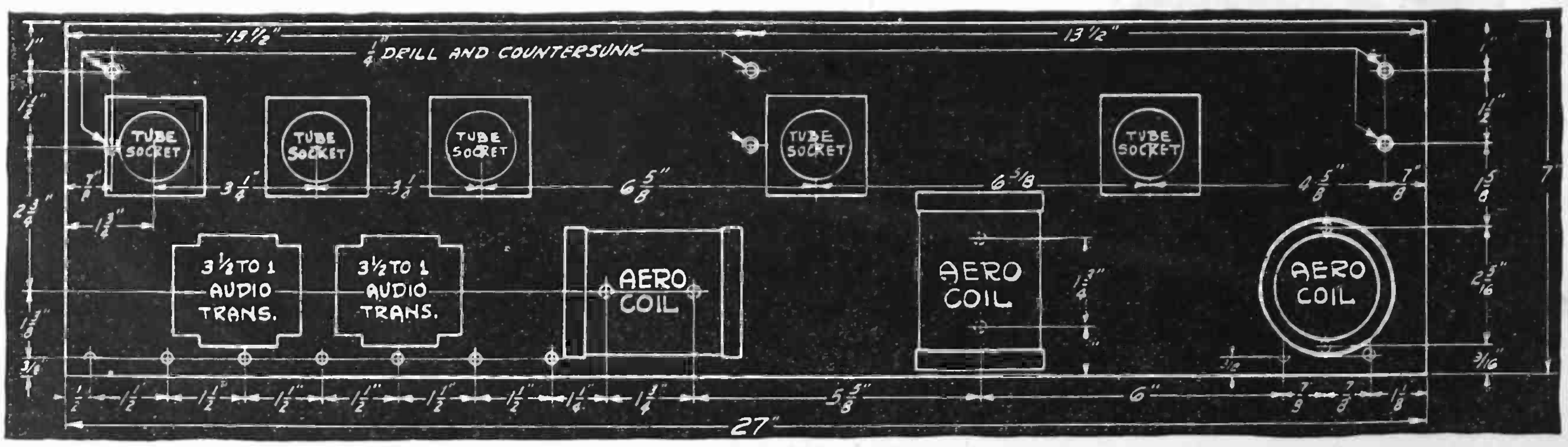
A bottom view of the Aero-Dyne sub-panel showing how the wiring is arranged.



A picture wiring diagram of the Aero-Dyne. The inexperienced radio builder will have little trouble in following this hook-up.



Panel drilling layout of the set, giving all dimensions for spacing of the holes.



Layout of parts on the sub-panel with dimensions for position of the parts as mounted thereon.

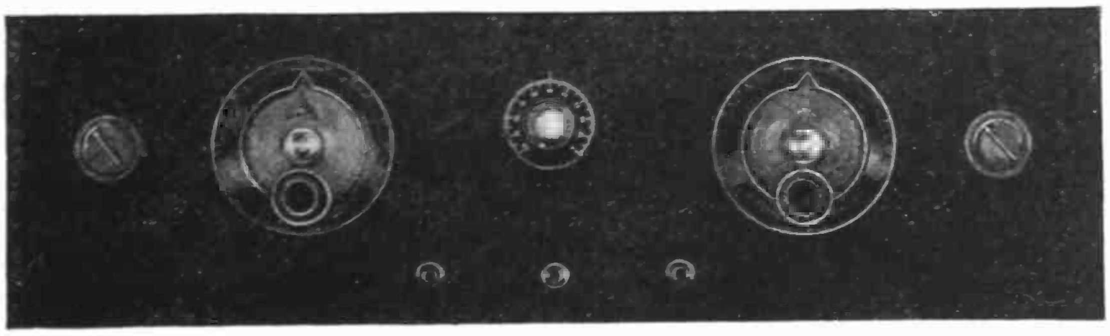
Adding Tuned R. F. to the Three Circuit Tuner

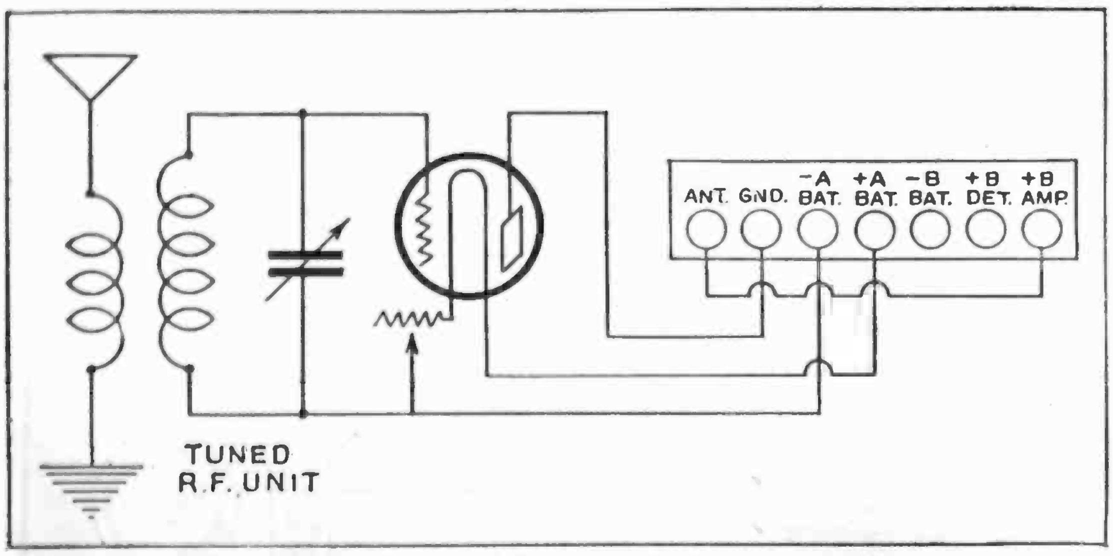
By REUBEN H. GROSS

IT IS only a brief span since I wrote the story about the old reliable three circuit tuner, yet in keeping with the general trend of radio in which new stunts come fast and furious, I have continued to experiment with the "old stand-by" and have made a few additions which in my opinion are worth writing about.

If you, kind reader, actually went ahead on the three-circuit tuner as described in the last issue of this magazine, you will agree that the "dope" was right and that there was more to the circuit than most "build your owns" thought.

The desire for more DX, clearer and louder signals and sharper tuning is a normal and natural desire of every broadcast listener, and being of that genus, I finally decided to take the advice of many writers on the subject, and try tuned R.F. amplification. After several months of trying out various circuits including single and double stage, regenerative and non-regenerative, I found that a very practical and most efficient receiver could be built which incorporated a single stage of tuned R.F. in conjunction with a regenerative detector. I feel quite satisfied that I am on the right track and thus unhesitatingly say to you "go ahead with this circuit and you will be well satisfied and happier therefor."

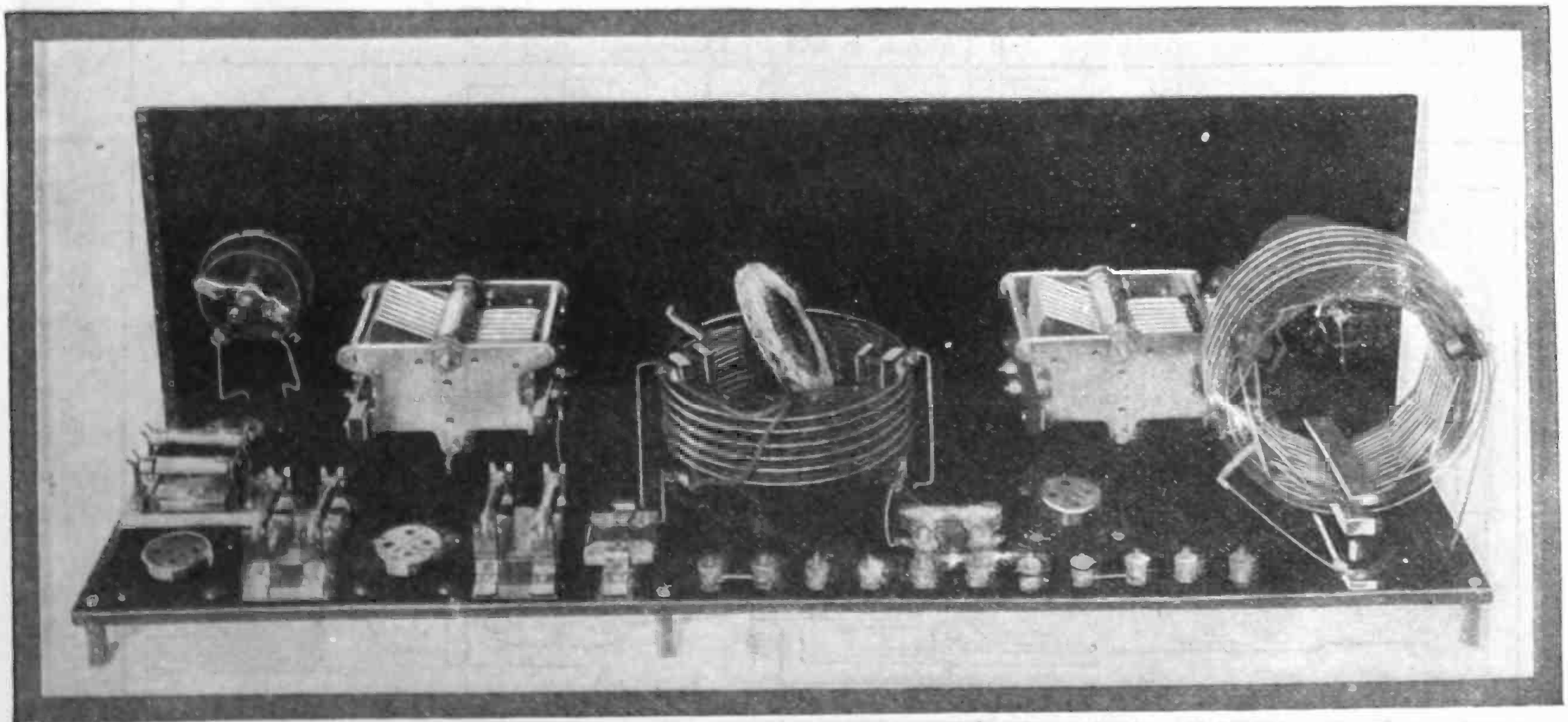

Panel layout of the set using a one stage R. F. amplifier.



Schematic wiring diagram of the tuned radio frequency stage alone.

Look at the photographs and the circuit diagram. You will notice that there is a tube in front of the old coil with a radio frequency transformer in close proximity. This is the R.F. tube which amplifies the signal before it reaches the detector. There are many advocates of more than one stage of this amplification, but the stability of such circuits is still unsatisfactory and until such time as a method of stabilizing has been devised, we shall stick to this.

It is needless to say that the addition of the extra tube and coil makes a remarkable difference in the volume of local signals, but this feature alone


A rear panel view of the three-circuit regenerative set with a single stage of radio frequency amplification added. This set employs resistance-coupled audio amplification.

is not the only good one. It is astounding how much farther out it can reach and how much louder the DX stations are heard. The selectivity is also remarkably increased and this should be inducement enough for any one in larger cities with their barrages of broadcasters.

Now for the description of the set. The R.F. transformer must match the three circuit tuner as nearly as possible so that the condensers can tune in step. The primaries and secondaries should be the same as to size of wire and number of turns. You remember our idea of getting the best parts only. Well then, we still feel the same way about it and shall advise you accordingly.

The Globe R.F. transformer is used in our set as well as the Globe three circuit tuner inasmuch as these instruments are perfectly matched, turn for turn. Note the aperiodic primary. There are several circuits which use an antennae coil coupled directly to the grid of the R.F. tube, and while I admit that the signals in such a circuit are very loud, I also find that the set tunes much broader than the set described here and hence my insistence upon this type of transformer.

A word about condensers at this time would not be amiss. We like straight line frequency condensers and have tried out many and diverse kinds. Those with eccentric plates take up too much room and require continued adjustment of the bearings. We finally hit upon the newest idea in condensers. These are the tapered, semi-circular plate type manufactured by Cardwell. These instruments take up no more room than the old type and are perfectly efficient in every respect.

Note the new sockets. These are the type which take all kinds of tubes except the old 199's. These sockets make a beautiful sub-panel job and with a little care are easily mounted. As to their efficiency, see for yourself how much material has been cut away, all of which added losses. When the tube is inserted in these sockets it is suspended on the contact springs which eliminates all extraneous noises.

Of course transformers for the audio-amplification can be used with sufficient satisfaction. Regardless of what is said as to costs, etc., for quality nothing can beat resistance coupled audio amplifiers. True, it takes 135 volts of "B" battery, but on the other hand, the drain on these batteries is much less than with the old type of amplifier. In the long run, the cost about equals itself inasmuch as with resistances, the batteries do not have to be replaced so frequently. A "C" battery should be used in the last stage only; four and a half volts is sufficient.

The proper tubes for this set depend a great deal upon the amount of money you want to spend. The 201A can be used throughout and are advised for

(*Continued on Page* 175)

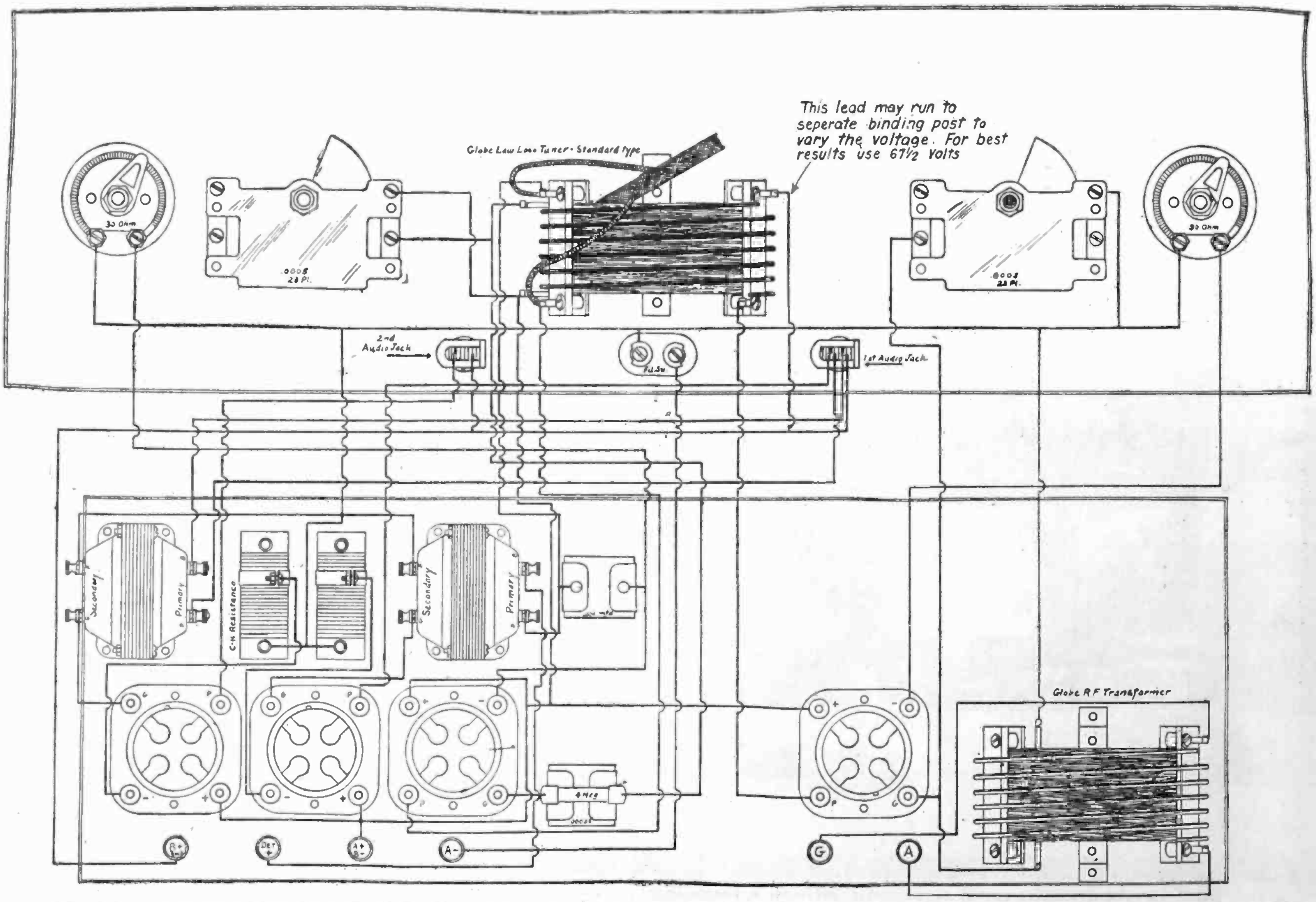
LIST OF PARTS REQUIRED

1 Globe low loss 3-circuit tuner.
1 Globe low loss R.F. transformer.
1 7x24 front panel (Bakelite or hard rubber).
1 7x23 base panel (seasoned wood or Bakelite).
2 .0005 variable condensers (Cardwell preferred) S.L.F.
5 Tube sockets (Standard or Panel mount).
2 30 ohm rheostats.
1 6 ohm rheostat for resistance amplifier tubes.
1 Double circuit jack for detector (if desired).
1 Single circuit jack for output.
1 Resistance unit.
1 .00025 grid condenser with clips.
1 grid leak, about 2 megohms approx.
1 Battery switch.
1 Binding post (if C Battery is used in the R.F. and Audio stages, otherwise use only 7 binding posts. That takes in an extra post for the R.F. amplifier, suitable for changing the voltage on the Radio frequency stage.
Dials, cabinet and tubes as desired.

Should transformers be desired instead of resistances, substitute the following:

Instead of the resistances, get 2 low ratio transformers, about 3 to 1.
Instead of 5 sockets get 4.
Instead of 6 ohm rheostat for amplifier get 2 amperites or Cutler-Hammer resistances, 25 ohms.
1 .001 fixed condenser.

NOTE.—When using wood base board, use the standard sockets.



A four tube layout and wiring diagram of the three-circuit set with R. F. amplifier and standard transformer coupled audio amplification. The two resistances shown in this layout control the audio amplifier tubes.

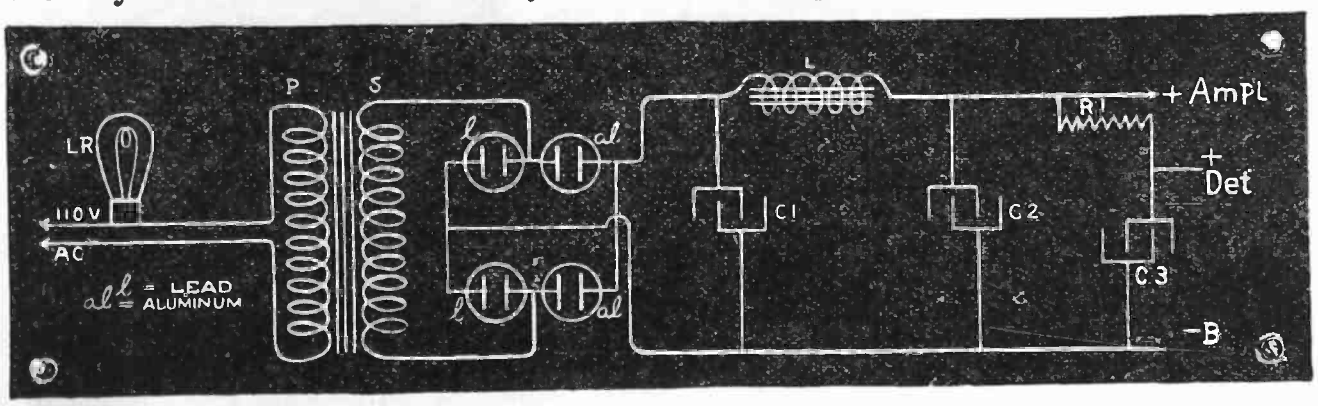
An Easily Built "B" Supply Unit

By C. E. JACOBS

SINCE publishing the article on a "Practical B Battery Eliminator" in the March issue of this magazine, the writer has received a large number of requests for a simpler design which would supply enough voltage for the average five or six tube receiver. To meet this demand details on a B Unit which is not only simple but inexpensive to build, are given herewith. In action this B Unit—provided parts of the right value are used—is second to none and it will give faithful service for a long time without needing any attention. No adjustment is required, once the B Unit has been installed.

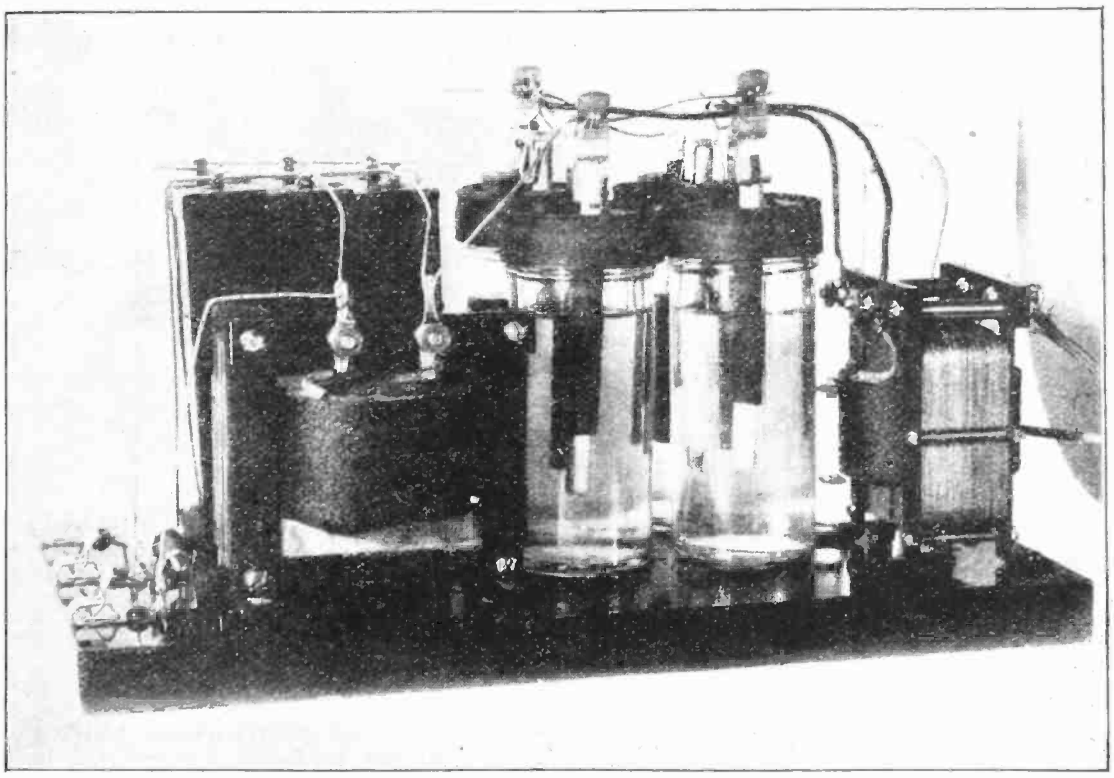
To reiterate, the working principle of a B Supply Unit is very simple. It consists essentially of a transformer—to step up the house line voltage—a rectifier and a filter system. Some designers have shown circuits for B Units without the step-up transformer, but this is not only inefficient, because the regular ground on the receiver must not be used, but it is apt to cause radio tubes to blow, if connected improperly. If a transformer is used, no change will have to be made on the receiver and it is impossible to blow any tubes, even if the B Unit is connected wrong. Besides it is not possible to get 90 volts on some receivers of the five tube variety, if no transformer is used.

Referring to the diagram P and S represent the primary and secondary of the step-up transformer. The output (S) is fed into a bridge circuit of four electrolytic rectifiers of the improved type. This arrangement rectifies both halves of the alternating current wave and leaves but very little hum to be filtered by the choke coil. The electrolytic rectifiers have been chosen in preference over rectifying tubes, which are harder to handle and require constant attention. There is also the item of expense which is much lower with the chemical rectifiers.



Wiring diagram of the "B" supply unit. The filter system employed in this is known as the "brute force type." The inductance of the choke coil L should be very high in order to completely eliminate the A. C. hum and other power noises.

The rectifier used in this Unit is of the type in which aluminum serves as the rectifying anode. This should be as pure as possible, as ordinary aluminum will not work at all or only fair. The constructor is cautioned to select chemically pure metal from houses who are willing to guarantee its purity. The aluminum electrode, as can be seen from the views of the Unit has a rubber sleeve shrunk over it, so only about one inch of the rod is exposed to the solution. This amount has been found to give very smooth rectification and insures long life for the aluminum electrodes. The rubber sleeve also prevents the familiar sparking where the electrode leaves the solution. The cathode material consists of a special graphite compound. This has been found to be superior to lead as the latter corrodes very badly under the influence of the current and lowers the efficiency of the rectifier after some time.



A photo of the completed "B" supply unit. Note that it can be very easily wired as there is no particular need for making a professional wiring job.

The filter system of this B Unit is of the so-called "brute force" type. This type is not only the simplest but also the most practical especially when used after full wave electrolytic rectifiers. The inductance of the choke coil (L) should be very high in order to completely eliminate the AC hum and other disturbing power noises. The choke coil employed in the Unit shown herewith has an inductance of 125 henries at 60 cycle and will take care of frequencies as low as 25 cycles. The input and output of the choke coil are shunted with large filter condensers. The values of these condensers should be at least 2 mf. each. Larger capacities may be used with an improvement in the filtering action, but if a good choke is used, it will be found that 2 mf. are sufficient. The lead from the positive

(*Continued on page* 166)

The Improved Model L-2 Ultradyne

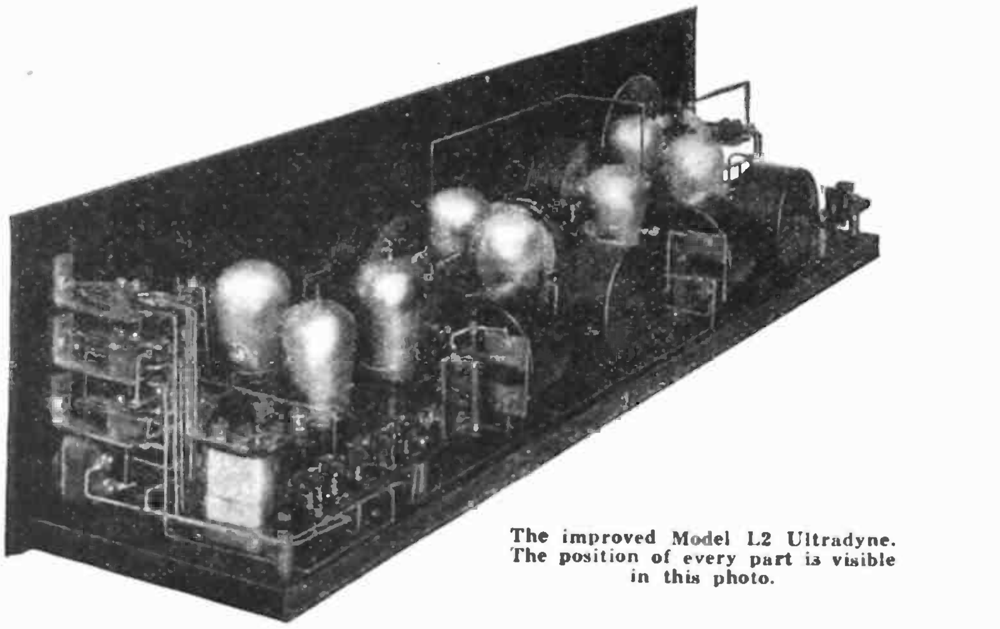
The International Broadcast Test Prize Winning Set

By ARTHUR REED

SUPERS come and Supers go but the Ultradyne marches proudly on. It has, so far, enjoyed two years of unfailing popularity and it certainly seems that it will continue to thrive. Particularly for the reason that it continues to out-perform all other competitors. Dr. J. D. Hullinger of Clinton, Iowa, who won the International Program Test, picked up fourteen foreign stations. Mr. Aaron Whitener of La Grange, Texas, picked up *72* stations in one evening, the furthest being Sydney, Australia, a distance of 9,600 miles! One can aptly say that the Ultradyne is a set that speaks for itself.

The extreme sensitivity of the L-2 Ultradyne is due to a number of factors, all of which have never been incorporated in any other form of Super-Heterodyne receiver. Probably the most interesting feature is the "Modulation System," which is the heart of the circuit. It was developed by R. E. Lacault, a well-known radio engineer. In the usual form of Super-Heterodyne, the first tube is employed as a detector or frequency changer. In the Ultradyne, however, the first tube is placed in a different form of circuit and functions primarily as a modulator. That is to say, aside from changing the frequency of the incoming signal, it impresses the resultant energy on the powerful oscillations produced by the oscillator tube and *modulates* them much in the same manner as carried out in the transmitter of a broadcast station. The process, as can be understood, is a trigger action, i.e., a weak signal is utilized to put a strong, local energy into action, said action being an exact replica of the orginal signal. Thus, considerable amplification is gained before the incoming signal passes to the Intermediate Frequency Amplifier. Further amplification is gained by introducing regeneration in the modulator tube.

The next important feature is the Intermediate Frequency Amplifier. No one seems to know just what form of Intermediate Frequency Amplifying Transformers are actually the most efficient for use in a Super-Heterodyne

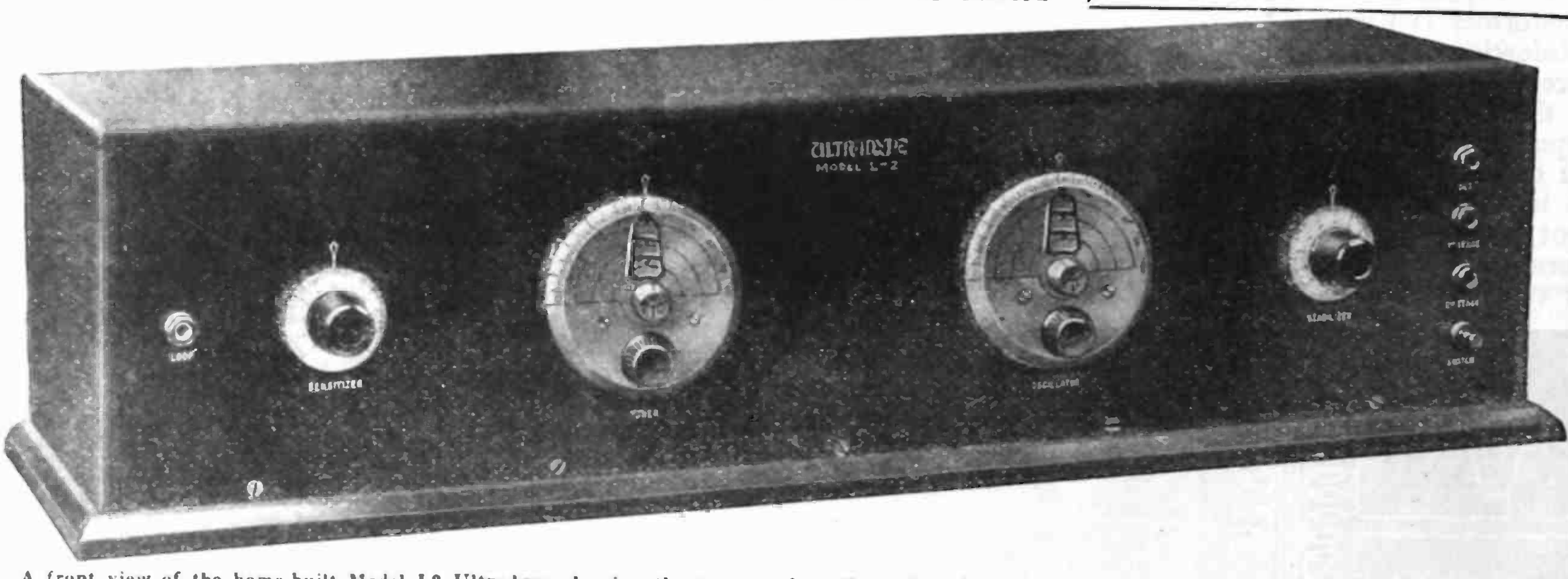


The improved Model L2 Ultradyne. The position of every part is visible in this photo.

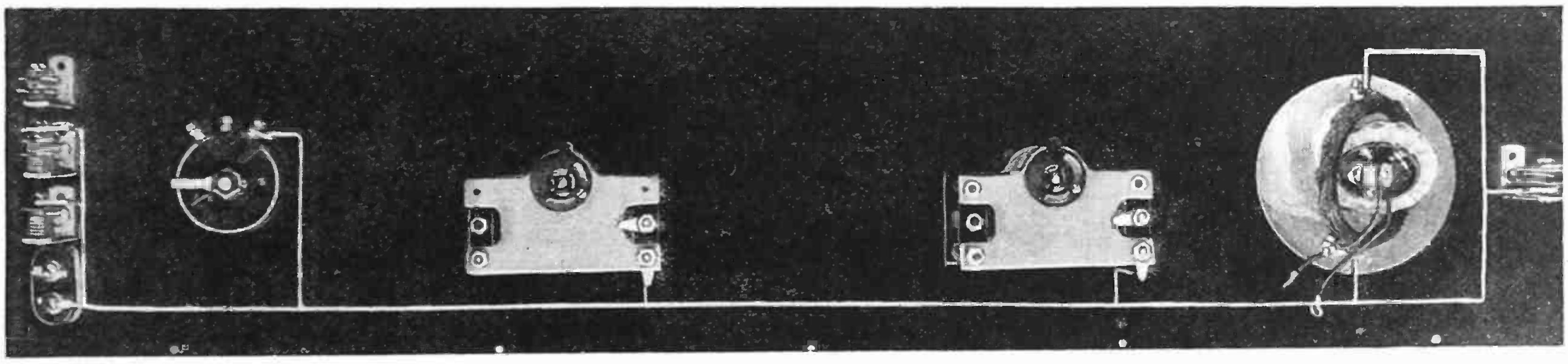
PARTS REQUIRED

1 7"x30" cabinet with baseboard.
1 7"x30" panel.
2 .0005 M.F. low loss variable condensers.
2 vernier knobs and dials.
1 low loss tuning coil.
1 low loss oscillator coil.
1 Ultraformer—type A.
3 Ultraformer—type B.
1 low loss 180 coupler with shield.
1 dial for coupler.
8 vacuum tube sockets.
1 dial for potentiometer.
8 amperites—type A.
2 double circuit jacks.
1 single circuit filament control jack.
1 double circuit filament control jack.
1 "A" battery switch.
2 audio frequency transformers.
1 variable grid leak.
7 binding posts.
2 bakelite binding post mounting strips.
1 .0005 M.F. condenser with grid leak mounting.
4 .00025 M.F. fixed condensers.
2 .001 M.F. fixed condensers.
1 .005 M.F. fixed condensers.
No. 14 tinned copper bus bar wire.
Assortment of screws and nuts.
1 400 ohm potentiometer.

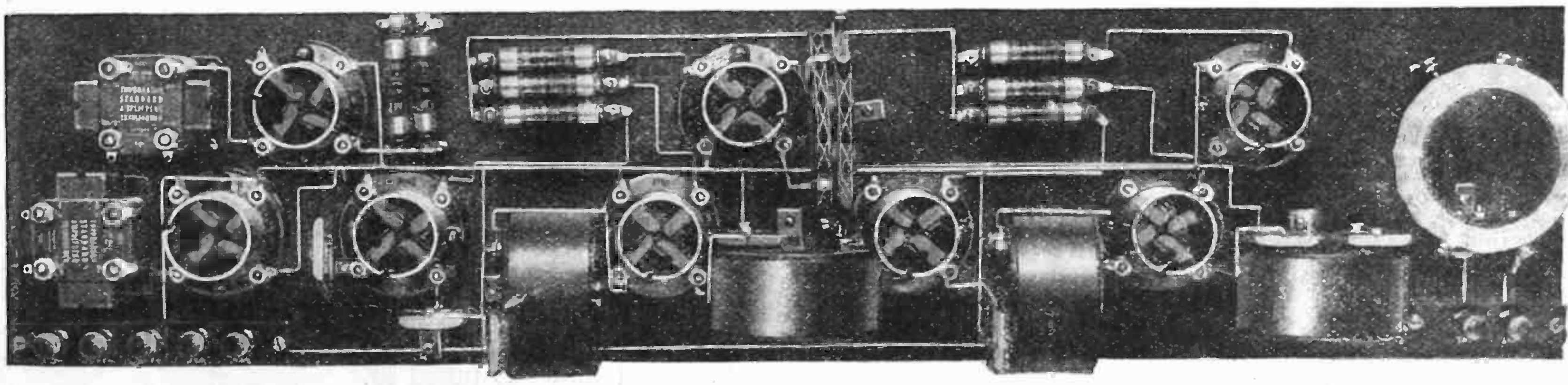
By all means purchase the best of materials. The L-2 Ultradyne is worthy of the best and if full service is to be expected, do not use any inferior parts.



A front view of the home-built Model L2 Ultradyne showing the tuner and oscillator dials in the center. The two smaller dials at each end of the panel are the sensitizer and stabilizer.



This photo shows the arrangement of the parts on the back of the front panel. The wiring as seen here may be done before fixing the panel to the baseboard.



Top view of the baseboard with all the parts mounted thereon. Note the position of the Amperites under the variable condensers.

set. It has been a matter of personal preference more than anything else. Some people swear by the low frequency iron core type, others the low frequency air core type and, it appears, very few the high frequency air core type. It is said that all types have their advantages and disadvantages. But this is not actually true. The iron core type are excessively broad in their frequency characteristics but are excellent amplifiers. Three are usually employed in connection with a tuned filter transformer of the air core type so as to attain some degree of selectivity. The low frequency air core type offer good selectivity, since each transformer can be tuned separately, by the use of condensers, but do not offer the same degree of amplification as the iron core transformers. The high frequency air core transformers, however, are an entirely different matter. For maximum amplification in a Super-Heterodyne circuit, *the Intermediate Frequency Transformers should be tuned to a wavelength ten times that of the wavelength to be received.* Since in broadcast reception we cover wavelengths from approximately 200 to 550 meters we strike a good average at 300 meters. Consequently, the Intermediate Frequency Transformers should be tuned to a wavelength of *3,000 meters,* a high frequency compared to those most commonly employed. The "Ultraformers" used in the L-2 Ultradyne are adjusted to this frequency; the secondary windings of each are shunted by small, matched fixed condensers so that each Ultraformer is tuned. The result is high amplification plus extreme selectivity.

The third radical feature of the Ultradyne is the oscillator circuit. It is quite important that the amplitude of the oscillations produced by the oscillator tube in a Super-Heterodyne circuit remain constant over the entire wavelength range of the receiver. It is also of great importance that the amplitude of the oscillations are not too great. Irregularity of amplitude at different wavelengths spells inconsistent reception. Too great an amplitude results in a decrease of amplification, consequently a decrease in sensitivity and signal strength.

In order to keep away from these difficulties, the very simplest form of oscillator circuit is employed in the Ultradyne and the coupling between the plate and grid coils is just sufficient to maintain oscillation at the highest broadcast wavelength.

Specifications

The accompanying photographs, together with the wiring diagram serve to convey the important layout details of the set.

There are no rheostats. The filaments of all the vacuum tubes are controlled by automatic filament regulating devises (Amperite). Filament control jacks are employed for the stages of audio frequency amplifications so that it is not necessary to play around with one or a couple of rheostats every time you shift. If you are using both stages of audio and wish to shift to the detector, out comes the plug with your own hands and out go the two audio frequency amplifier tubes without saying boo. Likewise, one or both go when the plug is inserted in one or the other jack.

All binding posts have been moved to the rear, where they rightfully belong, for there should be no wires in front or on the side of the receiver but behind where they are out of sight and out of the way. The two variable condensers, of the low loss type, are both of the same capacity, whereas, before, one was twice the capacity of the other. Making them both of a capacity of .0005 mf. provides a more even adjustment than was possible with the original type of Ultradyne.

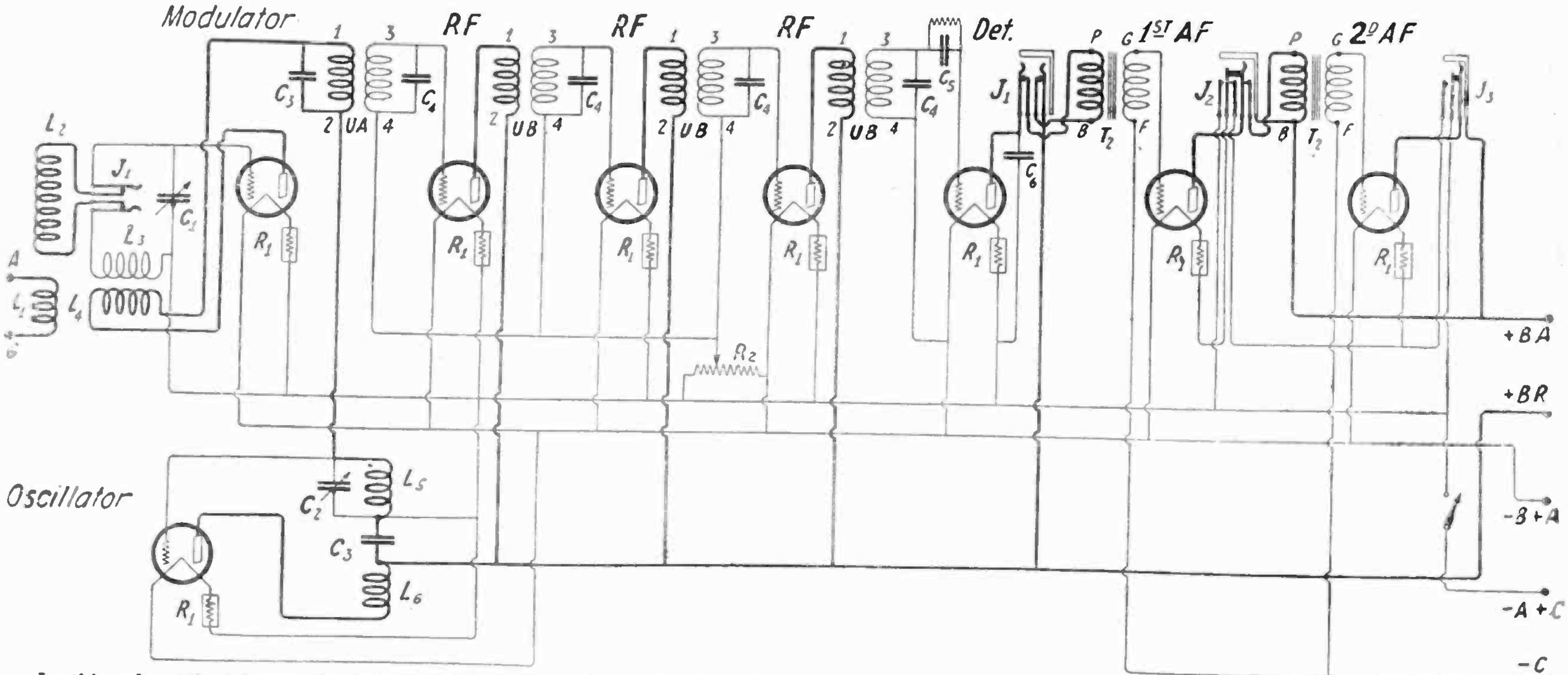
Naturally, the old type single layer cylindrical coils have been replaced by coils of the low loss type. These are the basket weave form and are more compact than the single layer type and decidedly more efficient.

It will be noted from the photo of Fig. 1, that there is a radical change in the position of the controls. Both the tuning dials are situated in the center of panel, really the most convenient positions for them — right where your hands normally rest. The regeneration control and the potentiometer for control are out to either side, being the less important adjusting mediums.

The Layout

The layout is work of art. Though the size of the panel is the same as in the former model, the instruments are not at all crowded and the leads from instrument to instrument are considerably shorter. It is a fact that it is much easier to wire this set than the old one or sets of similar design. A study of the accompanying photographs will assure you of this. The panel layout is shown in the photo on page 138. The loop aerial jack is at the extreme left followed by regeneration control knob, the tuner dial, the oscillator dial and the potentiometer control. The three phone jacks and the "A" battery switch are lined up on the extreme right of the panel.

A view of layout from the rear of the panel is shown herewith as well as that part of the wiring which is completed before the panel is attached to the baseboard. From left to right are: the phone jacks and "A" battery switch, the potentiometer, the 23 plate oscillator condenser, the 23 plate tuning condenser, the regeneration coupler and its copper shield and the loop aerial jack. A photo shows a view of the instruments mounted on the baseboard. The devices similar in appearance to grid leaks are the automatic filament regulators. The oscillator coupler is seen just to the right of the second rear tube socket. The tuning coil is situated to the extreme right of the baseboard. The Ultraformers are seen lined along the front portion of the baseboard, in the photo, though this is actually the rear. The "A," "B" and "C" battery binding posts are all mounted on a single strip of bakelite which is supported by two brass columns, and are at the extreme left of the baseboard, in the photo. The aerial and ground binding posts are mounted in the same manner and are seen to the extreme right.



In this schematic diagram the letters and numbers refer to the following parts: A and G, aerial and ground binding posts; L_1, primary tuning unit; L_2, secondary tuning unit; L_3 and L_4 are the stator and rotor of the sensitizer coupler; C_1, tuning condenser; J_1, double circuit jack; R_1, Amperites, R_2, potentiometer; C_2, oscillator condenser; L_5, grill coil of oscillator; L_6, plate coil of oscillator; C_3, .001 mfd. fixed condenser; C_4, .00025 mfd. fixed condenser; C_5, .0005 mfd. grid condenser.

Assembling the Ultradyne

The first job to be done is the panel drilling and the mounting of the phone jacks, "A" battery switch, the two 23-plate variable condensers, the potentiometer and the coupler and shield. Layout the baseboard next, placing each instrument in its proper position as shown in the photo herewith. The complete circuit diagram is shown above. Wire the instruments mounted on the panel first, then the instruments on the baseboard. Be sure and solder all connections and take your time about it to insure a good job. Be sparing with the soldering flux and use a hot iron. After both the panel and baseboard instruments have been wired, attach the baseboard to the panel and complete the wiring between the instruments on each.

Be sure and check all the connections when you have completed the wiring and as final check up, test each soldered joint with the battery and headphones to insure perfect electrical contact. As a precaution, before operating the set, connect your "A" battery to the "B" battery binding posts and with one tube, test each and every socket to be positive that there is no short between the "B" and "A" battery connection. If the tube lights in any one or all of the sockets, it is proof that the set has either been incorrectly wired, or the "B" battery wires are touching the "A" battery wires at some point.

After all instruments and connections have been tested, insert the tubes in the sockets, connect up the "A," "B" and "C" batteries to the proper binding posts, plug in the loop aerial or attach the aerial and ground and with the phones or loud speaker plugged in, pull the filament switch.

Tuning In

The following is the correct procedure for tuning the Model L-2 Ultradyne:

Turn the oscillator dial one degree at a time and for each setting of this dial turn the tuning dial slowly through its whole range. If nothing is heard at any setting, move the oscillator dial one more degree and repeat the process with the tuning dial. At some point, one should hear a station, and it will be noticed that a slight hissing noise is heard when the station is transmitting, but no speaking or singing into the microphone. This slight hissing noise indicates the presence of a carrier wave and will help materially in tuning in the various broadcast stations. All this tuning should be done with the potentiometer adjusted to a point where no whistles are heard. If whistling noises are present, the potentiometer should be turned towards the positive side until the whistling stops, at which point the amplifier operates at its maximum sensitiveness. When tuning in distant stations, it may be necessary to readjust the potentiometer slightly. This should be done only after the station is heard faintly but clearly enough to increase the amplification. When tuning in very weak signals, the feed back or regenerative coupler should be turned slowly until a point is reached where a whistle is heard, then moved back just below this point. A slight readjustment of the two condensers will then bring the signal to maximum audibility. When tuning in another station, turn the feed back coupler to zero (coils at right angle) and turn first with the two condensers, as explained above, then adjust the coupler once the station is tuned in.

Calibrating the Ultradyne

If the same antenna or loop is used at all times, the Ultradyne may be calibrated and a curve made giving the proper settings of the two condensers for any station. A somewhat similar procedure which will also prove useful is to keep a record of the two dial settings for each station heard. This permits the operator to tune any station which has already been heard by tuning the two condensers to the proper settings.

In Conclusion

It should be pointed out that the regeneration feature incorporated in the new Model L-2 Ultradyne is a form of

(*Continued on page* 163)

Amplification Without Distortion

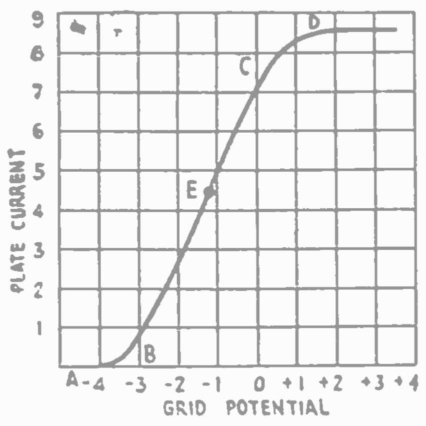
By T. H. NAKKEN

RHEOSTATS—how many uses are ascribed to them? How are they named? How their service is abused!

I have seen them labelled, not as Rheostats, but as Volume control, Distance control, Quality control, Oscillation control! These thin disguising names appear on many good sets. But no manufacturer seems yet to have caught the bright idea of giving the thing its true name, neither does he tell his customer to leave the rheostats alone! And that is what one should do: leave them alone—unless it is absolutely necessary to re-adjust—and then generally it is a sign that the battery is running down and should be recharged or replaced.

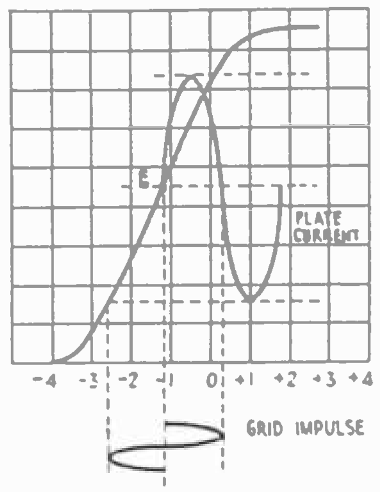
To realize that the rheostat is a distorter in all its ascribed functions, one must take account of its true functions: being a rheostat, a regulator of filament current. And so, to see truly what it should do, we must, as always, consider the vacuum tube and its operating characteristics, and above all in regard to the filament current. So here goes.

The vacuum tube consists of a bulb, in which are mounted a filament, and surrounding this we find a grid and a plate. When the filament is heated, it acts as a source of electrons, which tend to travel towards the plate, to which a positive potential is applied. The number of electrons that can reach the plate under given circumstances depends primarily upon the grid potential, which is governed by the signal impulses directly or after previous amplification by vacuum tubes. How this flow of electrons is governed by the grid is generally graphically represented by the plate current characteristic curve, which is seen in Fig. 1.



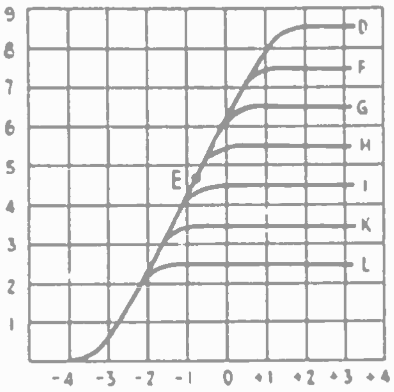
TYPICAL PLATE CHARACTERISTIC. GRID SHOULD BE BIASSED TO WORK AT POINT E

FIG. 1



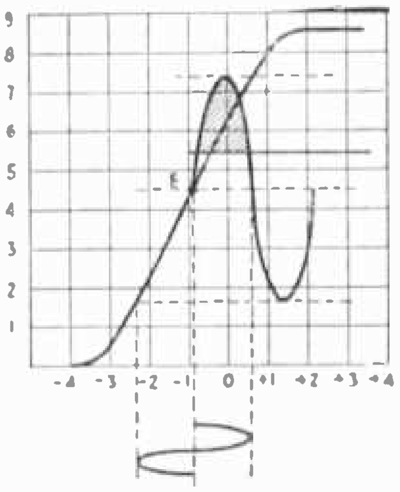
DISTORTIONLESS AMPLIFICATION WHEN THE GRID IS KEPT IN THE MIDST OF THE CHARACTERISTIC. THE PLATE CURRENT IS PROPORTIONAL TO GRID IMPULSES.

FIG. 2



WHAT HAPPENS WHEN THE RHEOSTAT IS TURNED DOWN: THE SATURATION CURRENT DECREASES GRADUALLY RESP. D, F, G, H, I, K, L.

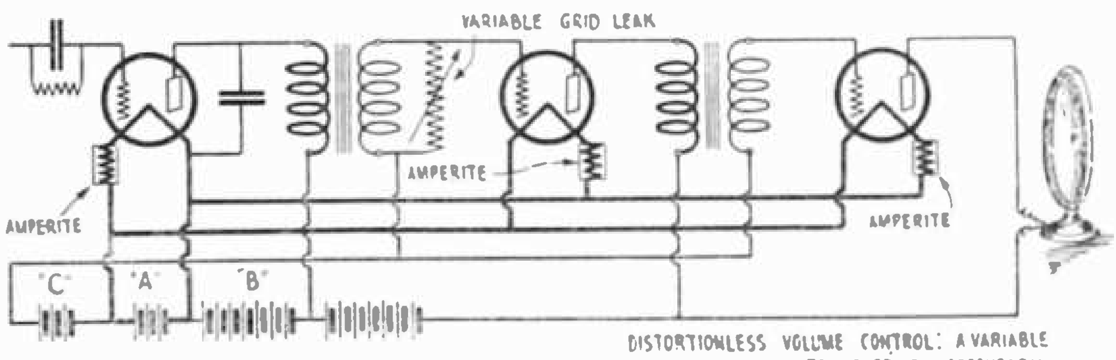
FIG. 3



HOW RHEOSTAT VOLUME CONTROL SPOILS QUALITY: THE SHADED PART OF TRUE AMPLIFICATION DISAPPEARS: DISTORTION.

FIG. 4

It will be seen at point D, that this curve flattens out—that a further increase in positive voltage does not increase the plate current any more—no—even worse: when the grid is made excessively positive, and draws a considerable current itself, the amount of plate current decreases. This comes because the plate current has reached its maximum value: that value, at which all electrons emitted from the filament are absorbed: the top of the curve is the so-called saturating current. We can then only increase the plate current by a higher filament temperature: and this, as we all know, foreshortens the life of such filaments, destroys the emission. The filament current should not be raised, so that the filament cannot reach a higher temperature than it is designed for.



DISTORTIONLESS VOLUME CONTROL: A VARIABLE GRID LEAK ACROSS TRANSFORMER SECONDARY

FIG. 5

Now, obviously, we try to operate the tubes at all times in a manner, that the grid-potential is held at such value as to make the tube work in the center of the characteristic. Under these circumstances an upward swing of the grid potential results in just as large an increase in plate current as the same downswing of the grid decreases the current. This is shown in Fig. 2.

When now we vary the filament current downward by means of the filament rheostat, we will obviously not change anything but the temperature of the filament and therefore its emission: We will have less electrons available and thus we limit the plate current. This is seen in Fig. 3, where it is seen that the saturation current has dropped, leaving all other things unchanged.

In Fig. 4 we have again put the signal as in Fig 2—and can see now at once why the rheostat acts as a volume control: the upward swing of the grid becomes less and less effective, because the plate current increase that should result, is impossible, because the plate current reaches saturation value. Whenever such a thing happens, there is distortion, as can be seen at once.

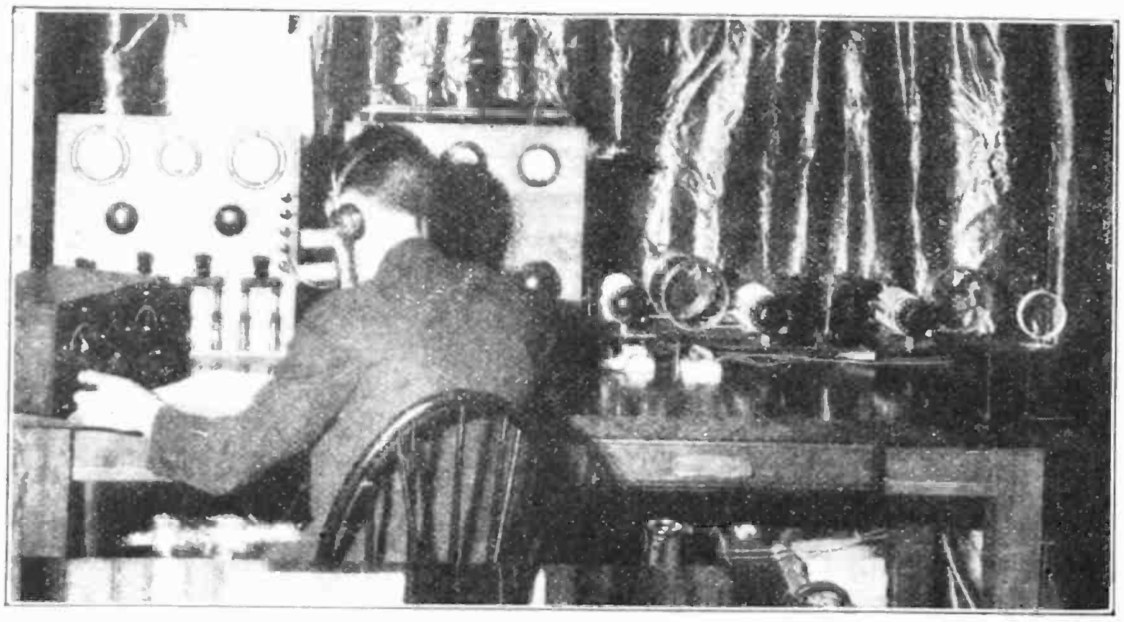
It will be clear, that this is true for all uses to which the rheostat under all its highsounding titles is put. As a volume control it cuts the peaks off the

(Continued on page 174)

A Simplified and Efficient Low Power Transmitting Set

By BERT E. SMITH

AT the recent Radio Show which was given in connection with the Convention of the Second District Executive Radio Council, there was one transmitter which had the double distinction of being the only outfit able to actually move traffic out of the Hotel Pennsylvania, in which the show was held, and of moving a record amount of traffic in the time it was on the air.



This photo shows the operating room of station 2QA with the transmitter as described herewith on the table.

This is particularly notable when it is known that the set in question used at 2QA was designed, built, and put in operation between noon Saturday and noon Sunday, while other sets which had expected to handle regular traffic from the Convention and failed, were veterans of some standing in the amateur world, and on whose design and construction a great deal of care had been lavished.

In order to explain why so much haste was used, a short diversion is necessary. It was originally intended to use a 100 Watt Hartley Oscillator at 2QA with a plate supply of rectified, filtered A. C. Preliminary tests, however, indicated that the plate supply might be deficient when finally set up, as during the experimental work the plate voltage dropped seriously whenever the key was pressed, and it was decided to build a low power set which could be operated on batteries for emergency service.

Considerable interest had been aroused by the Tuned Plate Tuned Grid Sets built by Messrs. Heintz & Kohlmoos, and described in November Q. S. T. and September and March issues of Radio. These magazines were accordingly dug out and a bread board lay-out made up employing a UX-210 Tube. After playing with it, some variations were found to be desirable in order to secure proper operation on one tube. In place of the small blocking condensers employed, .002 mfds. gave a much better result. The key was inserted in series with the gridleak after considerable experimentation, as there was much less trouble from key clicks when used this way.

The Roberts Battery Company of Brooklyn, very kindly volunteered to supply their storage batteries for the plate supply, and a Radio Corporation filament transformer was employed to light the filaments.

When it was finally operating to the complete satisfaction of the builders, it was reconstructed on a Bakelite panel, and after a short further test was packed and sent to the Hotel Pennsylvania along with the big set.

When the Convention opened Monday morning, the Roberts B Batteries had not yet arrived, and the big set was hooked up in the hopes that possibly it might work sufficiently well with a reduced input. As soon as the receiver was turned on, however, trouble was encountered, the QRN was terrific. In the Grebe booth across the aisle a Neon sign blazed merrily, and in the receivers it sounded like a miniature Klaxon horn. Countless elevators, motors and other electrical appurtenances around the building united in the earphones to produce a hideous cacaphony which threatened to make reception an absolute impossibility. WIZ was finally heard about R4, but could not be copied through the interference. Another stage of Audio was hooked on in the hope that even though it amplified the QRN more than the signal, we might be able to get something.

After the operators ears became somewhat used to the growls which were coming from the receiver, however, two or three stations were heard, and finally transmission was undertaken. CQ after CQ was sent out, but apparently we could CQ till we got sore arms without any result, and finally on Monday night we gave it up as a bad job, somewhat heartened, however, by the fact even though we had failed, so had every other transmitter in the place.

On Tuesday morning we had four 100 volt storage B Batteries, thanks to the Roberts Battery people, and three of them were promptly hooked up to the low power set. A few minutes sufficed to get it tuned, and once more the "Cans" were put on. WIZ continued to be the only station strong enough to copy, but finally the sign across the aisle stopped and several stations were heard. The switch was thrown and our first call was promptly answered—a 3 in Maryland reporting us R8, and from that time on throughout the whole show 2QA continued to move traffic, most of it however, being given to 2CCL, the station of NYU located at Washington Square, who very kindly co-operated with us by standing by at frequent intervals during the next three days, and almost continually Friday and Saturday. After making this contact no further DX was attempted, as it was practically impossible to hear anyone except very close-by stations, and after all our main job was to handle traffic.

The other stations at the show closed down entirely after the second day with the exception of 2ZV who operated by remote control to Richmond Hill where their transmitter was located.

The set was built in two units and requires very little description outside of the photos. It was made in two units, one being the oscillator proper, and the other the Antenna coupling unit. On a bakelite Panel 10"x24" two Cardwell Type 147B Transmitting Condensers were mounted ten inches apart. Between them a socket is placed as shown in the photograph, with the plate and grid connections towards the front. The choke coils were mounted on tips and arranged to plug into tip jacks in the base. The Inductances of edge-wise wound copper strip were mounted on the condensers by means of 2½" mounting pillars.

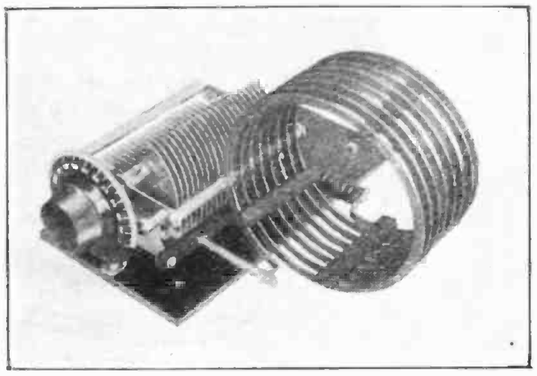
Both antenna and oscillator units were mounted on 2" mounting pillars placed at the corners to keep them up off the base.

The construction of the capacity-inductance units can be shown from the picture of the antenna unit which is on a larger scale than the others. Each coil is supported by three pieces of Bakelite ⅜ of an inch square in which slots had been sawed ⅜ of an inch apart with an ordinary hack saw. Possibly a trifle better result could be secured by glass spacers, but the difference would be very small.

LIST OF PARTS

- 10"x26"x⅜ Bakelite panel, drilled.
- 12"x 5"x⅜ Bakelite panel, drilled.
  Good dry wood soaked in Paraffin will be much cheaper and almost as good.
- 3 Cardwell condensers, type 147 B.
- 20 Turns 5¼" outside diameter edge-wise wound copper ribbon (C).
- 2 R.F. chokes, Type 198, complete with tips and tip jacks.
- 16 Cardwell mounting pillars 4616.
- 6' copper ribbon, 1/16"x¼" (C).
- 1 Milliameter, scale 0-250 milliamps.
- 1 Jewel ammeter, scale 0-2½.
- 7 Binding posts.
- 2 Dubilier micadons, type 580, capacity .002 mfds.
- 2 Dubilier micadons, type 601, capacity .002 mfds.
- 1 Lavite gridleak, 5000.

If no wave meter is available, the Antenna unit can be taken to some point where there is a wave meter, and with a Galvanometer or Neon Tube to close the circuit, can be calibrated and used to tune the set, then the meter removed and the Antenna and counterpoise hooked on using the unit for its original purpose.

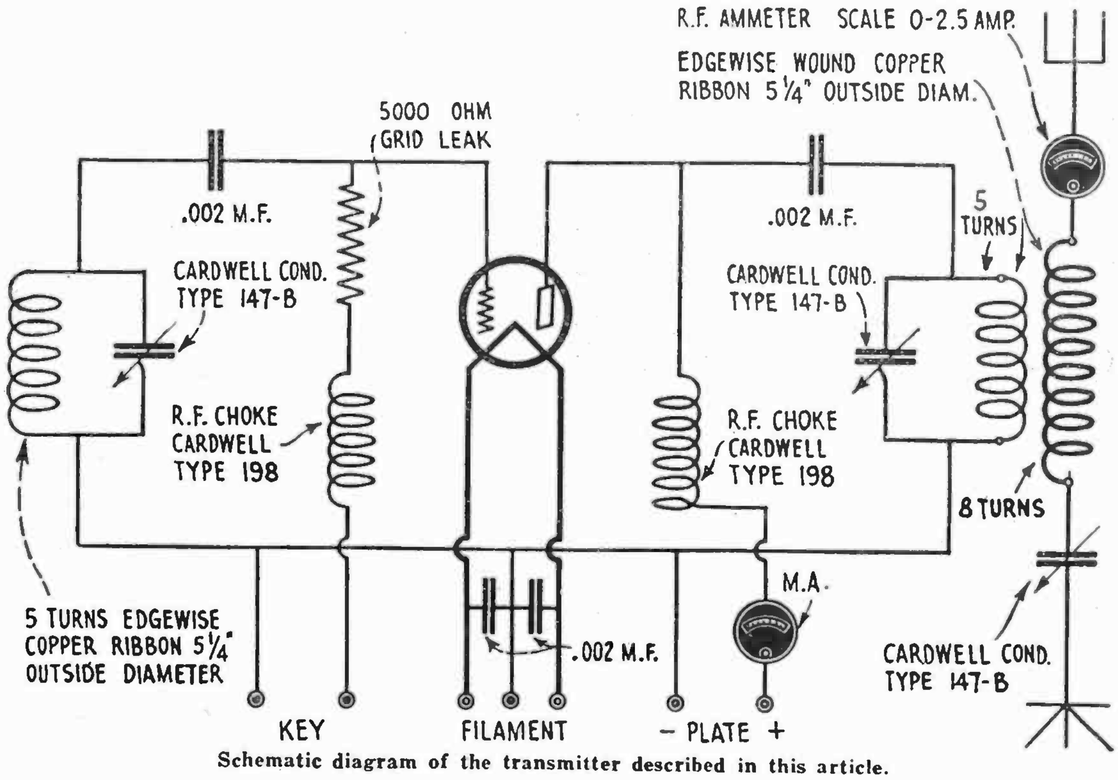


The construction of the capacity-inductance units is plainly shown in this illustration.

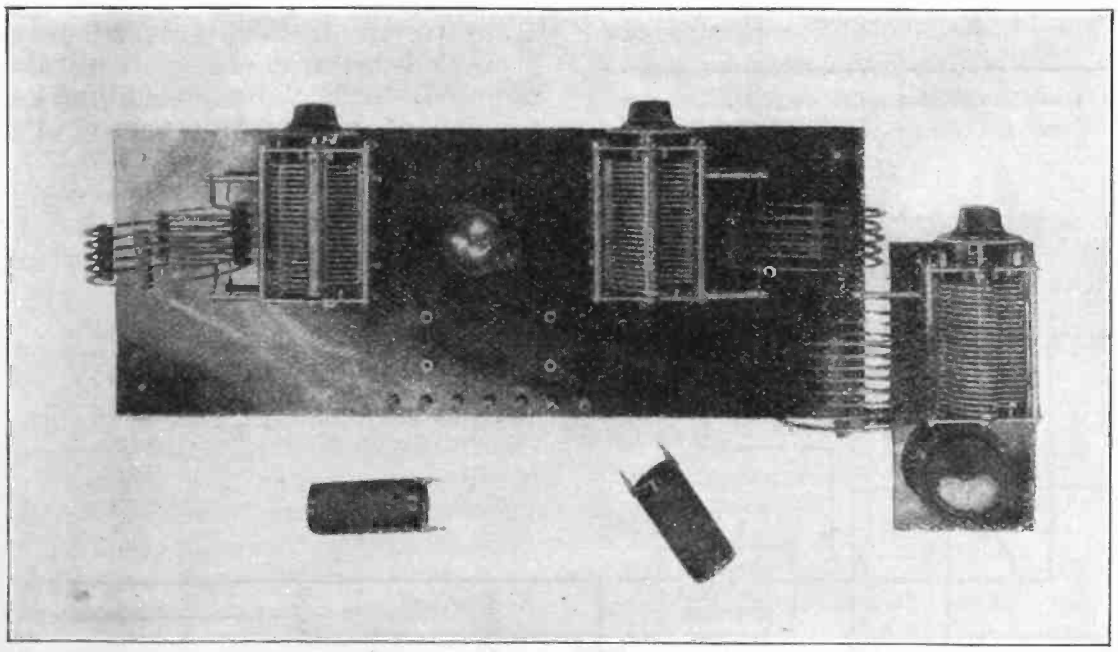
The set is very simple of operation. The grid and plate circuits are tuned to a point where with the key up, a milliameter in the plate lead shows either no current or a very small current, at which point the grid and plate circuits are in resonance. At this point depression of the key should result in a large plate current. For 40 meters this should take place at about 23 on the dials of the grid and plate condensers, and for 80 meters with both condensers about 96.

The antenna is tuned in the usual manner to the point where the maximum resonance is indicated by the radiation ammeter, but best results will probably be secured if it is then detuned slightly.

Using a UX-210 Tube with 300 Volts on the plate the set drew about 80 mils, and under operation of eight to ten hours per day the Roberts storage batteries were still going strong, showing only an eight or ten volt drop at the end of the week, and in view of their low cost and the frequent trouble with rectifiers and filters for a set using this amount of power, storage batteries seem decidedly the thing for plate supply.



Schematic diagram of the transmitter described in this article.



Layout of the transmitter, showing capacity-inductance units, tube, choke coils, etc.

Every unit in the set was constructed with the thought of easy conversion to a 50 watt outfit and nothing will blow if a tube of this size is used. The variable condensers have a breakdown point which will handle anything a 50 watt tube will put out, and the fixed condensers that were used, Dubilier type 577A, have a rated voltage breakdown of 2000, and in experimental work have withstood for several hours a voltage of about 2500. When a gridleak of the size shown is used, however, care must be taken not to

(*Continued on page* 161)

Construction of a "B" Supply Outfit

By M. H. LEITCH

THE design of a "B" Supply Outfit is described here after considerable experimenting with the various tubes that are on the market for rectifying purposes.

The use of a receiving tube, such as a 201-A for rectifying purposes has shown good results on small sets only. The small power used is easy to filter and obtain perfect results, but a "B" Supply outfit using this tube is recommended only for receiving sets of three tubes or less. Most of the other tubes designed to pass 50 milliamperes will give a good voltage reading on open circuit, but if the load of a five tube receiving set is applied the voltage drops far below the point considered good for correct reproduction of tone. It is not advisable to use a meter to check up your "B" Supply voltages for the above reason, and the fact that most meters will draw too great a portion of the available current to get a correct reading.

To construct the best "B" Supply Outfit which can be used with any size receiving set, full wave rectification is necessary with large reserve power. This can be obtained by the use of a R C A UX-213, or the Cunningham CX-313 Tube. The liberal proportion of this tube reduces the cost of this outfit by making the tube do some of the work which would otherwise be required to be done by an expensive filter system. This does not mean that a poor filter system may be employed. The use also of a double filter system, or condenser capacities as high as 8 and 12 microfarad is not necessary for good rectification with such tubes.

High test filter condensers are one of the necessary parts for this "B" Supply Outfit. By-Pass Condensers were not made for filter service and will not stand the strain of high voltage. Dubilier Filter, or Tobe Condensers have been used successfully.

The Transformer consists of three windings for 110 Volt—60 Cycle A. C. Line—the primary, secondary and filament windings. It has a metal case which is grounded to the core, and the minus B lead. The posts are neatly marked and it it supplied with a cord and plug, ready to attach to the houselighting socket. Both filament and secondary windings have center taps. It is known as Type 213. The choke Type C-2 is of 30 Henries Inductance. The case and core are electrically connected and brought out to a separate terminal. This terminal is grounded by connecting it to the minus B lead. The grounding arrangement allows the use of the choke in the positive lead.

(*Continued on page* 146)

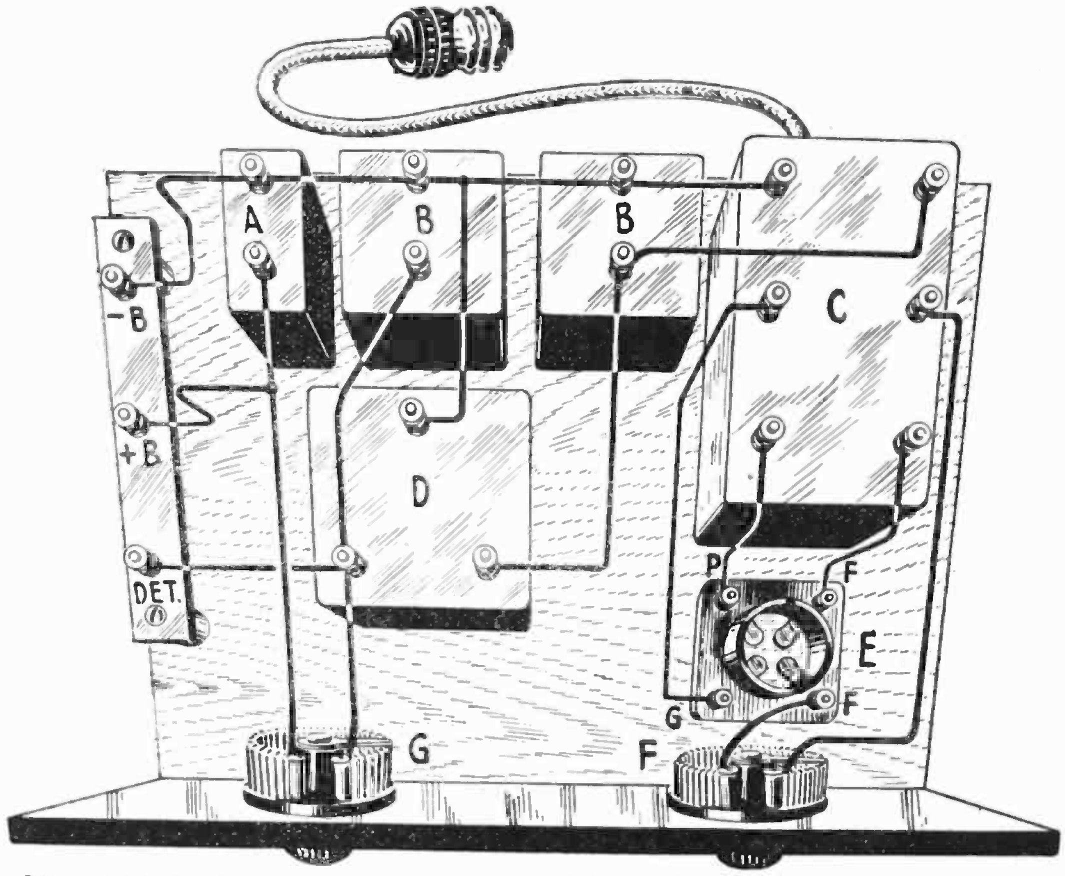


Diagram No. 1. A layout wiring diagram of the "B" supply unit showing how the parts can be arranged on a panel and baseboard.

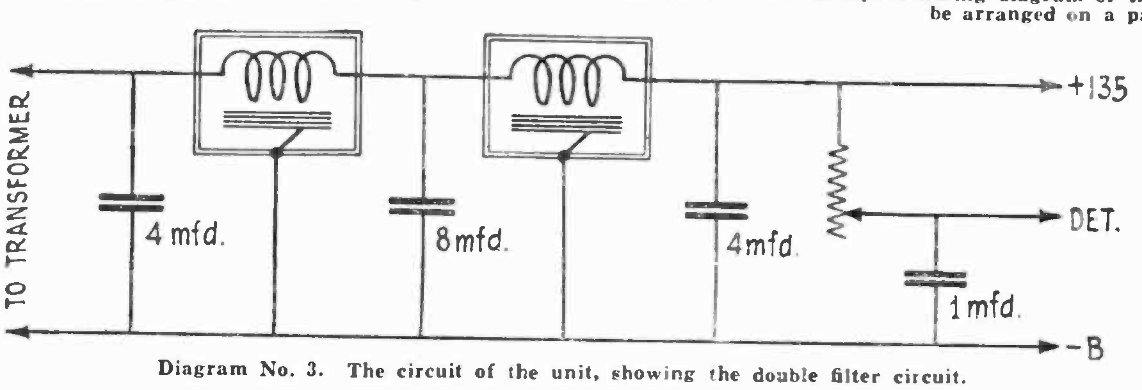


Diagram No. 3. The circuit of the unit, showing the double filter circuit.

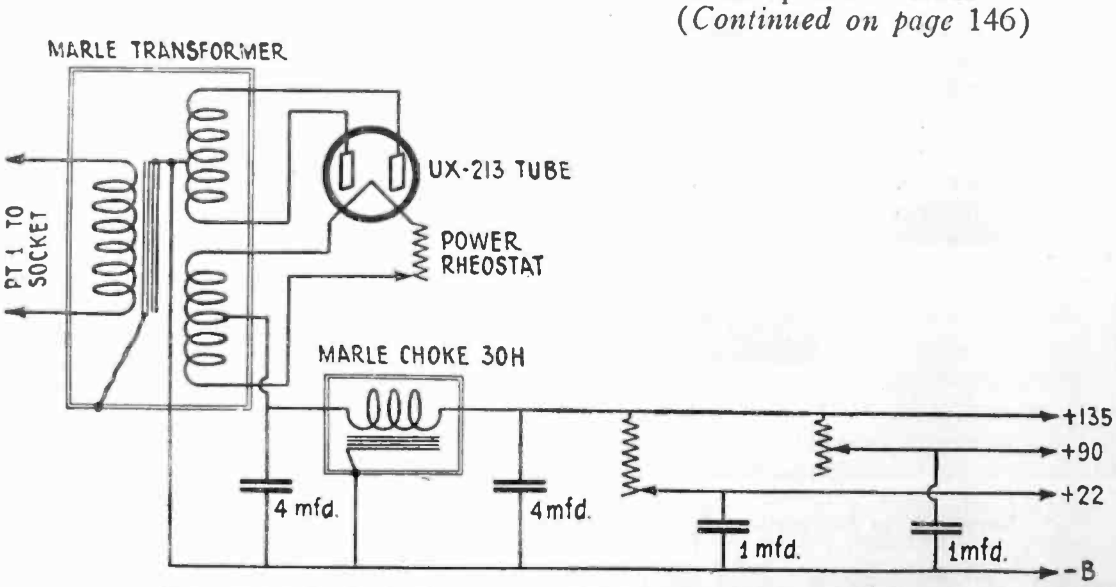


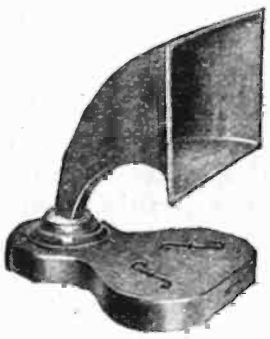
Diagram No. 2. Illustrating how the three B+ voltage taps are obtained.

Loud Speakers, Past, Present and Future

By L. M. WILLEY

LET us for the moment turn to history and there we find the original of the present day fiddle as an instrument called the Ravanastron, having been invented by one Ravana, then King of Ceylon, some 5000 years ago. It was made of a cylinder of sycamore hollowed out from one end to the other.

It is probable that musical instruments originated in Hindustan for Sanscrit scholars inform us that there are names for the bow which cannot be less than 1500 to 2000 years old. These names are Kôna, Gârikâ, and Parvàdas. It is almost identical with



The first model loud speaker of this type.

the Chinese fiddle of to-day called the Ur-heen and, coming a step westward, the Turkish and Arabian Kemangeh a'gouz. The literal translation from the Persian means: Kemangeh—"place of the bow" and a'gouz means "ancient."

Ash-Shakandi in the year 1200 mentions the Rebab as having been in use in Spain for centuries without having been thought worthy of notice on account of its rudeness.

There is still another branch of musical instruments to which we probably owe a part in the present day violin. It is the Welsh "Crwth." Its origin was probably about B. C. 1700, shown among the records of ancient Egyptians and is a form of primitive Lyre.

Without giving details we come to the year B. C. 700 at which time the Greeks and Romans had a Lyre of wonderful beauty. They were of many sorts and sizes and some had bridges.

The word Crwth in the ancient Saxon signifies, "Any bulging cavity."

To these two instruments we probably owe our present day violin, which assumed its present form about the 16th century—and from then on it has not materially changed in shape, construction or material.

Each of the masters made their instruments with certain individualism such as the "ff" holes, thickness from back to belly, base bar etc., but its general shape and construction has not changed in over 500 years. It cannot be improved upon although many patents have been granted on changes and additions but they soon died out after trials as not adding anything to the value or performance.

They were made of many woods, the best being deal, pear wood, poplar and maple.

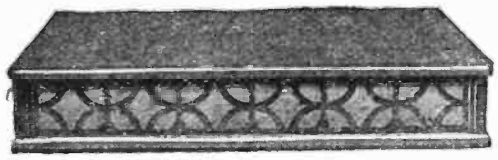
Every other present day musical instrument has gone through a long series of improvement but do you know of any improvement on the violin? The violin, called as it justly is, "the King of instruments" is perhaps the only human contrivance, which, taken as a whole, may be pronounced to be perfect.

Let us look at the "ensemble" of a violin. What is it? It is a hollow box form 13 to 14 inches long, at the widest part, 8½" and the narrowest part 4½" broad, about 2½" deep and weighs about 8½ ounces. This exquisite instrument, standing apart, in its mysterious simplicity from the vulgar herd of instruments of melody and harmony, is capable of expressing more by its unaided voice than all the rest put together and when this has been said, are we not justified in ascribing to it the attribute of perfection?

The violin has been made of many other materials than wood. A list is given below:

Earthenware: Its performance was described as "neither powerful nor pleasant."

Metals: (Copper, brass and silver) The metallic tone can plainly be imagined. A silver violin has been on display in a window in Green St., Leicester Square, London, longer than any living man can remember.



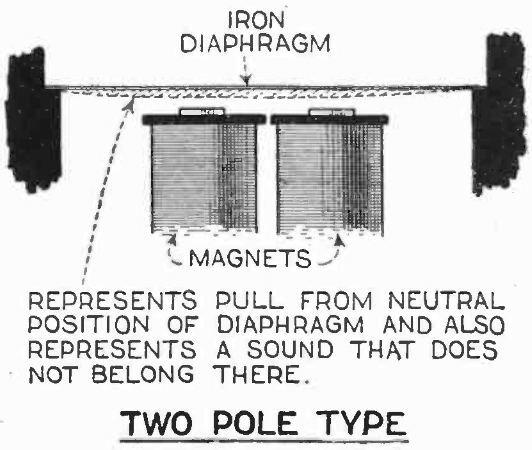
The luter model.

Leather and papier mache: The latter described as "hideous and ghastly."

Of shapes, there have been many, only to die as soon as born.

When we analyze a violin from the hands of the masters, Stradivari and Amati, we find they were made of a soft pine of even grain from Switzerland cut at certain times of the year and given a special treatment of seasoning. The maple in them was from the Carpathians. The wood was all cut to give certain grains and of different thickness to give certain resonance. This little journey into the history of violin making leads us to make the assertion that the ultimate loud speaker will closely resemble the violin in its reproduction of sound.

So much for the instrument itself at this time. Let us go to the definition of "Music and Acoustics." A sound having such regularity of vibration as to impress the ear with its individual character, as especially as regards pitch, and to enter into harmonic relations viz. musical sounds as opposed to noise. A tone is characterized by its



The two pole type unit.

pitch (rate of vibration), its force (amplitude of vibration) and its timbre (complexity of vibration). A simple tone is one resulting from a single vibration at a fixed rate. Its pitch is definite, therefore although its force may vary, it can hardly be said to have timbre. But nearly all musical sounds are complex or compound, that is, composed of two or more simple tones. These components are called partial tones, of which the lowest, which predominates and determines the pitch, is called the fundamental tone or fundamental and the others, upper partials, or overtones. The peculiar quality or timbre of a tone (also called tone color or clang tint) is due to the number, vibration rates and intensities of its overtones, and *varies with the nature of the vibrating body and the mode of excitation.* Overtones, which are in the harmonic series of the fundamental (that is having vibration numbers equal to 2, 3, 4, 5, etc., times that of the fundamental), are called harmonics. The tone of a tuning fork is nearly simple, that of a well-constructed musical instrument has harmonics chiefly for its overtones while inharmonic overtones are usually prominent in the tone of a bell.

Note particularly the reference made to "a well constructed musical instrument having harmonics chiefly for its overtones."

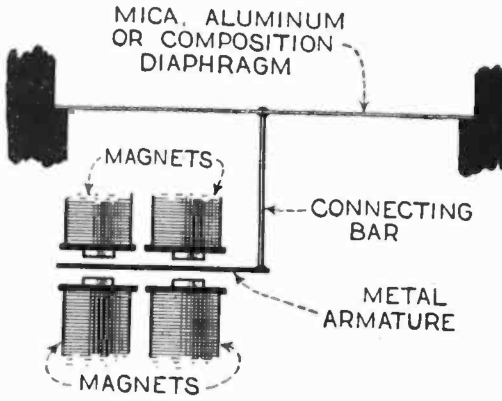
In the production of a loud speaker there are three important features to take into consideration, the unit, the horn or amplifying method and the material.

As regards the unit, there are two common types. A double pole and the four pole. Speakers such as the Timbretone discard the former type for the four pole which permits the armature to be balanced or held in a neutral position between the pole pieces. This cannot be done in the two pole unit as there is always a "pull" on the diaphragm, which the incoming signal must first overcome before the diaphragm assumes a neutral position to begin its construction of the tone vibration. The diaphragm is an important part of the unit. Many patents have been issued on various shapes and materials but most have died a natural death except the mica and metal diaphragms. In the use of the two pole units, iron forms the armature of the magnet and is also the diaphragm. Mica and aluminum are the common type diaphragms used on four pole units. Certain speakers use composition which does not give off any sound of itself and is resilient enough to "snap" back to the neutral position of its own accord. Shape, diameter and thickness must combine to produce the actual tone.

It is of the utmost importance that the horn be made to carry the output of the unit with fidelity. The small opening must conform to the diaphragms resultant and the length must be of a size to give volume without lowering the register. Of the many shapes tried, the straight sided rectangular form produced the best results. A round horn seems to give off a "barrel" tone, probably, because of a dead center or whorl. The phonograph manufacturers discarded the long horn twenty years ago and yet, this style has been adopted for a speaker horn by some manufacturers, probably from a commercial reason.

With regards to material, history tells us that wood has not been improved upon in over 5000 years as a material for tone reproduction. Would you think of enjoying a concert by Kreisler if the performance was given on a rubber, composition or metal violin? The horn must render an "ensemble" of tones without addition or subtraction of its own inherent qualities. Metals have a "ring" of their own, while compositions absorb or detract. Wood gives a resonance and quality unequalled.

If we follow the path of a broadcasted tone we start with a piano tone, for example; the microphone picks it up and the set receives it. On the head set this sounds almost perfect yet when it comes from the horn where does the distortion take place? Assuming, for instance, each unit up to and including the set has done its part faithfully, then the speaker must be faithful. Each of the component parts must reveal the care in its manufacture and the reason for its choice.



FOUR POLE TYPE
(ARMATURE BALANCED)

Note this type of unit and compare it with the operating principle of the two pole type.

A more thorough understanding among the radio public will result in a benefit to all interests. The inefficient speakers will die out, for their only attraction is price. At their best, they are a result of quantity production methods and cannot have the care or research that is so much a part of the "Quality" speakers.

Let us state an example of a usual evening's program. We are listening to an orchestra with an opera performance. There are twenty musicians and several singers—possibly the organ is a part of the musical score. Each of the voices range from 200 to 1024 vibrations, per second and are of course, distinctly separate as are the instruments accompanying them. The violin ranges from 198 to 3072 vibrations, the French horn, 100 to 900; the piano 32 to 4096 and the organ, 32 to 16,384, not to mention other instruments. At a simultaneous instant each voice and instrument hits its own respective tone and the diaphragm in the unit of a loud speaker must record the sum total of all parts with no distortion. It is really doing the "impossible."

Just a word in closing on the relative merits of the cone speaker versus the horn. Of the two, it is probable the horn comes nearer to fidelity of reproduction because the smaller diaphragm holds to the truer register. The cone, on account of its size gives better tone quality on low tones, which are slow moving tones but with the higher vibrations would naturally be sluggish.

(*Continued on page* 176)

Construction of a "B" Supply Outfit

(*Continued from page* 144)

Diagram 1 clearly shows the method used.

The list material required is:

A. 1—1 Microfarad filter type condenser (Tobe).
B. 2—4 Microfarad filter type condensers (Tobe).
C. 1—Three winding transformer center tap (Marle type "13").
D. 1—30 Henry choke—core grounded (Marle type C-2).
E. 1—UX Socket.
F. 1—Resistance (Clarostat).
G. 1—Power Rheostat 2 amp. capacity.

After the outfit is completed, at first a slight hum may be detected. This may be easily removed by a slight adjustment of the resistance and rheostat. Keep in mind, however, when making the adjustments that lowering the detector voltage, increases the amplifier voltage and reducing the brilliancy of the tube, reduces both voltages. There is a general impression that a slight hum in the loud speaker is not objectionable, however, this hum distorts some of the weaker notes and should be removed.

Some receiving sets require that the minus B battery lead be grounded. If this is necessary, examine your receiving set to make sure that one of the battery leads is not already grounded. If it is already grounded, an additional ground cannot be made. When grounding your receiver, try the ground at different places until the most effective point is found.

Additional taps for Radio Frequency Tubes may be obtained by adding another resistance and a 1 microfarad condenser. Diagram No. 2 shows the usual method of wiring.

Always when using your "B" Outfit, turn the radio on first. This will avoid giving a sudden shock to the receiving tubes, due to the condensers building up a high voltage. Also turn the "B" Outfit off first when the receiver is to be discontinued. Do not turn the rectifier tube off by using the rheostat as this will not turn off the current going to the transformer. Use the light socket to switch on and off.

Difficult locations have been troubled by a hum with some of the best "B" Outfits. If a complete outfit is purchased, it is not easily remedied. The builder of his own B outfit if annoyed by a slight hum, can arrange to add condensers or chokes and increase the efficiency of his filter circuit. A circuit of this kind, is herein shown.

Do not use the "B" Supply too near the receiver and arrange to mount it on a cushion if possible.

The New Acme Five-Tube Reflex

A Reflex Receiver Using a UV-200 Tube Detector and a B-Eliminator Set

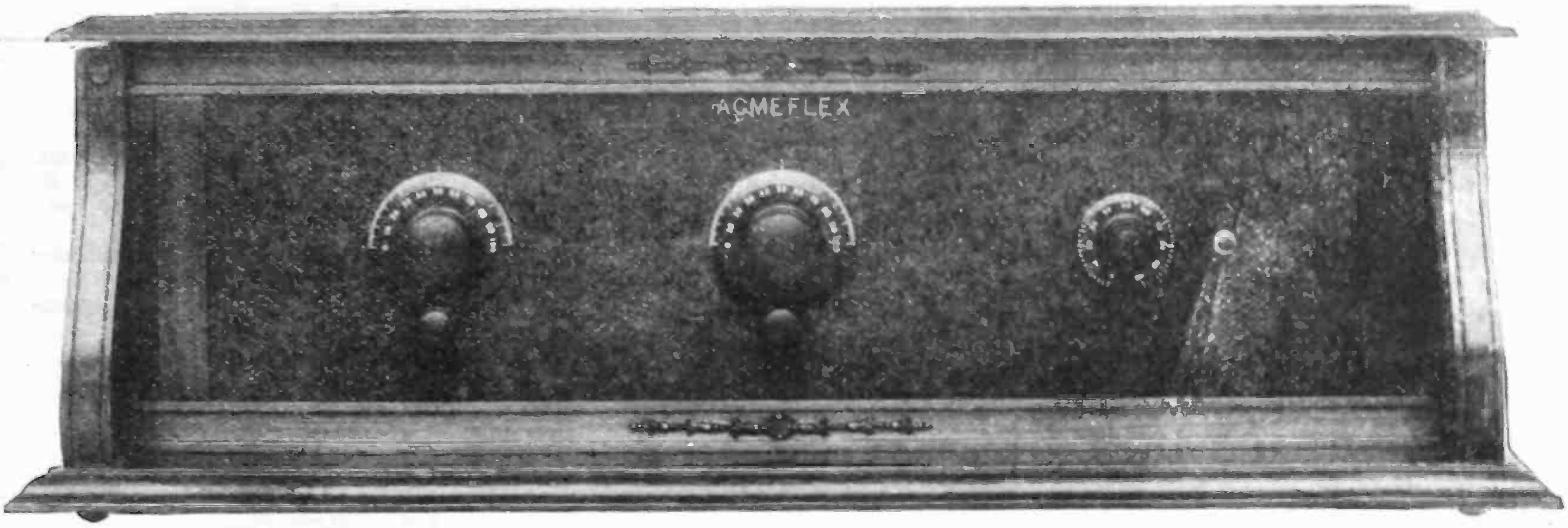
By G. E. M. BERTRAM

IT is exceedingly difficult to predict the trend of future Radio development but if we stop to consider the past we find in general a logical and well defined progression.

Briefly it began with "Wireless," then broadcasting of low power and poor quality, then because it was new and to see if it would work everybody went crazy over distance. For a man in New York to stick his head inside of a horn and imagine that the mumblings and scratches he heard were the letters K. F. I. or K. G. O. or some such place was something to be talked about for a couple of weeks and immediately made him the object of hero worship. But after a lot of people had heard across the country the thrill of filling a log sheet with a lot of call letters began to wane and at the present time everyone realizes that the transmission of intelligible sound by Radio can be accomplished and now the question is, how well can it be done. So that for the next year or so practically all of the Radio talk will be quality.

To start at the beginning, better announcers, orchestras, singers and performers have been employed to deliver better quality entertainment to the microphones. Following this the voice amplifiers, modulators and transmitters have been improved to put this better program on the air with less distortion and more power so that broadcasting has been decidedly improved.

With a driving force like public demand behind them, manufacturers of receiving sets have turned their efforts toward improving the quality of reception and already some of the leaders have accomplished results which again threaten to show up the remaining defects which are still in the broadcasting station. Sets, parts, speakers, eliminators and other accessories are all being designed with the thought in mind that "it's not where it comes from, but how well you hear it that counts."

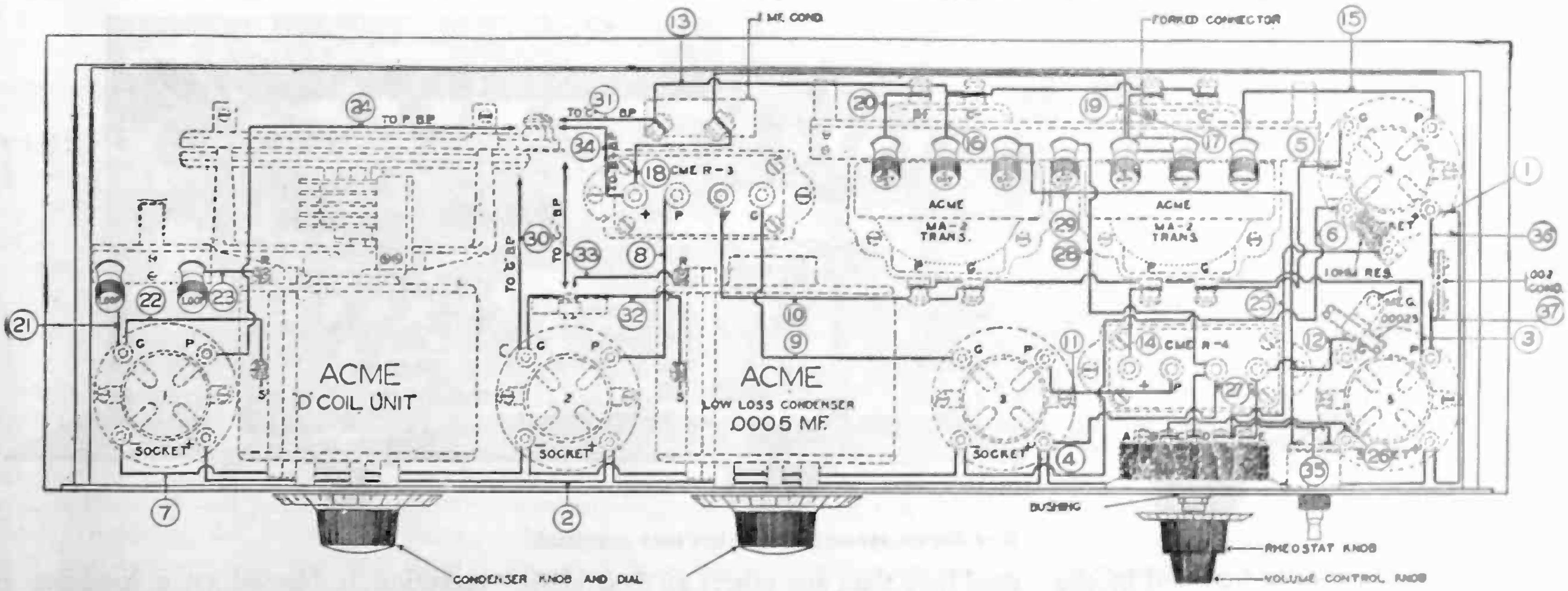


A front view of the new Acmeflex such as built with standard parts. This particular set has been encased in a decorative cabinet which is quite attractive.

The Acme Model S-2 Reflex

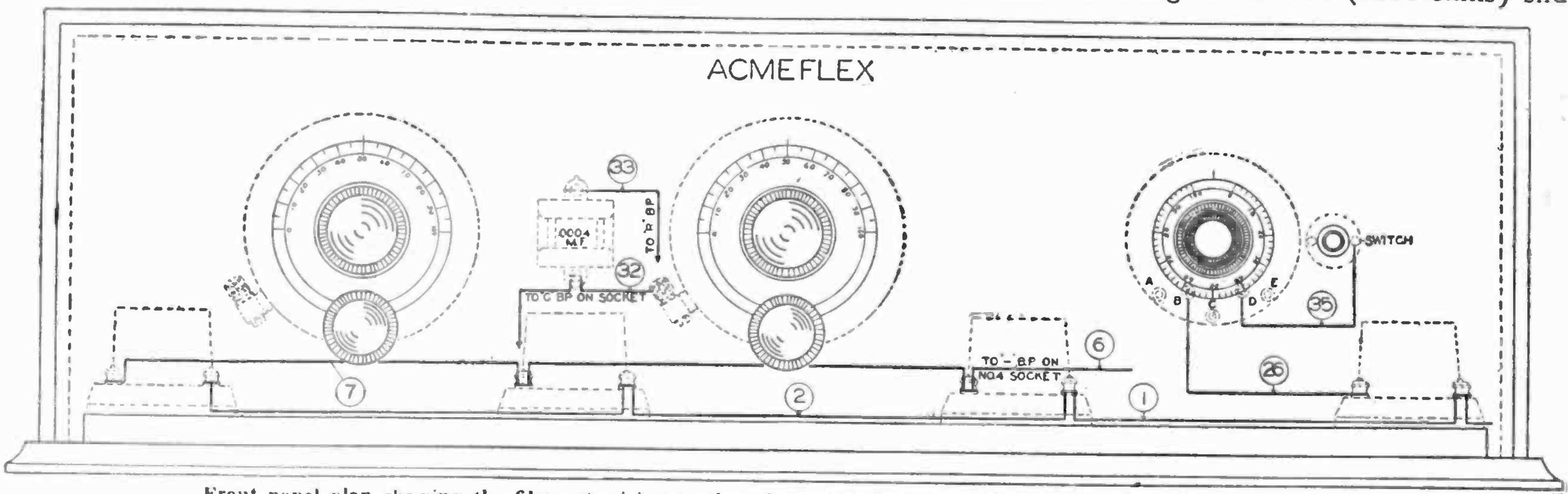
The set described in this article is the Acmeflex Model S-2, and it is especially designed to function as a receiver which will produce good quality.

The accompanying photographs show the layout of the front panel and arrangement of the parts inside. The three controls on front are, left to right, tuning control, sensitivity control and volume control. This arrangement provides maximum flexibility with very simple operation. You set the volume control to "Loud," adjust the tuning knob for the desired



The layout and wiring of the new Acme reflex. All parts are clearly indicated in order that the constructor can easily follow the same arrangement.

wave-length and turn the sensitivity control up as far as necessary. This last adjustment depends upon the strength of the received signal and therefore upon the distance and power



Front panel plan showing the filament wiring to the tube sockets and connection to the .0004 mfd. fixed condenser.

of the broadcast station. Once the set is tuned the volume control may be adjusted as desired.

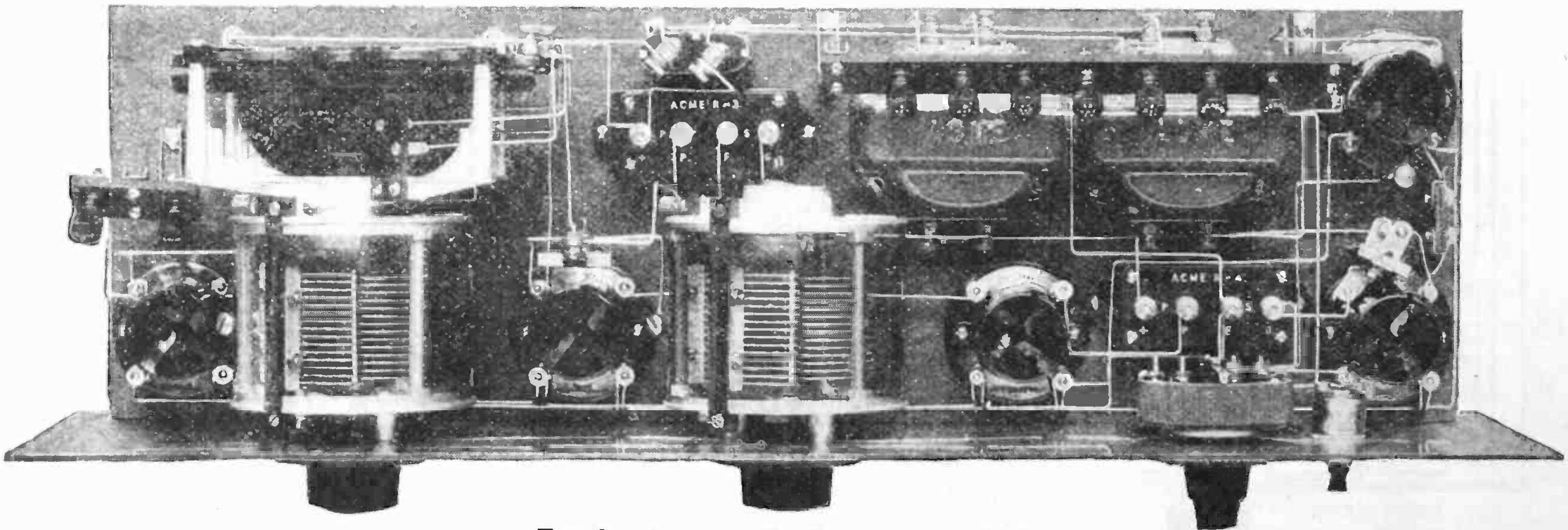
Referring to the wiring diagram it may be seen that the circuit is a "Reflex" circuit and consists of the following:

1. A pickup circuit comprising a loop antenna tuned with a variable condenser. For a set having as much amplification as this one such a pickup is entirely satisfactory and even better than an antenna in that it does not bring in as much interference from static and other objectionable sources. However in locations where there is almost no interference it is perfectly possible to connect an aerial to the loop by winding the lead-in wire from the antenna around the loop two or three times in the same slots as the loop wire and then connecting through a condenser to ground. Variation of coupling is accomplished by means of the external condenser.

2. Following the pickup circuit is a single stage of tuned R. F. amplification, accomplished by means of the "D" coil transformer and then come two stages of fixed transformer R. F.

LIST OF PARTS FOR THE NEW ACME REFLEX

2 Acme MA-2 transformers
1 Acme R-3 transformer
1 Acme R-4 transformer
1 .0005 mf. Var. condenser with screws
1 Twin Rheo, 6 Ohms, 2000 Ohms
5 Sockets (with screws)
1 "D" Coil unit complete with screws
2 3" Condenser Knobs and Dials
1 Front Panel, size 7 x 24"
1 Baseboard, size, 7 x 23"
20 Pieces No. 14 Tinned Wire, 24" long
All necessary screws are:
4 No. 6-32 Binding Post Tops
4 No. 6-32 Binding Post Bottoms
9 6-32 R. H. Mach. Screws 9/16" long
1 1-ohm fixed Resistance
1 .8 ohm fixed Resistance on black fibre
Soldering lugs
1 Filament Switch
30 No. 6 R. H. Wood Screws, ½" long
40 6-32 Hex. Nuts
30 ⅜" Brass Washers
6 6-32 R H. Machine Screws, ⅜" long
1 Type 640 Dubilier, .0004 mf. fixed condenser or Type R-26; .0004 mf. Splitdorf fixed condenser
1 Splitdorf by-pass Condenser 1 mf.
1 Type 601G Dubilier Condenser .00025 mf.
1 .5 Meg. Grid Leak
1 .002 mf. fixed Condenser
9 Binding Posts
3 Terminal Panel Brackets
2 Terminal Panels
4 Arms
1 Center Metal Piece
1 Base Metal Piece
2 Base Wooden Legs
2 Plain Binding Posts
2 ⅜" brass washers for 6-32 machine screws
1 10-32 round head machine screw, ½" long
1 ¾" brass washer for 10-32 machine screw
100 ft. Litzendraht Loop Wire
30 ft. rubber covered flexible wire for leads



How the set appears after it has been completed.

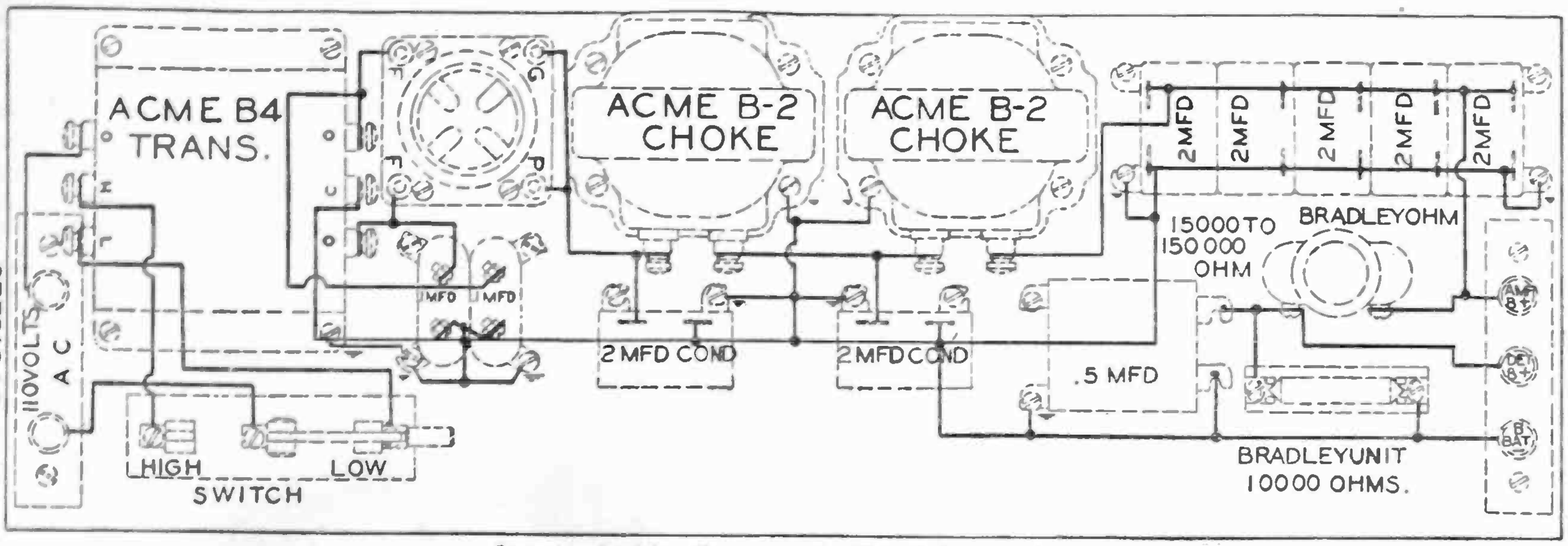
Amplification. This is followed by the detector, a UV 200 type vacuum tube, and two stages of transformer coupled audio amplification, the first stage being reflexed on the last stage of radio and both audio stages using the new Acme MA-2 audio transformers. These are brand new products with a 5 to 1 ratio which are carefully designed, and held to very rigid standards and will provide more amplification with less distortion used here than any others of their kind.

The filaments of the four amplifier tubes have their voltages controlled by a small resistance unit in the set while the detector filament is controlled by the rheostat at the extreme right.

The volume is controlled by means of a high resistance (2000 ohms) slide wire across the secondary of the last radio transformer.

It is very often that poor quality reception is blamed on a loudspeaker or batteries or some other accessory when as a matter of fact the trouble really lies in the audio transformers. This can be shown by substituting another speaker or battery which is known to be good and noticing no improvement in quality or else by substituting Acme MA-2's in place of the old transformers.

Of course it is understood that a set alone will not produce music. There hum which is characteristic of alternating current, but very few will give as good quality as dry batteries. In the Eliminator pictured here "Acme Type E-1" special precautions have been taken which not only shut out all trace of hum but do actually increase the quality of reproduction. This is due to several causes. In the first place a high, steady voltage of 100 to 150 volts is maintained on the amplifier. The detector is supplied with a voltage which is variable from 0 to 70 volts and the filter circuit which follows the rectifying tube is made up of high inductance, low resistance chokes and large condensers which act as reservoirs for storing sufficient energy to



Layout and wiring diagram of the "B" eliminator unit.

are certain accessories necessary. There must be a speaker and sources of power supply, and these have a very important bearing upon the operation of the set and consequently they too should be designed for quality.

The Acme B Power Supply

In addition to the set there is another part of the outfit which is becoming increasingly popular and which must be properly designed if the good quality of the set is to be enjoyed. That is the "B" power supply. There are quite a few "B" Eliminators on the market at present, working with various degrees of success. All of those that are any good at all eliminate the

PARTS FOR "B" ELIMINATOR

- 1 Acme B-4 Transformer
- 2 Acme B-2 Chokes
- 6 2 mfd. fixed Condensers
- 2 .1 mfd. fixed Condensers
- 1 .5 mfd. fixed Condenser
- 1 Bradleyohm 15,000 to 150,000 ohm
- 1 Bradleyunit 10,000 ohm
- 1 Socket
- 1 Switch Single Pole Double Throw
- 2 Terminal Panels 7/8 x 3 7/8 (Optional)
- 5 Binding Posts Complete
- 1 Baseboard (See drawing)
- 1 Raytheon Tube
- 10 Ft. wire No. 14 Tinned copper
- 26 Wood screws No. 6, 3/8 long
- 11 Wood screws No. 6, 3/4 long

bring out the low notes which require an excessive amount and to carry over the troughs in the 120 cycle wave that comes from the rectifier.

Easy to Build

In case expense should be a deciding factor in obtaining a radio outfit a very large portion of the expense of the set and "B" Eliminator can be saved by assembling them yourself. The parts required for the set are given herewith.

All parts for the "B" power supply unit are readily obtainable either from your local radio store of the manufacturers. The accompanying illustrations clearly show how the set and "B" battery unit are assembled.

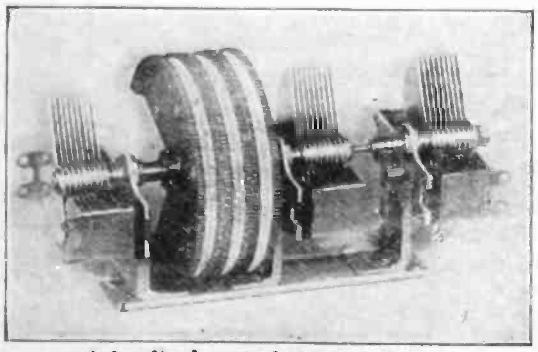
Up-to-Date Tuning Control

By LOUIS KUCKER

THE increased demand for easy and reliable operation of radio sets has led to remarkable improvements in design. Many of us can remember proud owners displaying sets with great glee, and occasionally hitting upon a lucky combination, which would bring in a station.

Better design, fixing upon the best constant values for circuits, previously varied, the use of automatic rheostats, and the like has made great strides in simplification. From a complex switchboard, requiring an expert operator, there has evolved the modern handsome set, which may be operated by any one.

In simplification, the main tuning



A localized control gang condenser.

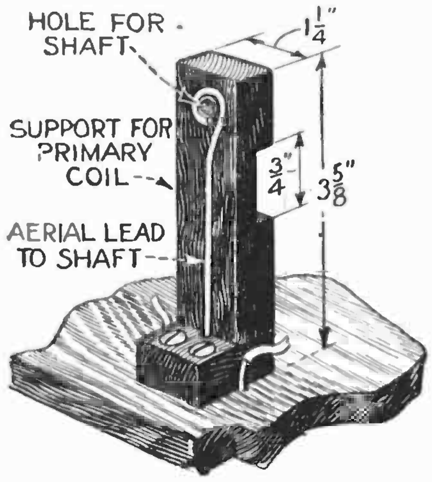
controls have been a major obstacle in the path of progress. Set designers and builders have found a real problem in eliminating the difficulty of manipulating several separate controls, without sacrificing the accurate tuning of each circuit. Localized control has now come forward as the logical solution for this vexing problem. It is now possible to tune all the circuits of the set at once with one hand and then by the same means with the same control to adjust each circuit for its maximum efficiency.

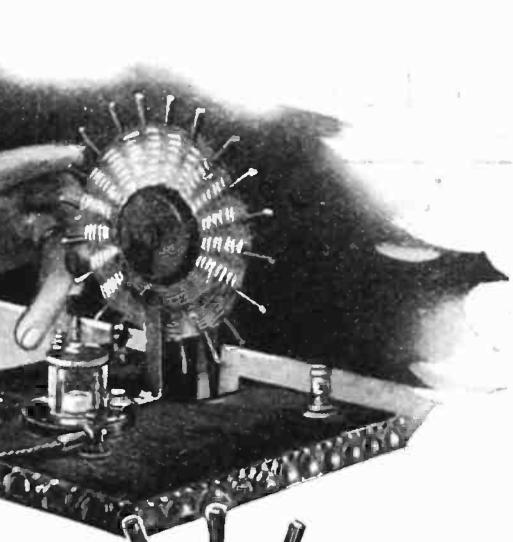
The earlier radio sets all had individual dials for each tuning circuit. Neutrodynes and tuned Radio Frequency sets had three dials while Super Heterodynes and the popular regenerative sets, such as the Roberts, Browning-Drake, Diamond and the Aristocrat had two tuning controls and a tickler adjustment. Either plain

(*Continued on Page* 170)

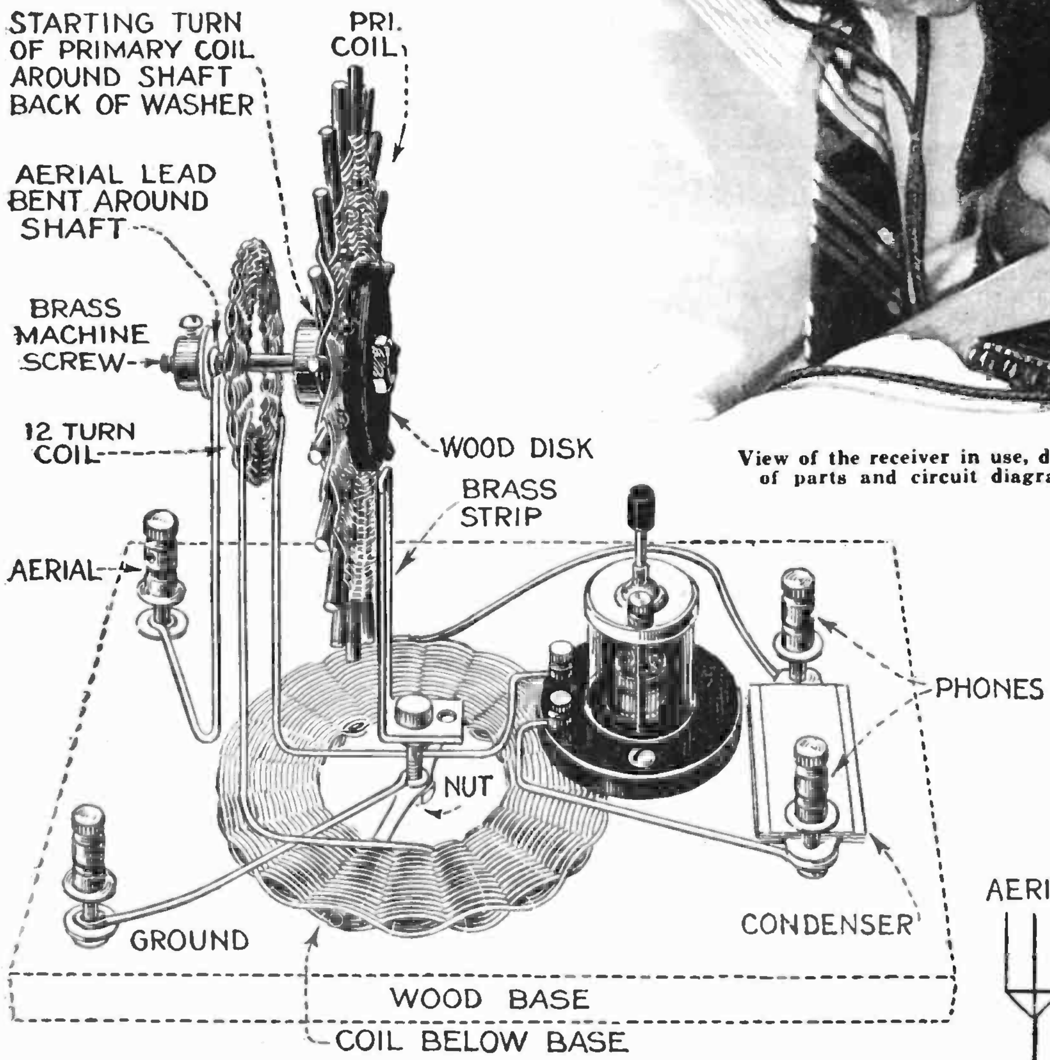
An Inexpensive Crystal Set

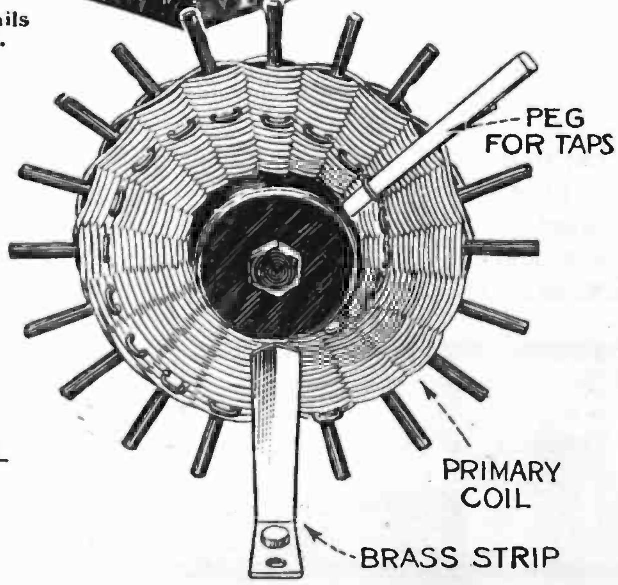
Local Broadcast Stations Can Be Received With Pure Tone Quality

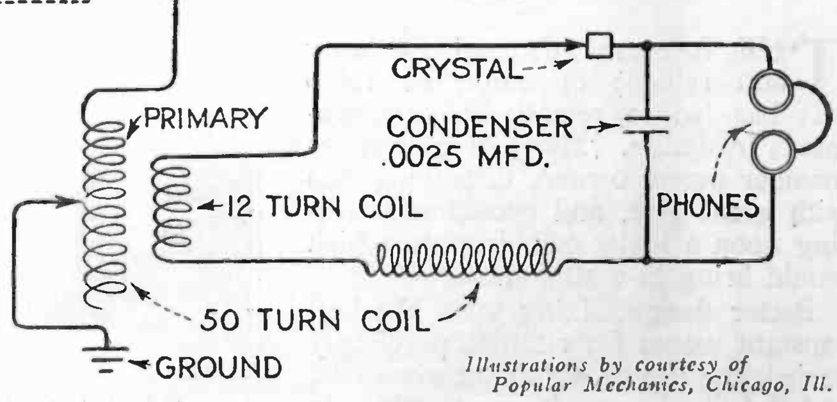


View of the receiver in use, details of parts and circuit diagram.







Illustrations by courtesy of Popular Mechanics, Chicago, Ill.

THE crystal receiving set has much to recommend it when the purpose is to receive local broadcasting. This set is easy to construct and simple to operate. It costs little to build, does not require batteries and has a justly deserved reputation for producing clear, undistorted tone quality. The crystal set described below by *Will H. Bates* which appeared in *Popular Mechanics* magazine, has the additional advantage of being able to separate the "close together" stations, giving the sharp tuning usually obtainable only in vacuum tube sets.

This simple, selective crystal receiver will bring in the broadcast programs within a range of 35 or 40 miles, and can be built for less than $1, exclusive of the headphones and the aerial and ground supplies. No variable condenser is used, yet the set will separate the local stations. This is of particular advantage in the larger cities, where several stations are on the air at the same time, and the average crystal receiver will not tune sharply enough to give satisfaction.

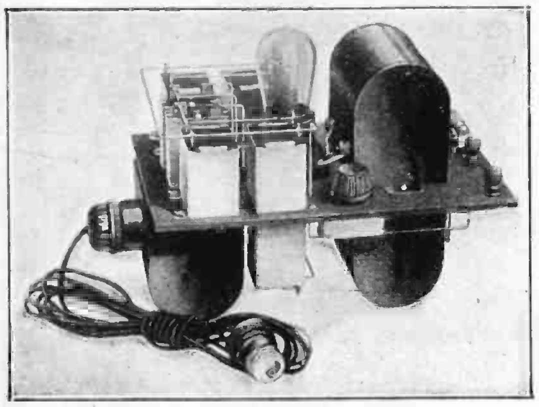
For local stations, a few turns of bell wire around the room behind the molding will answer for the aerial, and a wire clamped to a water pipe makes an ideal ground. The revolving coil makes the set easy to tune. This primary coil is rotated with the finger as indicated in the illustration. It is mounted on the wooden support, detailed in the upper left-hand corner. The shaft is a 1½-in. brass machine screw, and if an old discarded rheostat

(*Continued on page* 152)

Compact and Dependable B-Power Supply

By HARRY K. RANDALL, M.E. in E.E., A.I.R.E.

THE coming of the no-filament rectifier tube has given a wonderful impetus to the use of rectifying outfits in place of B batteries for all radio receivers. These tubes have made possible, for the first time, the construction of "B" power rectifiers which are open to neither of the two great objections to other B battery sub-



Neatness and compact design is a keynote of this unit.

stitutes—the presence of corrosive chemicals, and the filament which may burn out and have to be replaced. In addition, tubes of the Raytheon type have a high milliampere capacity, delivering ample current for any set up to ten tubes.

The principle of the Raytheon tube is now quite well known and will not be explained here. It is a three-element tube and uses the standard navy base, the "grid" prong being dead and

LIST OF PARTS REQUIRED

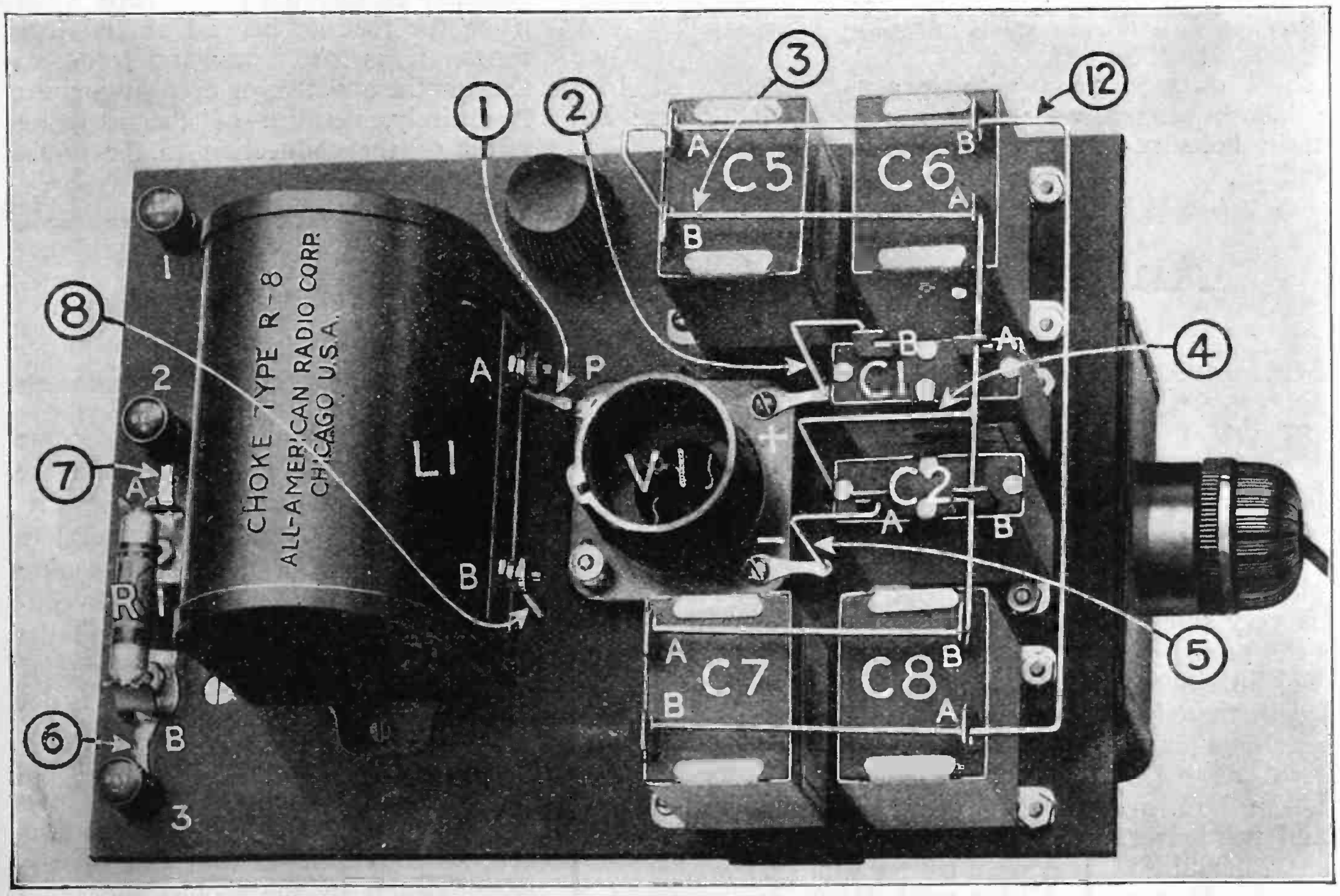
Reference Number	Pieces	Name of part
	1	Raytheon Tube, Type B.
	1	Panel, 7x10x3/16".
T1	1	All-American Type R-7 transformer.
L1, L2	2	All-American Type R-8 choke coils.
V1	1	All-American Type R-25 socket.
C1, C2	2	By-pass condensers, 0.1 mfd.
C3-4-5-6-7-8	6	Filter condensers, 2 mfd.
C9	1	Filter Condenser, 1 mfd.
R1	1	Fixed resistance, 25,000 ohms.
R1	2	Grid leak mounting clips.
R2	1	Variable resistor, 10,000 to 100,000 ohms.
	3	Binding posts.

Post. No.	Marked
1	B Amp.+
2	B Det.+
3	B Bat.+

Supply of soldering lugs, lamp cord with screw or prong plug, 6-32 machine screws with nuts, solder, etc.

WIRING INSTRUCTIONS

Wire No.	(Refer to Photographs)
1	V1-P to L1-A (Solder lugs, no wire).
2	C1B to V1+.
3	C5-B to C6-A to C1-A to C2-B to C8-B to C7-A.
4	Wire 3 (at point between C1 and C2) through hole to T1-B.
5	C2-A to V1—.
6	Post 3 to R1-B (Solder lugs, no wire).
7	Post 2 to R1-A (Solder lugs, no wire).
8	L1-B through hole to L2-A. (Now turn the assembly bottom side up).
9	C9-A to Post 2.
10	Wire 9 to R2-B.
11	L2-B to R2-A; leave ½" or more projecting over the resistor.
12	Post 1 to projecting end of Wire 11, then through hole to C5-A to C6-B to C8-A to C7-B.
13	T1-C to V1+ (Solder lugs, no wire).
14	T1-A to V1— (Solder lugs, no wire).
15	C3-B to C4-A to Post 3.
16	Wire 15 to T1-B.
17	L2-A to C4-B.
18	V1-P to C3-A.
19	C9-B to Post 3.



Top view of the "B"-Power supply unit showing how all parts are assembled and wired. (See Wiring Instructions.)

not used. With the "filament" prongs connected to an A.C. supply, the tube delivers through the remaining prong a rectified or unidirectional current. By a suitable combination of high grade heavy inductances and capacities, the pulsations are smoothed out from this rectified current, leaving a pure, hum-free B current.

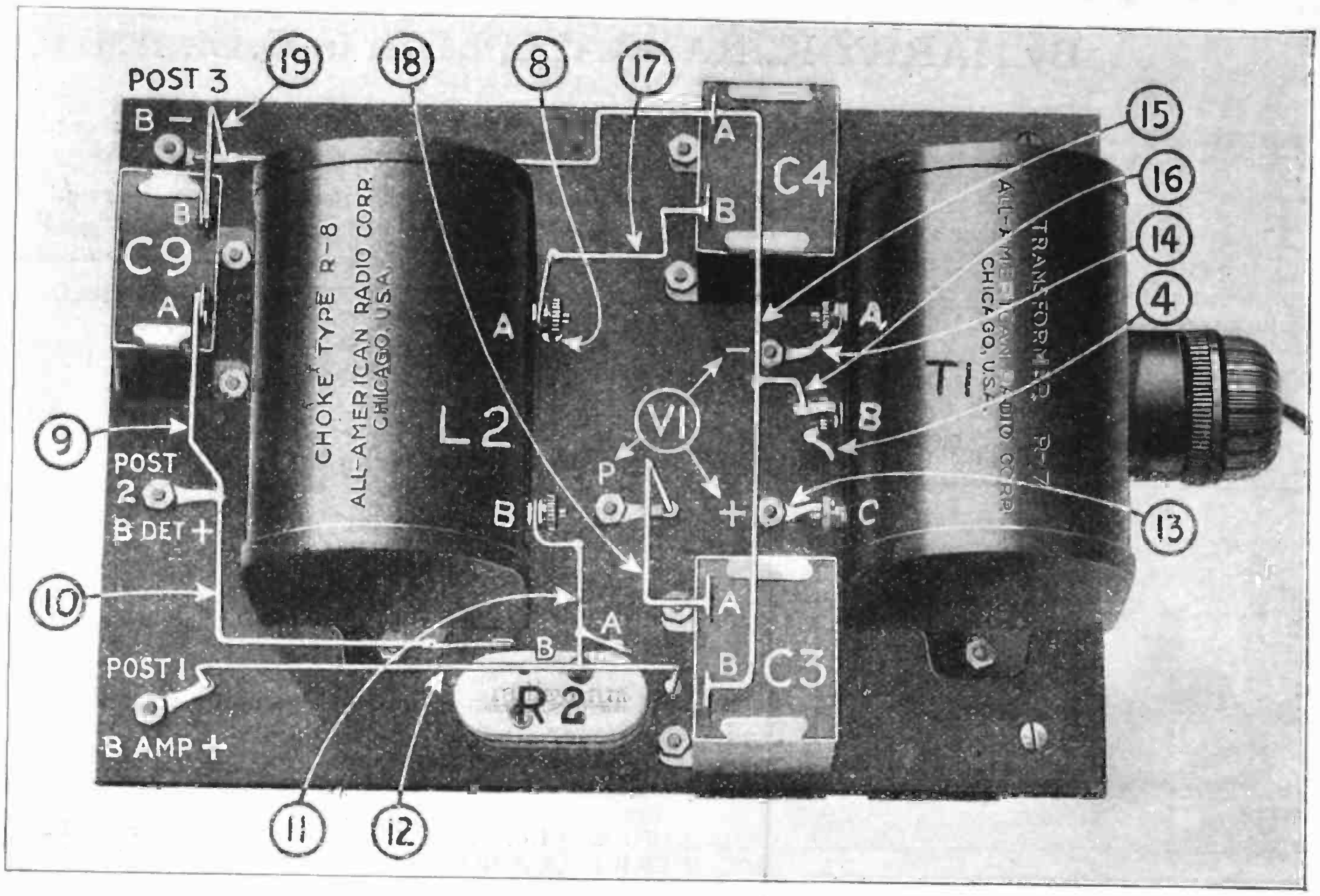
Even if all the parts are purchased new, the cost of building the rectifier here described will be considerably less than that of a factory-built article of equal quality. Many readers may have on hand a number of good fixed condensers, remaining from the days when rectifying devices were still in the experimental stage; for these the building of a modern plate power unit is especially profitable. The estimated life of a Raytheon tube, used in a well designed rectifier, is about ten years, so that no anxiety need be felt as to tube upkeep.

The author will be glad to supply, on request to him in care of RADIO REVIEW, a full size template for drilling the panel, but it is not at all necessary. All of the holes required can be located by laying out the parts which go on *top* of the panel, *except* those for mounting resistance R1 and transformer T1. All of these *must* be carefully countersunk, to avoid short circuits. They are seen on the bottom view photo, as are also the three holes required for wires 4, 8, and 12.

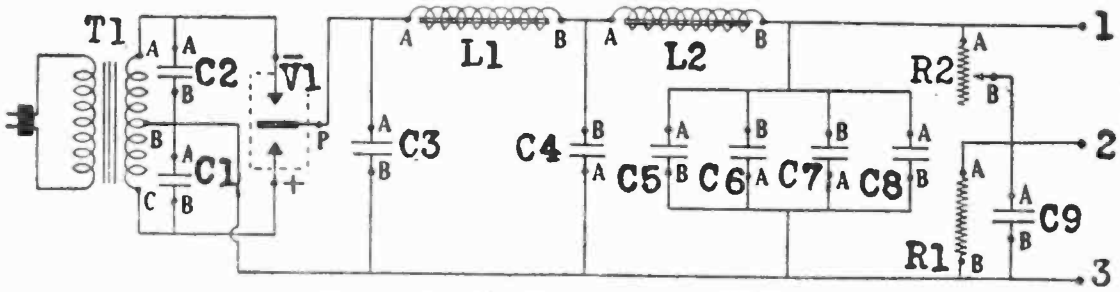
This "B"-power supplies ample voltage for the popular semi-power tubes: For the UX-120 type of tube, use with it a "C" battery of 16½ volts, and for the UX-112, use 7½ volts on the grid.

The expert can, of course, wire the rectifier entirely by reference to the schematic diagram, but probably even he will obtain a neater job by following the detailed wiring directions here given. In any case, great care must be taken to avoid short circuits between wires, and between a wire and the housing of any of the instruments.

A push-type switch should for convenience be inserted in the cord when using the rectifier instead of "B" batteries, it is often advantageous to shorten the antenna, or even disconnect it entirely, because of the assisting effect of the connection to the house lighting system.



Bottom view of the "B"-Power supply. All parts are clearly indicated as given in the schematic wiring diagram.



Complete Schematic Diagram of the "B"-Power.

An Inexpensive Crystal Set

(*Continued from page* 150)

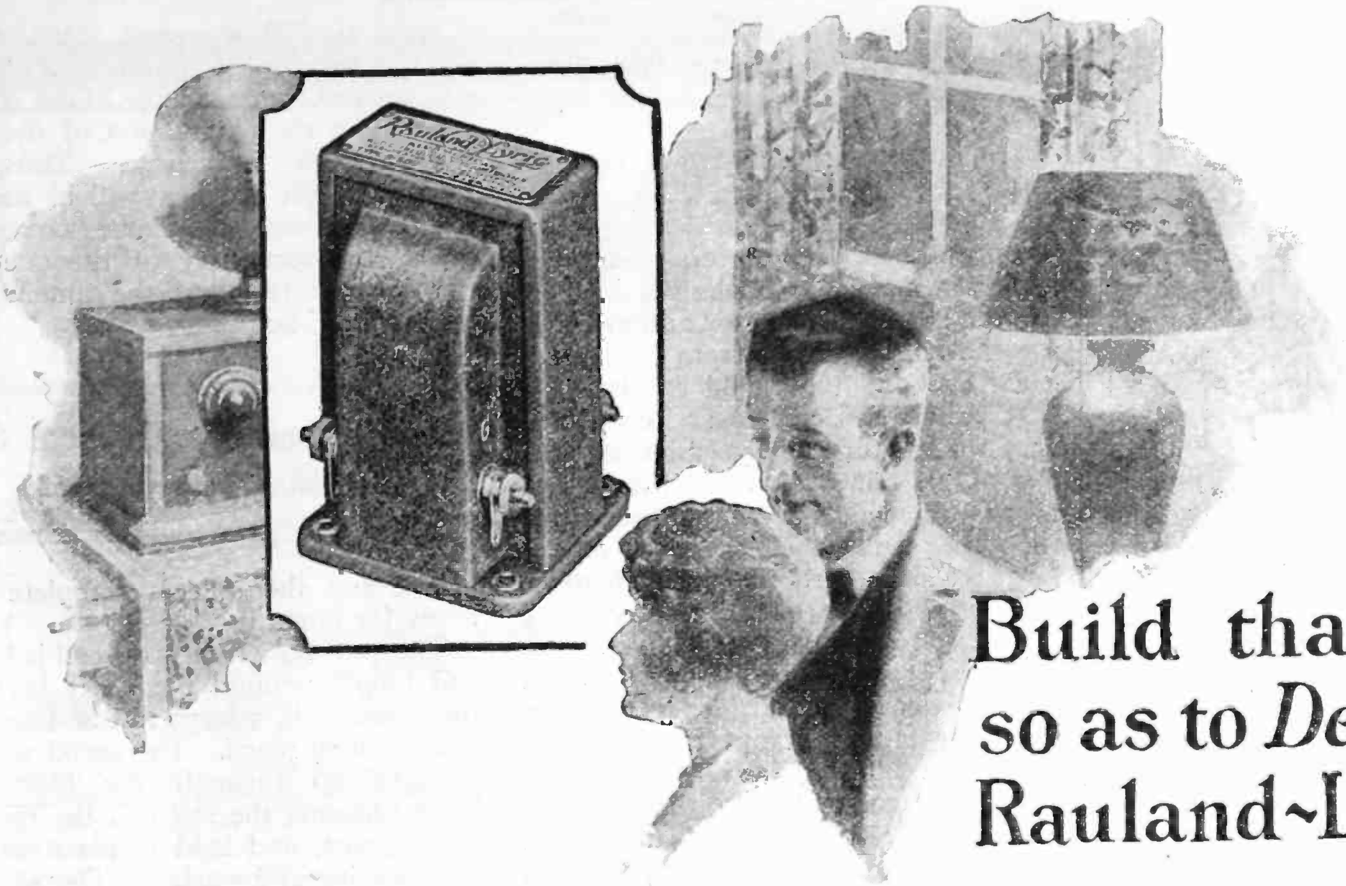
is available, its shaft, or that of a switch, will serve.

As the coil is turned, the taps are brought in contact with a thin spring-brass strip on the baseboard. The details of the primary coil are clearly shown and the winding is very simple. The form for the coil is the sawed-off end of a large spool, 1¾ in. in diameter. Holes are drilled in the edge for 20 burned-off matches, equally spaced. For the coil No. 22 d.c.c. magnet wire is used. Leave 1 in. or more at the beginning and wind over one spoke, under two spokes, and so on, for two complete turns. At the start of the third run insert a wood wedge to form a flat loop in the wire, as shown. When the turn is completed remove the peg. Every second turn on the coil will now bring the over-one turn on the adjoining spoke, and the peg is again inserted in the same way, thus advancing the taps in a spiral to the outer edge of the coil and forming 20 in all. The winding is then continued a part of the way around the coil, clipped and secured around one of the spokes. This end of the wire is not connected in the circuit; the loops are then scraped free of insulation and the spokes withdrawn from the coil. Heavy thread or light string is used to bind the coil, threading it in and out of the openings left by the spokes and tying the ends. The spokes are then re-

MATERIAL LIST

- 1 baseboard, ¼ by 7 by 7 in.
- 2 wood strips, ¼ by ½ by 7 in.
- 2 wood strips, ¼ by ½ by 6 in.
- 1 wood block, ½ by 1¼ by 1¼ in.
- 1 piece of wood, ½ by 1¼ by 3 in.
- 1 crystal detector.
- 1 .0025-mfd. condenser.
- 4 binding posts.
- 1 piece of thin spring brass, ⅜ in. wide and 2½ in. long.
- 1 brass machine screw, 1½ in. long, with nut to fit.
- 3 small washers.
- 1 small bearing with set screw.
- 1 large spool, 1¾ in. in diameter at ends.
- 1 small spool No. 22 magnet wire.

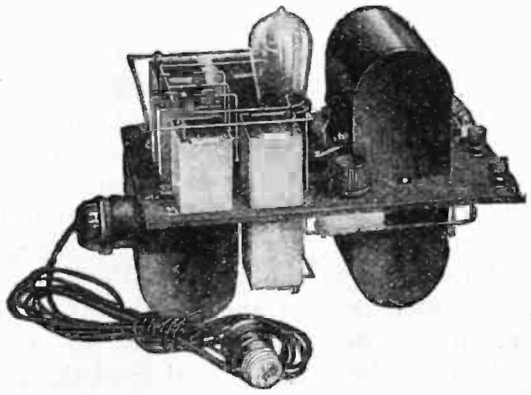
(*Continued on page* 154)



Build that Set so as to *Deserve* Rauland-Lyrics

Gone is the day of the jerry-built radio. Whether you build for use or for profit—one set or a hundred thousand—skimping on quality *does not pay*.

For the radio frequency stages, choose any good circuit and any type of coils you like—opinions differ. But, having chosen your circuit, *be fair to it*—let it show what it really can do—give it the benefit of *Rauland Lyrics*.



Build the B-Power supply described in Radio Review. The following parts are specified in the article:

B-Power Choke: inductance full 50 henries, in stout metal shield. Type R-8 $4.50

B-Power Transformer with separable plug (short-circuit-proof). Type R-7 $6.00

Tube Socket; the popular All-American bakelite socket is ideal for this purpose. Type R-25 ....75c

Raytheon Tube, each...$6.00

Send for Bulletin B-82, giving detailed directions with full-size templates for building the above illustrated B-Power unit. All-American Radio Corp., 4227 Belmont Ave., Chicago, U.S.A.

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FOR THE MUSIC LOVER
The Choice of Noted Music Critics

MEMBER RMA

OWNING AND OPERATING STATION WENR—266 METERS

ALL-AMERICAN

Radio Built for the Years to Come

The Silver Long Wave Receiver

(*Continued from page* 116)

If the operator prefers somewhat better efficiency, it can be obtained by using a separate oscillator and preventing the receiver itself from oscillating. Such an oscillator would consist of a .001 variable condenser connected across a 500 turn honeycomb coil. One end of the honeycomb coil would connect to the grid of a vacuum tube while the other end would connect to the negative side of the 22½ volt battery, the positive side of this battery being connected to the plate of the tube. This B battery should be by-passed by a .002 condenser or larger, if possible. A center tap taken out from the approximate center of the honeycomb coil should be connected to the negative side of the vacuum tube filament, the circuit of which is completed through an A battery and rheostat. Such an oscillator may be coupled to the receiver proper by means of a small 25 to 50 turn honeycomb coil connected in series with the antenna lead of the receiver, and comparatively tightly coupled to the oscillator inductance.

In operating the receiver with an external oscillator, it is probably at first simplest to tune the receiver to the signal when it is in an oscillating condition. The modulator would then be retarded until the receiver stops oscillating, whereupon the oscillator tube should be lit and the oscillator condenser adjusted until the signal reappears in satisfactory undistorted fashion. The oscillator is then functioning as a miniature transmitter supplying the carrier frequency for the incoming signal which was omitted by the transmitting station. The reason for this elimination is that on the longer wave lengths the available transmission channels are very few due to the comparatively narrow frequency range available. Thus, in ordinary speech transmission necessitating a frequency range of from 100 to 3,000 cycles, an actual band of 6,000 cycles would be required for an ordinary transmitter. For a single side band transmitter a range of only 2900 cycles would be required or less than half. From this it is evident that single side band transmission permits of advantageous conservation of available trans-oceanic telephone channels at the longer waves—say, from 3,000 meters up.

Not only may this receiver be used for the trans-oceanic tests but it will provide excellent service as a time signal receiver. Data on stations transmitting time signals may be obtained from any reliable call book.

If the builder prefers to construct the receiver as a one-control outfit, this can be done very easily by substituting a type of 210 iron-core transformer for the second 211 transformer. This will necessitate no change in the wiring other than the elimination of the second variable condenser. Thus, all tuning for the receiver will be accomplished by a single condenser connected across the secondary of the one 211 transformer coupling the antenna to the first RF amplifier.

An Inexpensive Crystal Set

(*Continued from page* 152)

placed and the unit is complete and ready for mounting.

The starting wire of this coil is bared and looped around the shaft back of the wood disk, a large nut and washer holding it in place. The aerial wire is brought up through the base and looped around the shaft at the rear of the support, and held in place with a lock bearing and washer. The wooden baseboard is ¼ by 7 by 7 in. and rests on four ½-in. strips tacked around the outer edge, so as to allow the larger secondary coil clearance underneath it.

The secondary coil, in two sections, is wound on a form made from the remainder of the spool, the rim of which is drilled to take 19 nails, as shown. The smaller section has 12 turns and is mounted directly back of the primary, and supported by its lead wire but not touching the shaft, spaghetti tubing being used to strengthen the supporting leads. The inside lead of the small coil is taken through the baseboard to the inside turn of the larger coil, and the outside end of the small coil to one side of the crystal detector. Both sections of the secondary are wound with No. 22 d.c.c. wire, the method of winding being over two spokes, and under two. Leave a start and finishing end about 8 in. long, remove from the form and sew together as before. The second section of the secondary has 50 turns, and is made in the same way. It is supported below the baseboard by a thin strip of wood; the author used a paper soda straw. The brass machine screw that supports the spring-brass strip also holds the supporting strip for the large secondary and forms the grounding terminal from the primary through the metal strip. The brass contact strip is bent to form a ½-in. mounting piece drilled for the machine screw, and mounted on the baseboard so that it will make good contact with the primary taps when the coil is rotated.

The .0025-mfd. condenser is mounted across the phone posts, under the baseboard. The outside end of the large secondary coil is connected to one phone post, and the other phone post is connected to the other side of the crystal detector, completing the instrument.

The Radio Broadcast "Aristocrat"

(*Continued from page* 112)

the units which comprise the resistance-coupled amplifier system.

Let us consider the ballast resistors first. They are shown in the diagram as, R 1-2-3-4-5. Now the selection of these resistors will depend entirely upon the types of tubes used and we have found what we consider an ideal combination in two of the standard storage battery tubes for the radio frequency amplifier and the detector with two high-Mu tubes in the first two stages of the resistance coupled amplifier and a semi-power tube in the last stage of the amplifier. Some tubes, such as the Western Electric 216A and the new Radiotron UX-210 will operate directly from a 6-volt storage battery without requiring any resistance in the filament circuit. Where tubes of this character are employed the ballast resistors and their mountings may be left out of the circuit entirely, or a direct connection may be made across the mounting, as shown in Fig. 2. In this receiver a ballast of ½ ampere capacity has been used with a Harvey Hubbell toggle switch connected directly across it. This makes it possible to use either 5 or 6-volt output tubes and either is thus assured the proper filament voltage. Most other high-Mu tubes are designed for use on 5 volts and where they are employed a ¼ ampere ballast should be used with each, or a single ballast of ½ or ¾ ampere rating may be used with two or three of them, in multiple.

That should clear up the resistance question, thought it may be well to say in passing that filament rheostats may be used if they are on hand, and for extremely sensitive operation it will be found that a rheostat in the filament circuit of the radio frequency amplifier tube provides greater flexibility than the ballast resistor method.

The Resistance-Coupled Amplifier

In choosing the system of construction for our principal model we have had in mind the idea that a certain balance may well be obtained between first cost and simplicity of assembly. For the inveterate experimenter we recommend the model shown in Fig. 2. In a layout of this kind there is all the room necessary for experimenting with various units designed for the same purpose. For the third type of home builder, who desires to have as much of the building of a receiver as possible done in the factory, we suggest the model in Fig. 3 where a complete three-stage resistance coupled amplifier unit has been shown.

One of the principal things to remember in connection with the building of a receiver in which a resistance coupled amplifier is used is that it depends for its operation to a great extent on the actual resistance of the units employed. If, for instance, in one of the plate circuits where we have specified a resistance of .1 megohm (100,000 ohms) you use a mounting made of some material which in damp weather will absorb moisture, a measurement of the resistance in such a plate circuit will indicate that there is less resistance in the mounting itself than in the resistor used in it. There are many such devices being peddled about and you will do well to be certain that the units you procure do not suffer from such a defect. In other types of mountings which have been submitted to our laboratory for test we have found that the clips for holding the resistors are held to the insulating base by machine screws and locknuts. Obviously, if the heads of the screws are not thoroughly countersunk and the mounting is placed on top of a condenser with a metal case, a short circuit is almost inevitable. Where you do your mounting on a wood base it is well to keep the wiring off the wood itself, as this will prevent leaks occurring in unexpected and undesired places. Some cheap condensers have been found to have a very low resistance in damp weather.

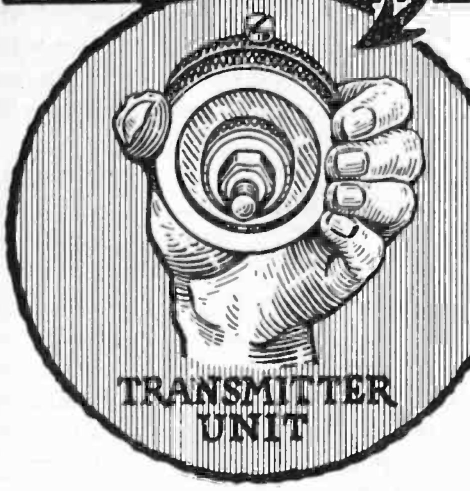
They are thus rendered entirely unsatisfactory.

When you have finished building this receiver and you want to make an actual test of its quality, in camparison with other receivers, connect first one and then the other to a Western Electric cone speaker. If the receiver is right, the cone can be worked with tremendous volume without rattling. The rattle, as a rule, is not an inherent fault in the cone; it is the result of imperfect amplification. In using a Western Electric cone, it should be remembered that the impedance of the cone is much lower than most other speakers and the output tube used with it should be one with a plate impedance that matches the cone, such as the new semi-power tubes to which we have previously referred. If an ordinary tube is used with the cone, an output transformer should be used which will make up for the unbalanced condition that would otherwise result.

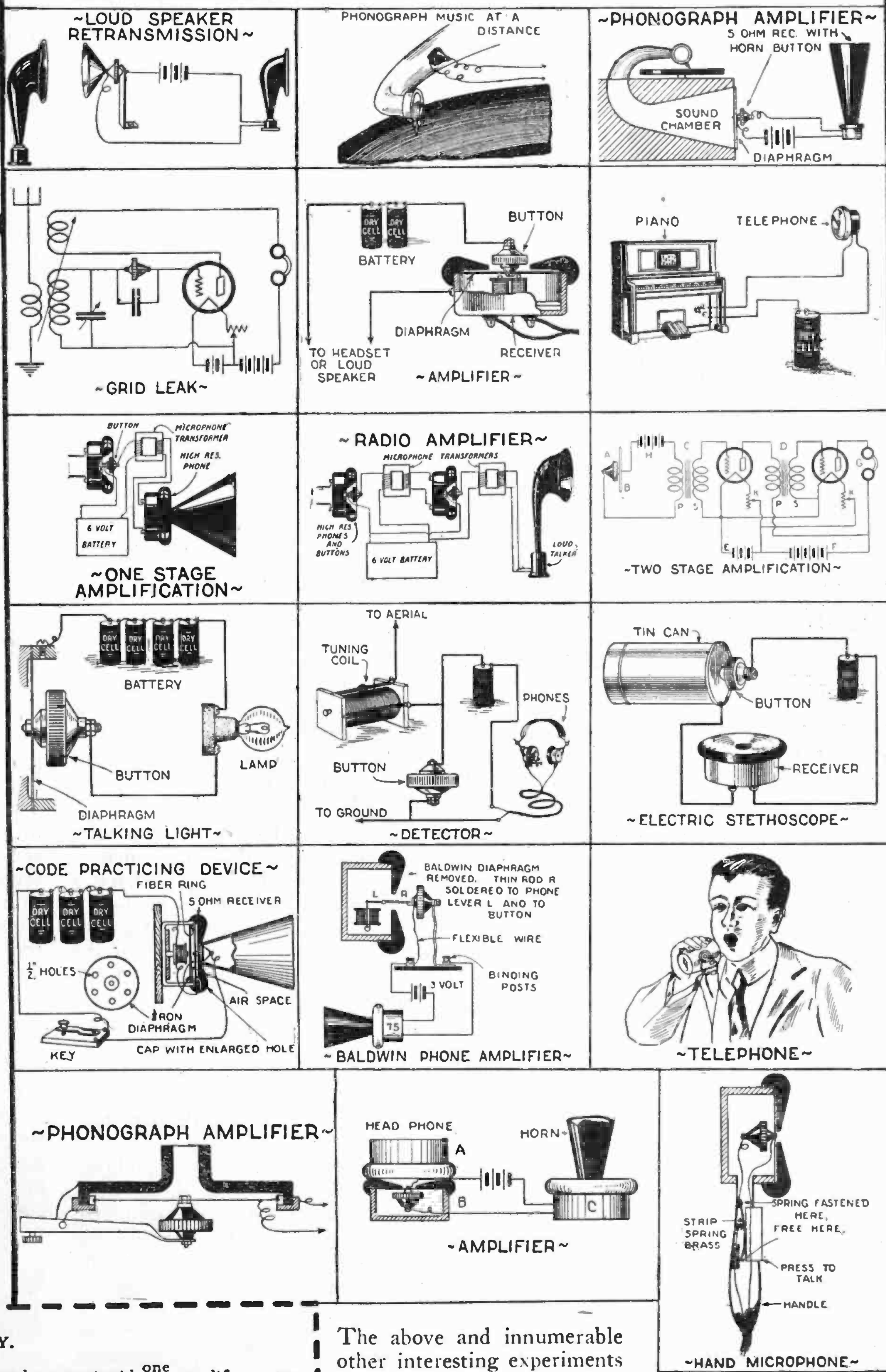
If you consider the little things in connection with the building of the "Aristocrat" you will produce a receiver which you will be proud to exhibit to your friends. You will enjoy radio as it is but very seldom heard.

One very simple method of procuring about the same set-up as that described here by Mr. Lynch could be had by using the standard Browning-Drake coil and condenser units as manufactured by the National Company. These, with good vernier dials form an ideal receiver. The set then becomes twin, instead of single control, an arrangement considered by many as most satisfactory.—Editor.

Thousands of Radio Fans use these Ingenious TRANSMITTER UNITS!



HERE ARE A FEW OF THE USES FOR THESE UNITS



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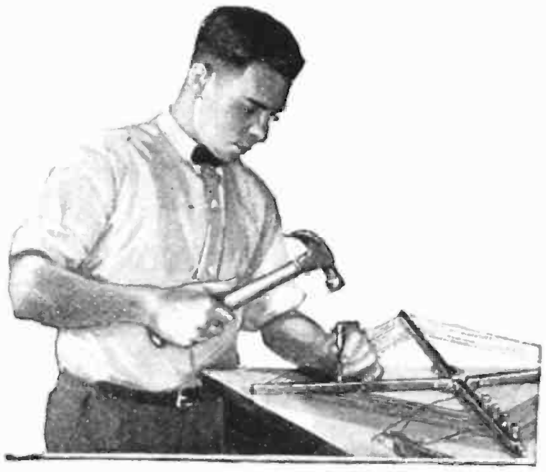
How to Make a Collapsible Loop

(*Continued from page* 130)

Fig. 1 and bend it along the dotted lines as shown in Fig. 2. Before bending, it is heated to a dark red and cooled quickly in water, whereupon the bending can be done easily and without danger of breaking the piece. An extra piece of brass of the same stock is sweated to the back of the centerpiece to reinforce it, as shown in the upper right-hand photo. Rough edges can be removed with a file. The three crossarms and the standard are fitted on the centerpiece and holes are drilled through both centerpiece and crosspieces for 6-32 round-head screws on which the crosspieces pivot. It will be noted that these holes are indicated in the pattern, Fig. 1, but are not drilled until the centerpiece and crosspieces are assembled.



Using a nail set to drive the small pins into the holes.

Get a spool of 100 ft. of loop wire and proceed to wind it on, which is done in the following way: Drive a small pin, about 3/8 in. long, in the inside hole on each crosspiece, put a knot in the wire about one foot from the end, slip the wire into the slot of the stand and then in the slot of the crosspieces, drawing it up tightly. Continue thus, driving a pin in each piece and then slipping the wire in and drawing it tight until the end is reached, which is knotted so as to draw the wire taut when slipped into the slot in the standard for the last time. All the pinholes can be filled up with wood filler. Four holes are drilled through the standard, beween the pins, to receive binding posts. Solder lugs are put under the nuts on the underside of the binding posts, and the beginning and end of the loop are connected to the first and last binding posts, while taps, taken off at the third and fifth turns from the outside end, are connected to the other two binding posts. The taps should be well soldered to the lugs and to the loop wire, which is bared for 1/2 in. The base is made of 2-in. wood, a 3/8-in. hole being drilled in its center to receive the standard, and rubber-head tacks driven into the bottom to prevent it from marring polished surfaces. The loop can be folded as shown in the center photo, and its size when folded is indicated by the hand holding it. When set up, the loop should have a slight bow in the opposite direction from that in which it is folded, to prevent it from collapsing. Stain should be applied to the wood before the wire is wound on and the pinholes retouched again after they have been filled with wood filler.

Figures 7 to 10 show a similar loop, the folding arrangement of which is somewhat simpler. In this case the standard is hinged to the top with a narrow hinge and the sidepieces with the specially made hinges shown in Figs. 7, 8 and 10. Four of these are required, two being bent as indicated by the dotted lines in Fig. 7 to slip over the corresponding portion of the other two when the loop is up. There must also be a slight bow in this loop to prevent it from collapsing. The tautness of the wires keeps it up when past the center. The method of attaching the wires on the loop is shown in Fig. 9.

No Wear in Radio Sets

Letters are often received from radio set owners who think that their sets are worn out after a number of months continuous use because they do not bring in the broadcasting as clearly as they did when first installed. Many persons think that radio sets wear out in a short while just as automobiles do. As a matter of fact there is nothing in a radio set to wear out. When the set ceases to function properly, the accessories probably need replacing. Storage batteries require frequent recharging and dry batteries must be replaced as they become used up. Tubes, likewise lose their power after a certain period of service and must be replaced.

There are only a limited number of moving parts in a radio set, and wear occurs only between moving parts. It is true that wear takes place at the bearings of condensers but these are designed with an ample factor of safety and so should last for a number of years without adjustments. Other parts of the radio set should last indefinitely.

The parts within a set can be injured by rough treatment. Repairs will be necessary if the set is dropped on the floor or otherwise roughly handled, but such treatment cannot be justly classed as "wear." Dust also may cause a set to lose its efficiency. When dust gets between the plates of the condensers, it is sometimes responsible for leakage of radio frequency currents. The dust should be removed at frequent intervals, using a soft cloth or a pipe cleaner.

Vegetables Grown in Your Own Garden Taste Best

(Continued from page 117)

built it myself. I'm always tinkering to improve it, even now, and if I can get down to Cortlandt Street today, I'm going to investigate a new three circuit tuner that those who have tried it tell me is 50% better than the one I have got."

"But, Bill," I persisted, "isn't it a lot of bother building and fooling around with a radio set when it's so easy to buy one and have it over with? You've got to agree that there must be some good factory made sets on the market."

"Yes, I suppose there is," condescended Bill, "but—." Before he could finish I was making a flying leap for the door and just about managed to get out before it closed. Hearing a shout I turned around to find Bill's head sticking out of the window. "I was going to say," he shouted, "that vegetables are easier to buy than grow but they always taste better when they come from your own garden."

On my walk to the office I mused over what Bill had said. "So simple and easy to build I didn't have to call up for help once;" "can't come up to my little three tuber even when they're working, which is seldom;" "get a lot more satisfaction pulling in a station with 3 tubes than they do pulling in the same station with five;" "because I built it myself;" "vegetables always taste better when they come from your own garden."

And that is why the regenerative circuit has continued to be and will continue to be for a long, long time to come. Because it is easy and inexpensive to build; because after all, it will do everything, or nearly everything a five tube set will do; because it will always be made rather than purchased complete; and because "vegetables taste better when they come from your own garden."

Regeneration is the phenomenon whereby energy is fed from the plate or output circuit of a tube back to the grid of input circuit where it decreases the resistance of the input circuit to such an extent that signals which would otherwise be too weak to be evident in the output circuit that manifest with considerable strength.

There are many ways of effecting regeneration in a circuit, all; however, basically the same. Fig. 1 shows the original Armstrong circuit and it is interesting to note that there are no fewer than 14 controls. Fourteen controls on a tube set, about three times as many as on a present day five tube set!

Fig. 2 shows a later development of the Armstrong circuit that had six controls, seven with the audio ampli-

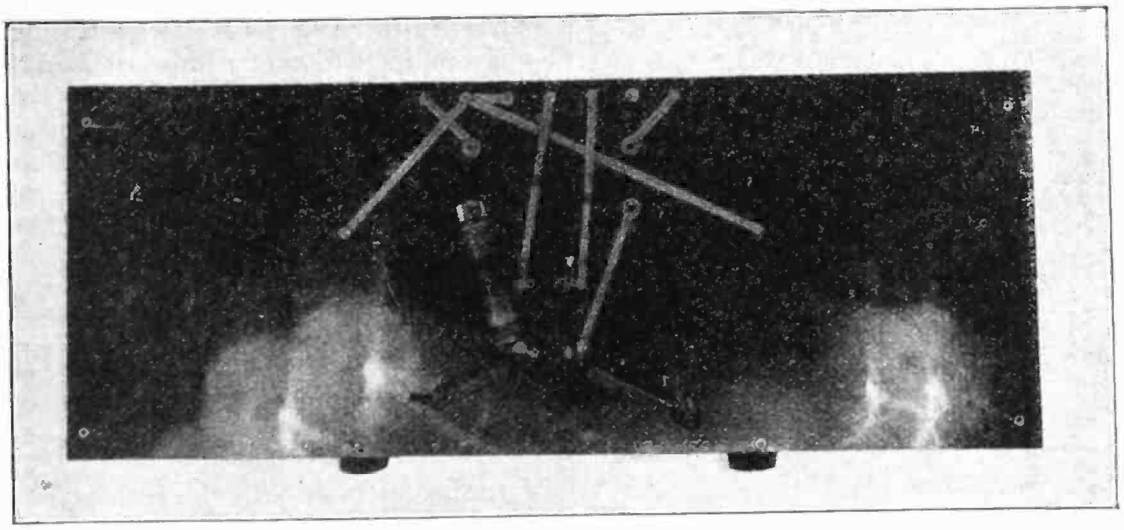
(Continued on page 164)

A Simplified and Efficient Low Power Transmitter

(*Continued from page* 143)

keep the key depressed for too great periods, as it will heat up sufficiently to mar the varnish of the table on which the set is standing (when a 50 watt tube is used.)

In the view of 2QA the short wave set stands at the right end of the table, in front of it is the wave meter and about the center of the table may be seen the current supply switch and the Antenna-Counterpoise changeover switch. The radiation ammeter is in the center of the table shaded by the operator. At the left end of the table are the power supply unit and 100 watt set which failed to produce results, and on the extreme left end is the R.E.L. receiver which was used during the week coupled to the amplifier at the extreme left.



Bottom of sub-panel showing the grid leak and ribbon connections.

Two Efficient Short Wave Sets

(*Continued from page* 114)

of the audio frequency amplifier circuit. (The receivers shown in the illustration were designed primarily for the reception of amateur telegraph signals and therefore only one stage of audio frequency amplification was used). This is accomplished by inserting an ordinary solenoid (L_4) having about 120 turns of No. 36 wire wound on a one-inch diameter tube, in series with the positive B battery lead to the plate of the detector tube. This coil is known as a radio frequency choke coil simply because its purpose is to keep the radio frequency out of the audio circuit.

Wiring the House for Radio

(*Continued from page* 96)

of tuning is required. If you have a portable set, that is, one with battery compartments so that it can be moved around from place to place without any trouble, this system of wiring can be used in another way. In such cases, the aerial and ground can be brought to any room provided with the wiring arrangement shown in Fig. 2 by connecting an aerial and ground to the terminals of a phone plug as shown in Fig. 4.

Inserting the plug into the wiring system connects the aerial with one spring of each jack and the ground with the other spring of each jack, then, all that is necessary to connect the receiver with an aerial and ground is to connect the antenna terminal of the receiver with one terminal of another phone plug, and the ground terminal of the receiver with the other terminal of the plug, as shown on Fig. 5. Care should be taken that the antenna and ground terminals of the antenna system and of the receiver are connected to corresponding terminals of the phone plugs and of the jacks in the wiring system.

When only a temporary extension is required to bring a loud speaker or aerial and ground system to another room, a portable jack, such as that shown in Fig. 6 can be used. The other end of the cord is connected with the output terminals of the receiver either with binding posts or by using another phone plug to plug into the loud speaker jack of the receiver. The loud speaker plug can then be inserted into the portable jack.

These two devices make it a very simple matter to carry radio to every room of a house so that all can enjoy the programs under the most comfortable and convenient circumstances.

The Improved Model L2 Ultradyne

(*Continued from page* 140)

radio frequency amplification and consequently plays its most important part when you are receiving a long distance station. Its use does not increase the volume of the signals received from the local stations to any appreciable extent, this not being the object. Greater volume can always be obtained by the addition of audio frequency amplification; but it does increase the volume of stations at a distance for the reasons that the weak signals are boosted in amplitude before they pass through the long wave radio frequency amplifier. Since the object of the regeneration feature is to make the Ultradyne more sensitive to weak signals, it should be evident that it will not only increase the volume of signals from distant stations that could not be heard on an Ultradyne without regeneration.

As has been said, no great difference will be noticed in the volume of local stations, but it is surprising what the regenerative feature does in connection with the reception of long distant stations. Probably the most advantageous point is that it insures reliable and consistent reception from stations that heretofore faded or swung badly, and this is exactly what is desirable in a receiving set.

With the addition of regeneration, it will be found that the second stage of audio frequency amplification is of real use only when receiving from very distant stations. All the volume desired is had with one state of audio frequency amplification when receiving local or semi-local stations. The second stage of audio frequency amplification, however, is quite desirable for long distance work.

Tips for the Radio Fan

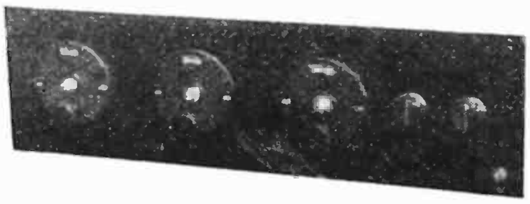
In disconnecting leads between the radio set and the battery, it is desirable to disconnect at the battery end first. This procedure avoids the possibility of bare ends of the leads from the battery touching and short-circuiting the battery.

If battery acid is spilled on cloth, it may be neutralized by pouring some ammonia over it at once. Bi-carbonate of soda will answer the purpose if no ammonia is available. This should be sprinkled on and then moistened with a little water. Additional bi-carbonate should be added until the fizzing stops.

The Bodine R. F. Receiver

(Continued from page 132)

choice may be made to suit the builder's individual taste and pocketbook.

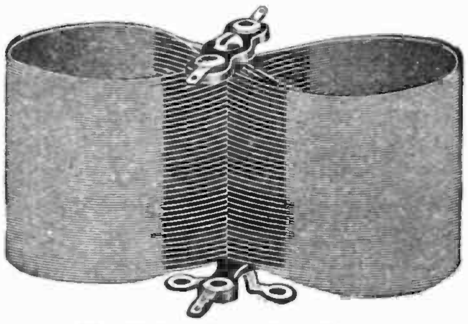


Front panel view of the Bodine set.

When the set is wired up and ready to test give it a final inspection to make sure that no mistakes have been made in the connections and that there are no wires touching each other. After connecting the batteries put one tube in a socket and turn up the rheostat to see that it lights properly before putting in the other tubes. Connect the aerial and ground to the proper binding posts and see that the loop switch is closed. The aerial and lead-in should have a combined length of 75 to 100 feet. Plug in the loud speaker and turn the rheostat and high resistance knobs almost all the way to the right. Now turn the dials, keeping them all reading about the same, until a station whistle is picked up. Then turn the high resistance knob to the left until the whistle stops and adjust all three dials until the station comes in best. Make a record of the dial readings for future reference. After you have the set logged and have become familiar with the method of tuning it will never be necessary for the set to whistle as you can set all three dials to the proper readings and then turn the volume knob until the signal comes in clearly.

LIST OF PARTS

- 3 Bodine Twin-eight R.F. Transformers. type T-35.
- 1 Bakelite Panel 7"x24".
- 1 Base board 8½"x23".
- 3 Amsco .00035 m.f. SLF Variable condensers.
- 3 Marco clockwise vernier dials.
- 1 Centralab 0 to 200,000 ohm variable resistance.
- 1 Yaxley 6 ohm rheostat.
- 1 Yaxley single circuit jack.
- 5 Na-ald sockets.
- 2 Thordarson 2-1 audio transformers
- 1 Potter ½ m.f. by-pass condenser.
- 1 Dubilier .001 m.f. fixed condenser.
- 1 Dubilier .00025 m.f. fixed condenser with grid leak mounting.
- 1 Muter single throw, single pole switch.
- 1 Muter 3 megohm grid leak.
- 8 Eby binding posts.
- 12 lengths of No. 14 round bus-wire.
- 6 lengths of spaghetti tubing.



The R.F. coil used in the set.

For loop operation use a Bodine Standard Model B-12-X Loop Aerial. This loop brings in KSD at about 97 on the first dial and reaches the low wave stations satisfactorily. Connect the two outside terminals of the loop to the Ground and Loop binding posts respectively, having first disconnected the ground and aerial leads. Open the loop switch so that the first coil is disconnected from its condenser and the loop is being tuned in its place. For any station, dials 2 and 3 will read the same as when tuning with the outdoor aerial but the first dial will have a somewhat different setting. The loop should be pointed approximately in the direction of the station desired. In tuning out an interfering station the position of the loop must be adjusted carefully. More careful adjustment of the dials is necessary when using the loop aerial.

Vegetables Grown in Your Own Garden Taste Best

(Continued from page 160)

fier, and required a 30 inch cabinet to house. Fig. 3 shows the latest development in regenerative circuit design—the one Bill spoke of—that has but two controls and requires with the audio amplifier, nothing larger than a 10 inch cabinet.

This is bringing simplicity in radio down, or rather up, to an art especially when it is considered that Fig. 3 with its two controls is in many ways more efficient than Fig. 1 with 14 controls.

The circuit of Fig. 3 employs the Clarotuner, the only three circuit tuner on the market that makes use of the latest feed-back development—tickler fixed and resistance controlled. This is a distinct improvement over the old style of rotating type ticklers, for these reasons:

Rotating tickler types of three circuit tuners have the stability common to regenerative receivers working at peak efficiency in that they burst into oscillation — "spill over" — whenever the circuit is disturbed. This efficiency has been overcome in the Clarotuner by having the tickler always in fixed relation to the secondary and controlled by a variable resistance, in this case a Clarostat, which not only makes the circuit more stable, but increases the volume as well because close coupling can be maintained between tickler and secondary on all wavelengths.

The function of the Clarostat, R.I. across the tickler or plate coil, L.I., as shown in Fig. 3 is to strengthen or weaken the magnetic field produced by this coil without disturbing the constants of the rest of the circuit, which invariably accompanies a change in the position of a movable tickler. Another feature of the resistance control in the Clarotuner is that a more even approach to the point of saturation—the "spilling over point"—can be effected, allowing weak and distant stations to be pulled in that would be entirely lost with rotating type ticklers.

The modulator shown in the drawing of Fig. 4 has been found to be a necessity wherever transformer coupled audio frequency amplification is employed. Its function across the secondary of the transformer as shown is to balance the amplifying characteristics of the combination of transformers, so that all voice frequencies, high and low, are amplified to the same degree.

It also serves in the convenient capacity of volume control. A Clarostat should be used here because it is extremely important that the modulator have the requisite range and that it can be depended upon not to change its resistance setting down when adjusted.

All the terminals on the Clarotuner are designated and it is incorporated in the circuit of Fig. 4 by having terminal No. 1 go to the antenna, 2 to the ground, 3 to one end of the grid condenser and leak, (of which the other end goes to the grid of the first or detector tube) 4 to an A plus lead any place in the circuit, 5 to the terminal marked "P" on the first A.F. transformer, (of which the terminal marked "B" goes to the "B" plus Det. terminal of the binding post strip) and 6 to the plate of the detector tube.

Forty-five volts is commonly used on the plate of the detector tube but if the circuit oscillates too violently, that is, "spills over" too suddenly at this voltage it should be reduced until the regeneration control is smooth and even. Failure of the circuit to regenerate can be remedied by increasing the capacity of the by-pass condenser. An incorrect grid leak value will also cause instability in the circuit, and care should be exercised in selecting the right value.

The list of parts required are as follows:

1 Clarotuner Model TCH.
1 .0005 variable condenser.
2 Audio frequency transformers.
3 RCA 201-A tubes.
3 Amperites
1 Mucher binding post strip.
1 Clarostat
3 Tube sockets
1 .00025 Grid condenser, mica mould.
1 .001 By-pass condenser, mica mould.
1 2 megohm grid leak, mica mould.
1 Single circuit filament control jack.
1 7 x 10 or 7 x 14 panel, micarta.

The circuit will fit nicely without undue crowding on a 7x10 panel, but if it be desired a 7x14 panel will give spacious room for all the parts.

An Easily Built "B" Supply Unit

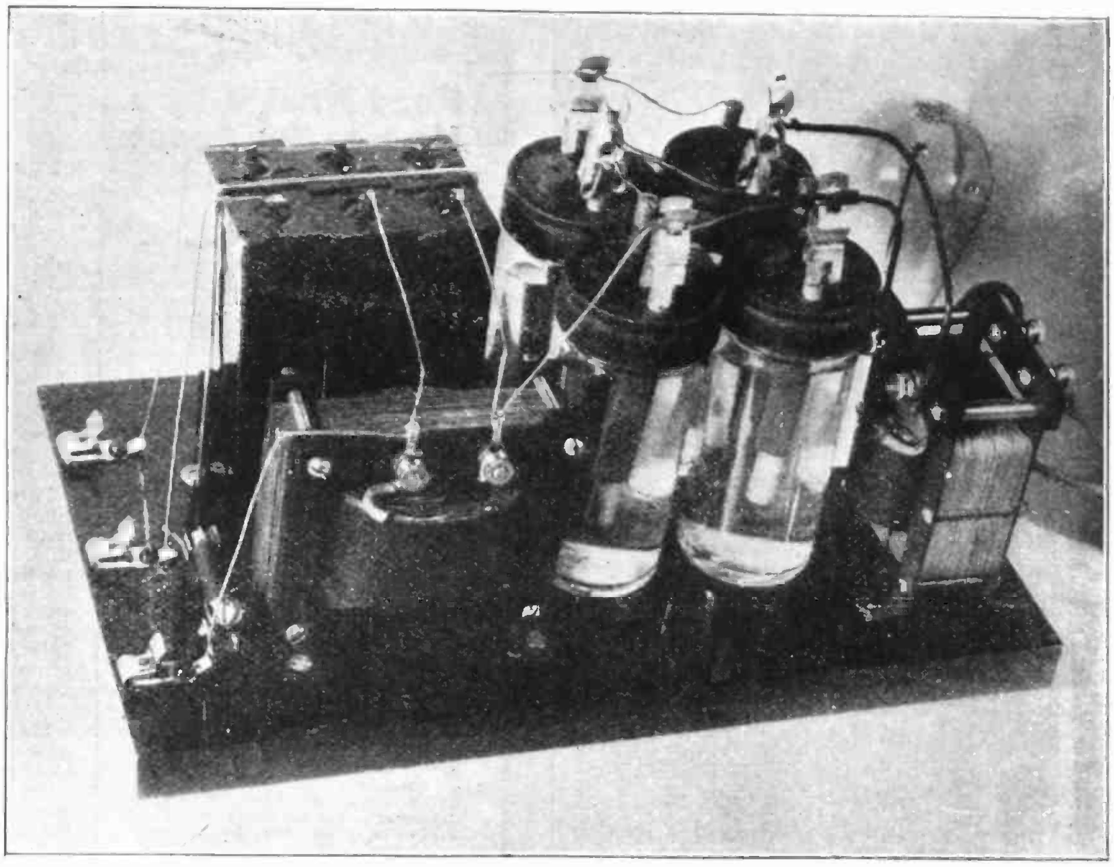
(*Continued from page* 137)

(aluminum) elements of the rectifier forms our high voltage tap for the amplifier tubes, while the lead from the graphite (1) posts forms the minus B tap. To provide a tap for the detector tube a fixed resistor of 100,000 ohms is connected into the plus amplifier tap and another condenser of 1 to 2 mf. capacity is connected between plus detector and minus B. This fixed resistor will give a voltage of around 25 and is correct for hard tubes. Should the builder desire to use a soft tube of the 200 or 300 variety, a variable resistor, such as a Bradleyohm or Clarostat should be connected in series with the fixed resistor. This will give a very flexible adjustment and works out very well. If another tap should be required for the radio frequency tubes, such as 45 or 67 volts, this can also be arranged by tapping into the plus amplifier line with a Bradleyohm or Clarostat. Any voltage from 40 to 80 can be had this way.

Where the B Unit is to be used on the average receiver which requires only 90 volts on the amplifiers some kind of an adjustment must be provided to regulate its amplifier voltage. One of the best and cheapest ways to do this is by some form of resistance in the primary side of the power transformer. This can readily be provided by the ordinary electric light bulb which may be had in sizes varying from 10 to 40 watts. These sizes have the correct resistance when used with the B Unit. The output of the power transformer should not be any higher than 160 volts. With a 25 watt lamp in the primary lead this will give a DC output of 15 milliamperes at 130 volts or 30 milliamperes at 95 volts, which is sufficient to take care of all receivers using six tubes or less. It will even supply some Superheterodyne receivers using eight or nine tubes, if they are designed with an eye for economy.

A word about the rectifiers:

As stated before, the aluminum should be the highest grade available, and is best procured from makers of B Units. Most manufacturers have a secret compound which they furnish for the electrolyte and these can also be had readily. If the constructor can get a supply from a local chemical house, he may choose a number of rectifying salts. Some of the better ones are: 1. ammonium phosphate (Monobasic); 2. ammonium borate; 3. sodium acid tartrate.



Another view of the "B" supply unit. In this photo all wiring is in evidence.

The chemicals should be 100% pure and nothing but clean distilled water should be used. Be sure to have no trace of acid in the solution, and for this reason do not use a hydrometer for filling the jars if it has ever been used on a storage battery.

The B Unit described herewith will be found to be very smooth and free from all AC hum on practically every type of receiver. Those using loop aerials should have the minus post of the A battery grounded, if a slight hum comes through. If a receiver is provided with a ground, and there is still a hum, this may be due to the fact that the A battery is not connected to the ground within the receiver proper. This should always be done, otherwise there might be an annoying AC hum.

The hardest receivers to handle with a B Eliminator are those using resistance coupled and impedence coupled audio amplification. On resistance coupled sets, it is advisable to use a higher plate voltage on the detector tube than is recommended if a B battery is to be used, and the tubes in the audio amplifier should be shifted around until the best combination is found. In case of trouble, the manufacturer of the resistance coupling should be consulted, as he is able to give additional information on his products.

The current consumption of a B Unit with electrolytic rectifiers is very small. With a well designed transformer and a good rectifier the cost per hour may be as low as 1/20c per hour, and rarely more than 1/5c per hour. As far as service goes, one can expect 1000 hours and more before the electrolyte will have to be renewed. When this is to be done the aluminum electrodes should be cleaned with fine sandpaper to remove the layer of oxide. The rectifiers connected in the bridge form of circuit are self-forming, and do not have to be formed before putting them into the B Unit.

A good many of my readers have asked me if this scheme of making DC current for the plates of the tubes could not be utilized also to eliminate the A battery. The theory is fine, but in practice it does not work out so well. To make an A Eliminator on the same style as the B Unit would make a rather unwieldy piece of apparatus and would require more attention than a storage battery with a trickle charger.

Fixed Condensers in Radio Receiving Sets

(*Continued from page* 108)

should be connected at this point.

It will be noted that in some of the previous paragraphs definite data is given regarding the sizes of condensers, whereas in other places, no data is found. This is because of the fact that in some cases it will be necessary for you to determine the size of the condenser that is particularly suitable to your needs and, therefore, it is advisable that every experimenter have an assortment of condensers of various sizes at his command so that the best capacity can be quickly found. Another thought is to use a calibrated variable condenser and to place this at the desired point and change its capacity until the best results are obtained. Then, read the capacity being used on the calibrated scale and obtain a fixed condenser of approximately the same capacity.

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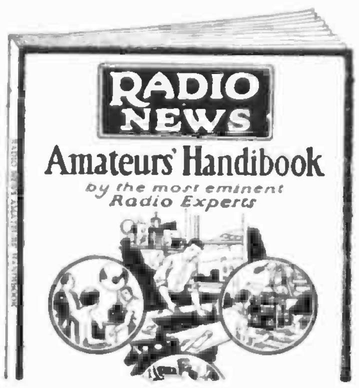

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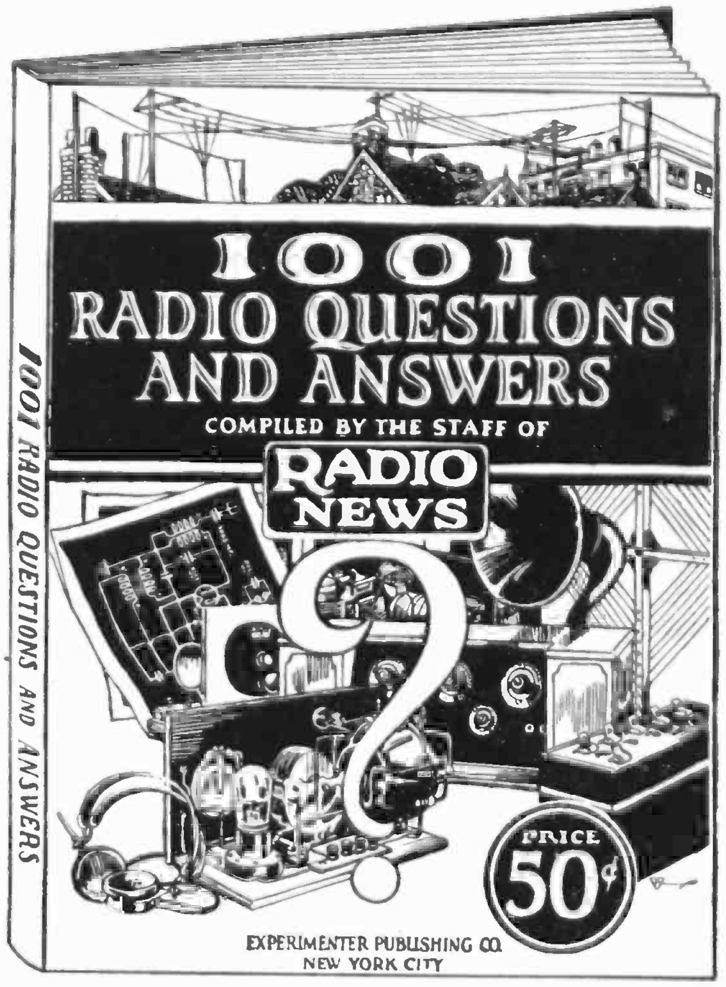

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Building the Aero-Dyne Receiver

(*Continued from page 133*)

neath the sub-base in order to present the best of appearance.

The coils should be mounted as shown in the sketch, the antenna coil upright, second RF coil horizontal and with its axis at right angles to the panel, and the third coil (detector), horizontal with its axis parallel to the panel. This mounting provides the minimum of interstage magnetic coupling and makes oscillation control very much easier. The condensers, tube sockets, audio transformers, rheostats, varible resistance and filament switch are mounted to the baseboard and panel in the positions clearly shown. It is a good plan to attach soldering lugs to all terminals of apparatus before it is mounted, making sure that all contacts are tight and will not work loose. Inspect the tube sockets especially as they are the greatest source of trouble. Check each wire on the drawing with a pencil. Wire directly from the plus A post, through all the sockets and rheostats back until you end up at the minus A post. Then check the wiring once, insert five tubes in the sockets and connect a storage battery to the proper posts. Snap the filament switch and control the brilliancy of the filaments with the rheostats. The left hand rheostat controls the RF tubes, the center controls the detector, and the right hand controls the two audio tubes. If everything checks OK, go on with the wiring, if not carefully recheck until you find the trouble. Many blown tubes can be saved by these precautions.

The rest of the wiring is simple. Keep all grid and plate leads as short and direct as possible and of nearly the same length. Wire in the varible resistance and by-pass condensers, being certain that the connections of these latter are exactly as shown. If the mfd. by-pass is incorrectly connected a great deal of unsatisfactory oscillation may result.

When the wiring is complete, connect up the batteries and insert one tube in the socket. It should control the same as before. If anything has been done wrong, this procedure will save the other four. Everything will probably be found OK, the other tubes should be inserted and filaments lighted to average brilliancy. Insert phones in first jack and connect antenna and ground. Set the three tuning dials at the same reading, and vary the adjustable resistance. The set should go into oscillation as the resistance is decreased or turned to the right. This condition is manifested by a soft swish or thud, accompanied by increase in volume of static or signals. The sensitive position of the variable resistance for distant reception is just below, and as close as possible, to this point of oscillation. The set will only oscillate when the three dials are in resonance.

Now adjust the primary on the antenna coupler to about 15 degrees from the main coil, as shown in the photograph. Sweep the scale, from zero to 100, keeping all three dials in step, and the receiver just below the point of oscillation with the variable resistance. The position of this resistance will be different for every wave-length (for best distance reception) and will be further to the right for higher wavelengths. For local reception the resistance need seldom be touched.

The adjustable primary coil is one of the biggest features of this system's success under varying interference conditions. Lifting the primary further away from the secondary increases selectivity and decreases volume. Putting it closer causes the opposite to be true. The best compromise for each condition of interference, length of antenna, etc., can be best found by trial. When local stations are off the air, of course, the best distance reception can be had with the primary coil fairly close to the secondary. The user should familiarize himself with these effects so that he may obtain the most out of the set.

If all instructions are carefully followed and the simple operation clearly understood, there is no reason why the user cannot obtain very superior results with this system. Some remarkable distance records have been obtained right through adverse conditions of local interference, when other similar sets have been helpless. Again the superiority of good design, low-loss parts, careful attention to detail and complete instruction in operation, triumphs!

Up-to-Date Tuning Control

(*Continued from page* 149)

dials or some form of so-called Vernier was used. These controls were simple and efficient. Variation in antenna and in tubes was taken care of. Each circuit was operated in maximum. Once located, a station could be logged and returned to at will.

The awkwardness of the three separated controls early led to attempts toward simplification. A single main control driving all three condensers with separate small condensers for final adjustment of each circuit was used for tuned radio circuits. This had the advantage of making the rough adjustment easier, but three separated controls were still necessary. Unless all controls were in the exact position, signals, especially the weaker ones, were lost. This device was also difficult to log. A similar result was obtained by loosely connecting the condensers so that all could be moved together or the tuning controls set separately. This device could be logged, but was not particularly easy to handle. This and similar devices were used to considerable extent, but all introduced complications, added expense and still left at least three separated adjustments to be made.

The attempt to provide actual single control encountered many snags. It was necessary to compensate for differences in antenna, tubes, slight variations in coils and condensers, and capacity effects from the surroundings of the set. The result was usually that the tuning of all circuits was broadened and the extra apparatus was added to compensate for the loss of efficiency. Results approaching and in some cases actually equalling the performance of separate controls were obtained. However, simplification of controls was procured at the sacrifice of efficiency, economy or both. To overcome the decrease of efficiency to compensate for all the variations of the set, considerable extra apparatus and expense was necessary. More careful adjustment and servicing of the whole was required to obtain anything like the same performance previously obtained with separated controls.

It remained for localized control to provide the real solution universally in its application. By centralizing all controls at one place, where all are under the fingers of one hand, single control advantages are realized. The three controls move at will as one. The station is picked up and with a slight motion of the fingertips is brought to maximum. Perhaps it is a lecture, and you wish music. Another slight motion of the fingers and another station comes in, and again, with the same controls is brought to maximum.

The motion is rapid enough to enable you to go from highest to lowest wave lengths almost instantaneously, yet the same control is so delicate that maximum value, even of the sharpest control is easily reached. Handsome appearance, universal application, with Bakelite, metal or wood panels and the elimination of body capacities have been combined by the designers of this device with the condenser corrected to get the best distribution of stations.

The localized control marks a big step forward in the simplification of radio controls. For the amateur set builders, as well as for the regular manufacturer, this new method of tuning offers advantages never before attained.

The Use of Meters in Radio Sets

(*Continued from page 98*)

in the carpet or ruining the furniture of the household on account of spilling acid.

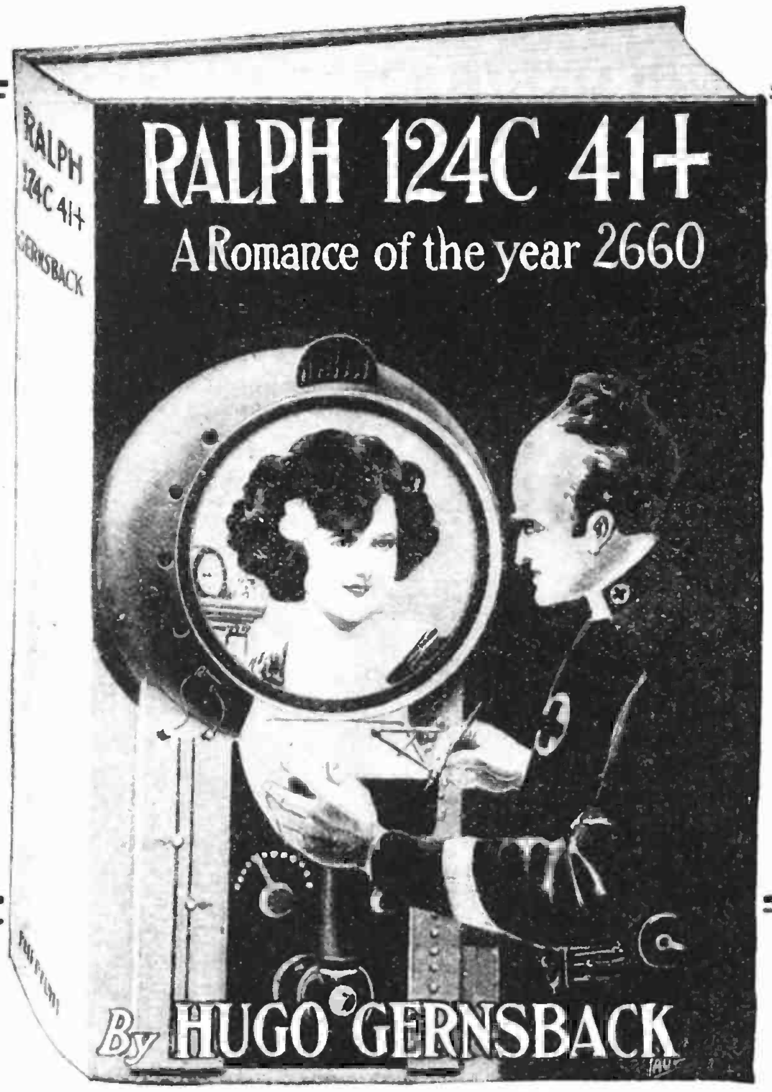
To many fans the thought of grabbing a hydrometer and finding out if the battery needs charging seems repulsive, for some strange unknown reason. Why this is so we will not hazard even a wild guess, but, alas, such is the case. However for those gentlemen, who have the anti-hydrometer complex, there has lately been introduced a remedy.

This remedy is shown in the accompanying illustration. The panel meter with the double scale should prove to be a boon to the gentlemen with the complex that we mentioned above. On the left side of the scale is indicated what the battery is doing; i. e. whether it is discharging or being charged. This is a great advantage, for many times the battery charger is in the cellar along with the storage battery and the set it upstairs. Now it is entirely possible for a system of switches to be devised so that, by merely throwing a switch, the battery is put on charge and the rate may be observed by means of this meter.

But we can hear our friend with the complex mutter, "How does that save my poking a hydrometer into the battery?" He should look closely at the other end of the meter scale before he cries; for there he will find a scale having three colors instead of the familiar figures. These colors are green, yellow and red; and if he is familiar with railroad signals he will find a similarity. Beneath the green section of the scale is marked "Full;" beneath the yellow strip will be found "½," and under the red part, which is universally known as Danger, is found "Too Low." The needle of the meter is sent to that end by merely pushing the small button in the middle of the meter. So with one of these meters installed on a receiver there really is not a great deal of excuse for not knowing the condition of a storage battery.

The other small meter is one of the more familiar type. This is also mounted on the front of the panel, is used to determine the amount of voltage at the terminals of the "A" and "B" Battery, depending on the manner in which the meter is connected. This type of meter can be obtained in several different ranges, for reading the voltage, as well as the current delivered by a battery.

The largest of the meters in the illustration should delight the heart of an experimenter, for it is really five meters in one. By connecting



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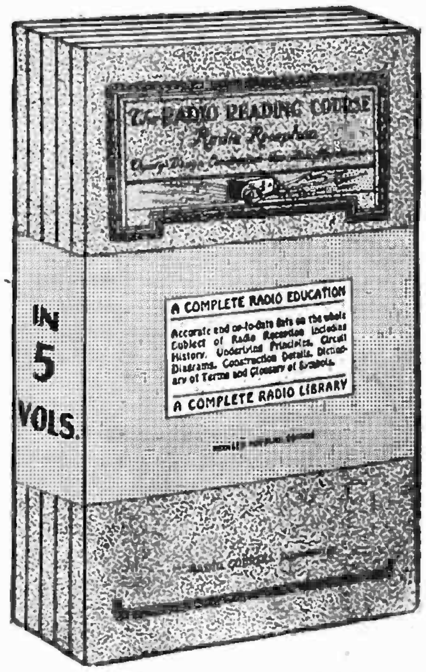

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leads to the different binding posts two voltages can be read, 0-7.5 and 0-150. The current ranges are 0-15 milliamperes, 0-75 milliamperes and 0-7.5 amperes, these being about the only ones needed by the experimenter in the radio field.

The person who is familiar with meters in general will wonder, where is the switch to throw the different resistances, that are necessary, into the circuit? This switching is taken care of in quite a unique manner. The outside rim of the round meter case is knurled, providing a grip to turn the case. An arrow on the side of the case indicates the voltage or the current to be read. For instance, suppose we wish to test the voltage of our "B" battery. We will connect the leads to the two binding posts marked 150 volts and turn the meter case until the arrow points to the same designation. The reading of the battery will be found on the upper scale of the meter, which is 0-150.

The intelligent use of meters should be cultivated by the radio fan. These little instruments are not so very expensive, and upon several occasions we have been repaid the price of the meter, many times over, in the saving of tubes. After a set is built, a voltmeter is a mighty handy instrument to have, in order to check up on the wiring and see that we are not trying to light the tubes with 90 volts or something equally foolish.

Switches and Jacks in Radio Sets

(*Continued from page* 103)

needed and a little increase in volume is desirable, the tuned primary will be found most effective.

For connecting one or the other of two fixed condensers in a circuit with an inductance or some other instrument, the circuit shown in Fig. 16 can be employed. Here another standard type of single-pole double-throw cam switch is employed and the connections are perfectly clear.

For shunting a variable condenser with a fixed condenser so as to increase the effective capacity of the variable condenser C1, the switch shown in Fig. 17 is employed. This is of the type shown in Fig. 6 and connected in the circuit with it is a fixed condenser C. Closing the cam switch connects the two condensers in parallel and opening it leaves only the condenser C1 in the circuit.

A careful study of the drawings reproduced herewith and of the directions given in connection with them will quickly show the reader a good many tricks that can be employed with jacks and switches.

Amplification Without Distortion

(*Continued from page* 141)

plate current increases, as a distance control (control of r.f. amplifying tube filaments) it does exactly the same, as an oscillation control it does the same thing in another manner. it is emphatically everything but a quality control!

Such an automatic rheostat is the well-known Amperite. This device operates on the Thermo-Electric principle.

Two ways of controlling volume are given here: In Fig. 5 we see the conventional two-step amplifier. But with a volume control in the form of a variable resistance across the secondary of the first A.F. transformer. Another way of perfectly accomplishing the same thing is given in Fig. 6,

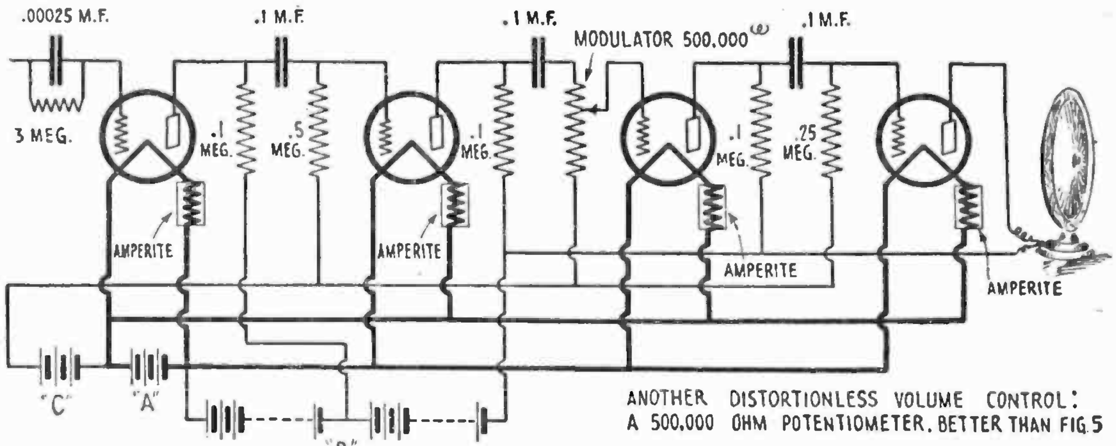

FIG. 6

The moral seems clear: The rheostat should do one thing and one thing only: regulate the filament current to its proper value. If it does so automatically, so much the better: then no one will fool around with knobs that serve only to either shorten the filament life or to distort the reception.

where we see a high resistance potentiometer arranged for resistance coupled stages—and the same purpose is accomplished.

These two examples both are distortionless and accomplish their purpose by limiting the grid-action—obviously the only correct way to control volume.

Short Wave Broadcasting and How to Receive It

(*Continued from page* 122)

wind the primary on in the same direction as the secondary, the primary consisting of 7 turns on No. 24 D.C.C. copper wire. The tickler coil is rotatable and is wound on a 2½" per wire. These three windings are indicated in Figure 6.

R_1 is the variable grid leak; C_1 the 150 mmf. condenser, C_2 is the grid condenser, having a capacity of

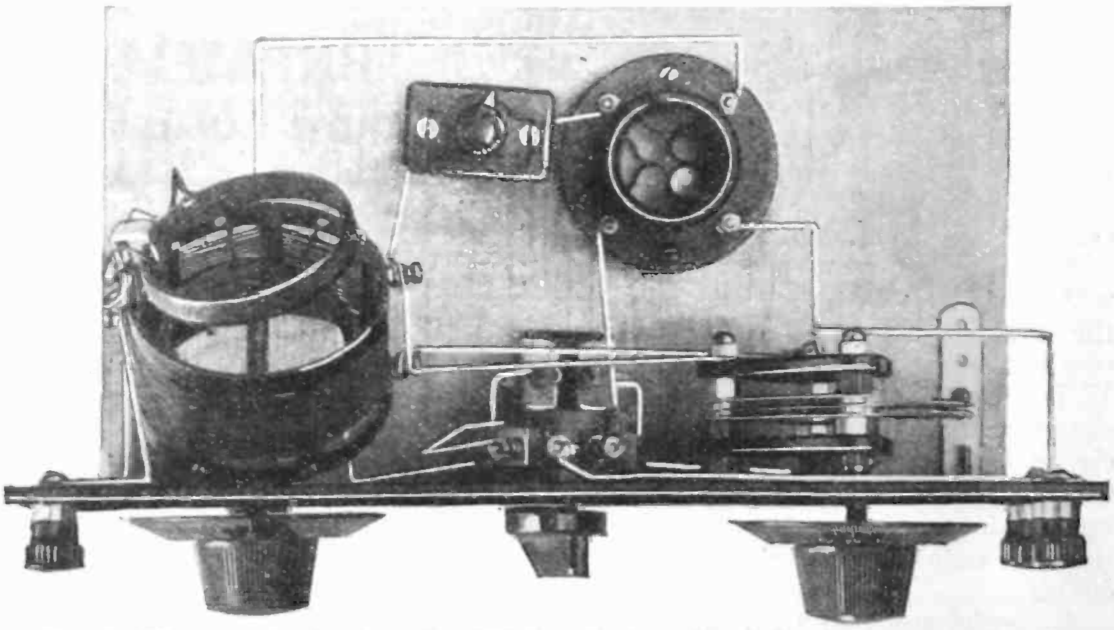

Fig. 8. This view clearly shows the mounting of the units of the short wave regenerative receiver shown in Fig. 6. A variable grid leak will assist greatly in controlling oscillations.

tube, approximately, and placed on a shaft inside the primary and secondary windings. The tickler consists of 6 turns of No. 24 D.D.C. cop-

.00025 mfd. and C_3 is a small fixed condenser (.00025 mfd.) across the phones. The resistance of the rheostat will depend upon the type of tube used.

Adding Tuned R. F. to the Three—Circuit Tuner

(Continued from page 136)

the R.F. stage and for the detector. Power tubes can be used in the audio amplifier, and will increase the volume and the quality of the signals. I am now using Hi Mu type tubes in the first two stages and a power tube in the last stage. Some of these tubes have a six volt filament and require no rheostat, but if the 201A tubes are used, one fixed resistance of from 6 to 10 ohms can be used for the 3 tubes. This also cuts down the controls on the front panel. Tonal quality can't be improved in my humble opinion. With a good cone speaker which also in my opinion is an excellent speaker, the sounds of music reach your ears in a way that must please even the most critical.

STATEMENT

Of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912, of RADIO REVIEW AND RADIO LISTENERS GUIDE AND CALL BOOK, published quarterly at New York, N. Y., for June, 1926.

State of New York, } ss.
County of New York, }

Before me, a notary public in and for the State and county aforesaid, personally appeared S. Gernsback, who, having been duly sworn according to law, deposes and says that he is the editor of the RADIO REVIEW AND RADIO LISTENERS GUIDE AND CALL BOOK, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, The Consrad Company, Inc., 64 Church Street; Editor, Sidney Gernsback, 64 Church Street; Managing Editor, W. G. Many, 64 Church Street; Business Manager, R. W. DeMott, 64 Church Street.

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is ....(This information is required from daily publications only.)

S. GERNSBACK, Editor.

Sworn to and subscribed before me this 6th day of April, 1926,

(SEAL) JOSEPH H. KRAUS.

Notary Public, Queens County Register's No. 4523, New York County Register's No. 7364, New York County Clerk's No. 481. (My commission expires March 30, 1927.)

New Radio Developments

(*Continued from page 82*)

Rheostats, resistances, etc., should not be counted as controls. In fact, there are now on the market automatic filament adjusters which satisfactorily take care of the filament temperature of the tubes, thus simplifying what would otherwise be an unnecessary complication.

Radio Forecast

Just what is this interesting and progressive industry leading to? We read every day of new and fascinating inventions which operate on radio principles. Radio controlled airships, battleships, automobiles, submarine-boats, torpedoes, etc. etc. Just at present radio is mainly being used for the broadcasting of amusement and entertainment. Its ability to serve this purpose will still further be enhanced by developments which we have every reason to believe are due in a short period, that will permit radio broadcasting of motion pictures. Its most useful accomplishing purposes will be derived when some lucky inventor will develop a practical means of broadcasting electricity or power, as it is many times referred to. What we could do if this device should be invented, is self-obvious. Flying air ships, dirigibles, with no fuel problems as the ether will then be constantly saturated with electricity. Homes, factories, trains, boats, etc., will obtain their power from the ether. Who can say, perhaps all this may come about within the next half century. At the present rate of progress being made, we have every reason to believe that this seemingly ultimate, scientific revolution, may yet be attained.

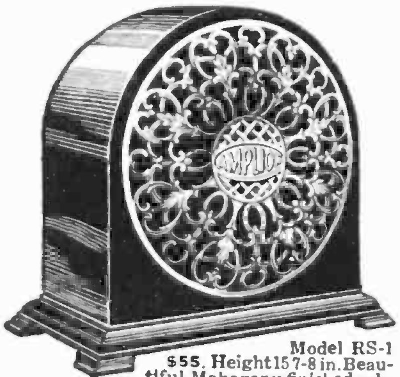
Loud Speakers, Past, Present and Future

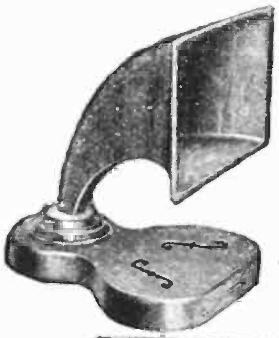
(*Continued from page 146*)

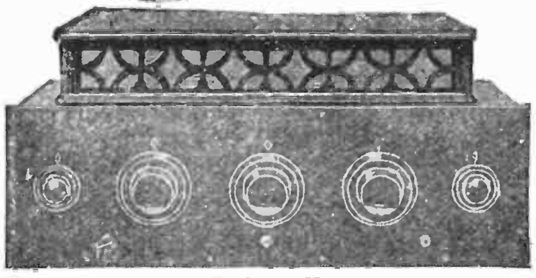
The "ultimate"speaker has not yet "arrived."

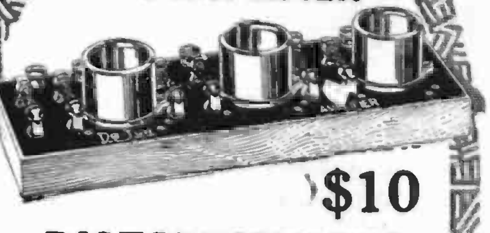
Credit must be given, however, for the wonderful improvements since 1923. It will help if the radio public will ask for and demand "quality" and prove the incentive for the manufacturer to give their best efforts in research and test.

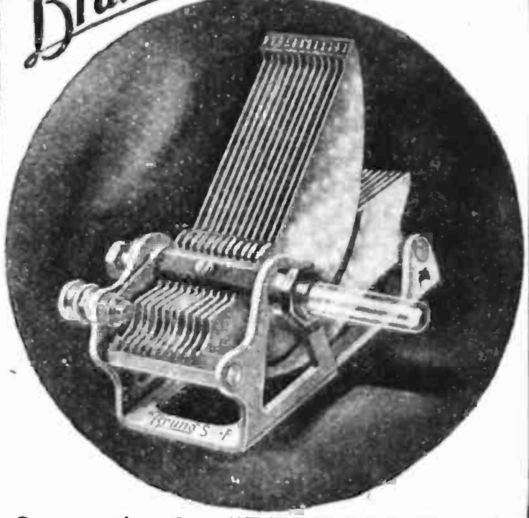
FOOTNOTE: The writer is indebted to the wonderful work of Ed. Heron Allen's "Violin Making, As It Was and Is," for the historical data given.

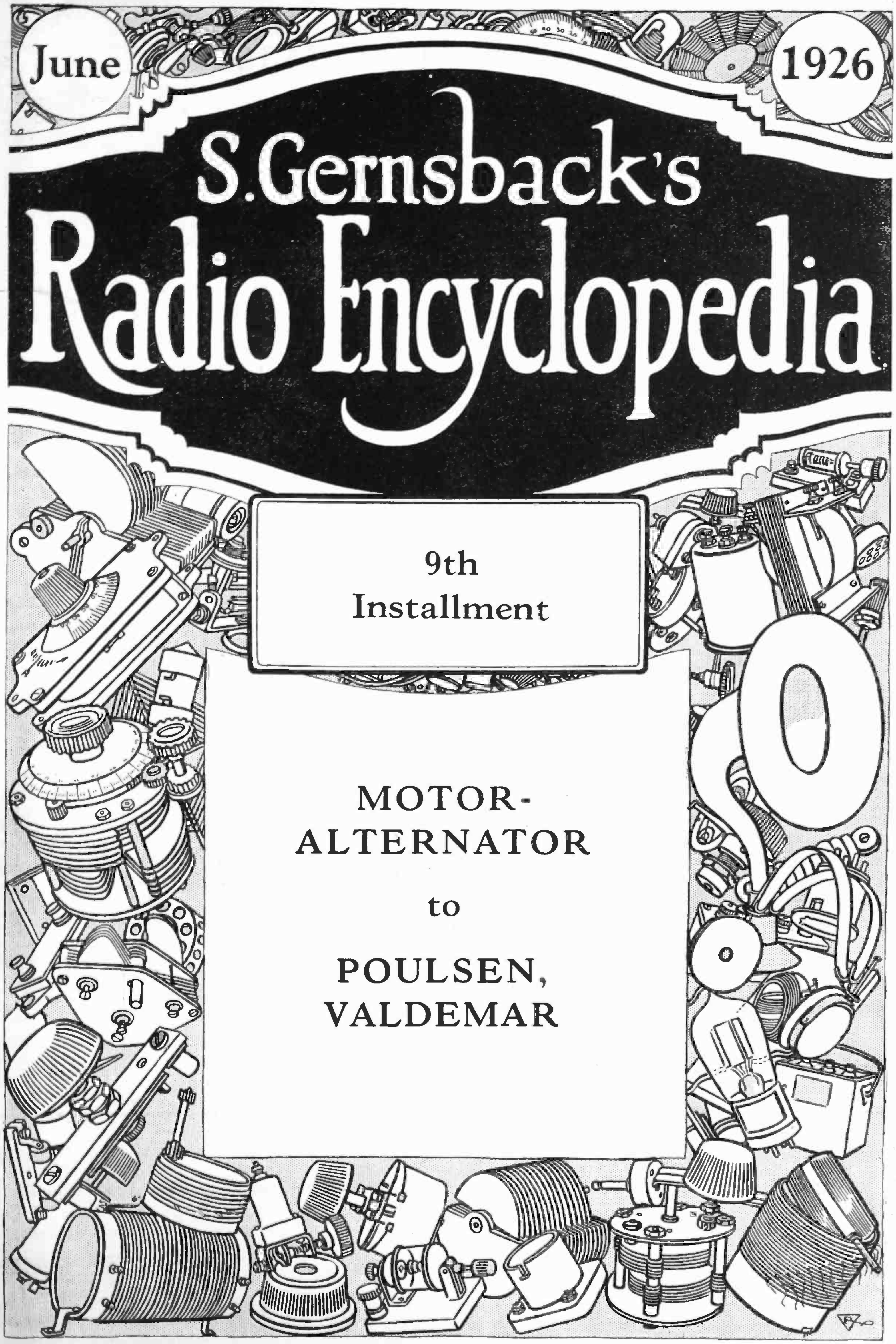












June 1926

S. Gernsback's Radio Encyclopedia

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ERRATUM

In the March issue of Radio Review, on page 188, under the heading of "*Marconi, Guglielmo,*" which appears in the Encyclopedia, it is stated that "Marconi came to England in 1876." This date should read "1896."

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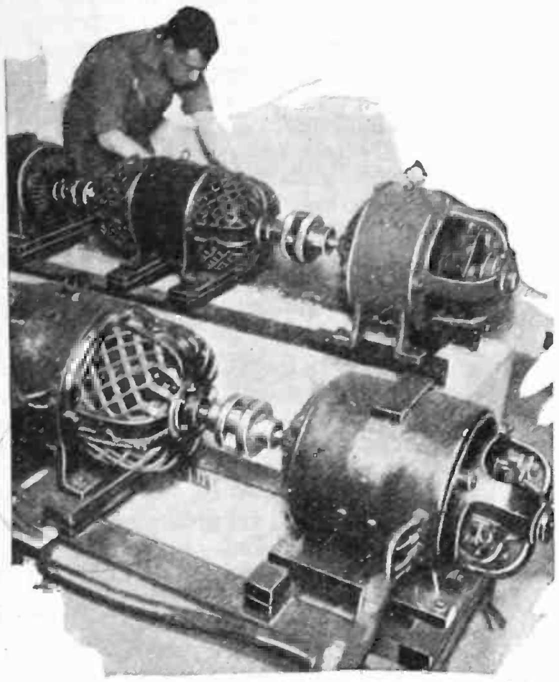
MOTOR-ALTERNATOR—A *motor generator* (q.v.) set consisting of an *alternator* (q.v.) driven by a direct or alternating current motor. Such a set



Motor Alternator set installed at Station WRNY.

may be used for converting from direct to alternating current, or for frequency changing.

MOTOR-GENERATOR—A generator or generators driven by an electric motor. Motor generators are used for converting alternating current to direct current or vice versa, for changing from one voltage or from one frequency to another or to obtain a variable from a fixed voltage.

MOVABLE COIL—Inductance coils which can be moved or rotated so as to vary the inductance. Examples of movable coils used in radio are vario couplers, loose couplers, etc. (See *Coupler, Loose; Coupler, Vario,* also *Fixed Coils.*)

MULLARD, S. R.—British radio authority. Born in 1884, he was educated as an electrical engineer and was ultimately appointed head of the research laboratory of Edison & Swan, Ltd., where he developed the Pointolite arc lamp. During the World War, he served in the Royal Air Force and became head of the wireless section laboratory at the Imperial College of Science for the Air Ministry. He carried out a series of researches on vacuum tubes and in 1920 founded the Mullard Radio Valve Company.

MULTIPLE—As applied to an electric circuit, a divided circuit. Two conductors are said to be connected in multiple or *parallel* (q.v.) when their two ends are joined together.

MULTIPLE SERIES—See *Series Parallel.*

MULTIPLIER—A resistance placed in series with a voltmeter for limiting and controlling the amount of current flowing through the voltmeter windings. This resistance may be either internal (enclosed by the voltmeter case) or external.

MULTI-POLAR—Having more than two poles. Usually a generator or motor whose field magnet has more than two poles. Small machines may be made with two poles, *bi-polar* (q.v.), but all others have a number of poles, that is to say they are *multi-polar.* The use of multi-poles results in a lighter machine and incidentally there is a saving of field copper and a reduction in sparking. If there are too many poles, however, there will be excessive *leakage flux* between the poles. (*See Homo-polar.*)

MUSICAL SPARK—A spark giving a regular distinct musical note. This may be produced by a high speed rotary discharger, a *quenched gap* (q.v.) or an arc.

MUSICAL SPARK SIGNALS—Signals in which the sparks occur at regular intervals of time and fast enough to give a musical note. Usually the spark rate is between 100 to 1200 discharges per second.

MUTE ANTENNA—A local circuit or resistor used in testing transmitting apparatus. The mute antenna in this case is substituted in the place of the actual antenna. It is also referred to as a *dummy aerial, phantom antenna, mock antenna,* or *artificial antenna.*

MUTUAL CAPACITY—The capacity effect of one conductor upon another one in the same electrostatic field. The mutual capacity is not the same as the capacity of the two wires regarded as the two plates of a condenser, one positively charged while the other is charged negatively. It really represents a decrease in the capacity of one of the wires with respect to earth caused by the presence of the electrostatic field of the other. The total capacity of the two wires is diminished by the overlapping of the two individual fields. (See *Capacity Measurement of Antenna.*)

MUTUAL INDUCTANCE—Symbol M—The magnetic flux that is common or mutual to two inductively coupled circuits. The mutual inductance of two circuits is the change in the interlinkage of flux that takes place in one circuit for a change of unit current in the other. This is also called the *coefficient* of *mutual induction* or the *mutual induction coefficient.* The units of mutual inductance are the same as those of *self-inductance.* (See *Inductance, Mutual; Self-Inductance, Induction, Coupling, Induced E.M.F., Induction, Mutual; Coefficient,* and *Mutual Induction Coefficient.*)

MUTUAL INDUCTION—The interaction between two current-carrying coils, not having direct metallic connection. The reactance of a coil such as shown in the illustration at A_1 is reduced by the proximity of another coil, A_2 if the circuit of the latter contains no external source of electromotive force, such as an alternator. The reason for this lessening in the primary reactance is that the flux excited by the first coil induces a current in the secondary coil and this current opposes the action of the primary current. As a result the total *magnetomotive force* (q.v.) the *flux* (q.v.) and consequently the *counter-electromotive*

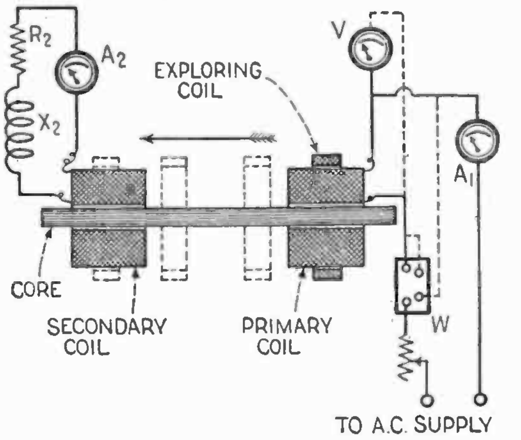


Diagram illustrating mutual inductance. The reactance of the coil A_1 is reduced by the proximity of coil A_2, since the circuit of A_2 contains no source of electromotive force. The effect of the secondary coil depends not only upon its distance from the primary coil but also upon R_2 and X_2. The presence of the iron core greatly increases the action.

force (q.v) induced in the first coil are reduced. The effect of the secondary coil depends upon its distance from the primary coil and upon the amounts of the resistance R_2 and reactance X_2. If both coils are mounted on the same iron core, the action is greatly increased. In some instances mutual induction is desirable, as in the case of coupled radio circuits, or even in the ordinary transformer. In other cases, mutual inductance may be undesired as in the case where a radio antenna parallels a power line. (See *Induction, Mutual; Mutual Inductance,* also *Mutual Induction Coefficient.*)

MUTUAL INDUCTION COEFFICIENT—Another name for *mutual induction* (q.v.) That coefficient by which the rate of change of the current in a circuit must be multiplied to give the electromotive force induced in an adjacent circuit. From the principle of conservation of energy, it can be shown that the mutual inductance of a circuit A with respect to a second circuit B equals the mutual inductance of B with respect to A. (See *Mutual Inductance, Inductance, Mutual; Self-Inductance, Induction, Coefficient,* also *Coupling.*)

N

NAGYAGITE—A mineral containing lead, gold, antimony, sulphur, and tellurium. It receives its name from the location of its discovery near Nagyag in Transylvania. It is also known as black or leaf tellurium, and has been used as a crystal rectifier in conjunction with zincite.

NALLY, Edward Julian—American radio pioneer. Born April 11th, 1859, in Philadelphia, he joined the Western Union Telegraph Company in St. Louis and worked his way up in the telegraph service until in 1913, he was appointed vice-president and general manager of the Marconi Wireless Telegraph Company of America. Nally was one of the first to see the possibilities of wireless, and under his control the first commercial wireless communication was established between the United States and Japan, in 1914, and in 1920, he founded the first commercial wireless service between the United States and Great Britain, and afterwards to other countries. He was appointed the first president of the

Radio Corporation of America, and is a member of many scientific and other societies.

Edward Julian Nally.

NAME PLATE—A metal plate affixed to a radio set or other apparatus, giving the maker's name, trade name of apparatus, serial number or other details concerning the machine.

NAPERIAN BASE—The base of the so-called natural system of *logarithms* (q.v.). It is usually represented by the symbol ϵ (epsilon) and is numerically equal to 2.718 appx. (See *Damped Waves.*)

NAPERIAN LOG—See *Naperian Logarithms.*

NAPERIAN LOGARITHMS—Also called *Natural Logarithms.* Logarithms to the base ϵ. Logarithms constitute a tabular system of numbers, by which the operation of multiplication can be performed by addition, division by subtraction, involution by a single multiplication, and evolution by a single division. John Napier, Laird of Merchiston, Scotland, is generally regarded as the inventor of logarithms. The logarithms set forth by Napier were those of trigonometric functions. Later on Napier's logarithms were adapted to positive integers, using as a base the number 2.718 appx. and these logarithms are now called natural or Naperian logarithms. (See *Decrement,* also *Logarithms.*)

NATIONAL ELECTRIC CODE—A uniform code of rules, based upon the requirements of fire underwriters, for the electric wiring and electric installations in buildings. Unless these rules are compiled with fire insurance will not be issued or if issued previously will be voided. The National Electric Code contains a section covering special requirements for radio installations. The code is revised annually to meet new conditions and requirements. Copies of the code can be obtained from local insurance agents or from the National Board of Fire Underwriters at New York or Chicago.

NATURAL ELECTRIC WAVES—Wireless waves due to natural causes such as lightning discharges. When received in the radio apparatus, they are called *strays* (q.v.), *static* (q.v.), atmospherics, *X's* (q.v.), and various other names. There are many different causes for these stray waves. Some produce a grinding noise in the loud speaker, others a hissing noise often associated with snow or rain. Nearby lightning produces a sharp snap. Another type of strays cause loud crashes in the speaker.

NATURAL MAGNET—A substance which possesses in a natural state the properties of a magnet. Such a substance is the *lodestone,* a magnetic oxide of iron also called *magnetite* (q.v.). (See *Loadstone.*)

NATURAL FREQUENCY—The frequency at which free oscillations occur in a circuit. If L, C, and R are respectively the inductance, capacity and resistance of a circuit, then free oscillations in the circuit will have the frequency

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

This is the natural or *fundamental frequency* of the circuit. The natural frequency of an aerial is the frequency corresponding to the natural wave length. (See *Natural Wave Length,* also *Measurement of Wave Length.*)

NATURAL RECTIFIER—A mineral which possesses the property of conducting an electric current in one direction only. (See *Crystal,* also *Crystal Detector.*)

NATURAL WAVE-LENGTH—Length of the wave emitted by an aerial when no added inductance or capacity is inserted in the aerial circuit. This is also known as the *fundamental wave length* (q.v.). By putting *inductance coils* (q.v.) (*loading inductance*) (q.v.) in the aerial circuit, longer waves may be radiated, while condensers put in series with the antenna enable it to produce shorter waves than the aerial would ordinarily radiate. The use of a series condenser is avoided wherever possible since it has the effect of decreasing the total capacity of the aerial circuit and thereby decreasing the amount of power which can be given to the antenna. The addition of some inductance has a beneficial effect, since the decrement of the aerial is thereby lessened and a sharper wave results. (See *Measurement of Wave Length; Wave Length.*)

NAUTICAL MILE—abbreviation *Naut*—A marine unit of distance. Equivalent to one minute of longitude at the equator. This unit is also sometimes referred to as a *Telegraph Naut.* It is equal to 1.1528 statute miles (the statute mile being equal to 5,280 feet). The term *nautical mile* is used especially in submarine cable work, and also in matters pertaining to navigation. The term *naut* is differentiated from *knot* in that the former refers to a distance whereas the latter refers to a rate or unit of speed.

NEGATIVE CARRIER*—An electron combined with neutral gas molecules. When the velocity of the electrons in a vacuum tube is less than the value necessary to cause ionization by collision, the electrons attract the neutral gas molecules and so form heavy negative carriers. The ease with which this formation of negative carriers takes place depends on the nature of the gas. Such gases as argon and mercury vapor do not readily form negative carriers, while hydrogen and oxygen combine with electrons more easily. The effect of this negative carrier formation is to counteract the reduction of the negative space charge occasioned by the heavy positive ions formed by collision ionization. The positive ions are ions of the gas from which one or more electrons have been removed. The ions therefore have very nearly the same weight as the gas atoms. The negative carriers, on the other hand, may consist of an atom or molecule to which has been attached an electron. It is also possible that the attraction between an electron and the neutral gas molecules can result in the formation of clusters consisting of more than one molecule held together by the electron. These negative carriers, therefore, move as slowly as, and often more slowly than, the positive ions and consequently have a relatively great effect in counteracting the tendency of the positive ions to reduce the negative space charge of the electrons. (See *Electron Theory,* also *Ion.*)

(*Van der Bijl—The Thermionic Vacuum Tube.)

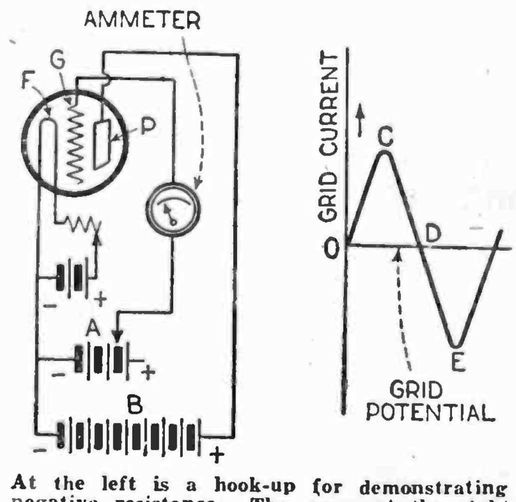
NEGATIVE CORPUSCLE—The natural unit of negative electricity. The *electron* (q.v.). It is more usual to refer to the negative corpuscle simply as the *corpuscle.* This was the name given by Sir J. J. Thomson to the carriers of electricity shot off from the cathodes in vacuum tubes. The corpuscle was found to have a charge equal to the electron and a mass which is $\frac{1}{1845}$ of that of the hydrogen atom.

NEGATIVE ELECTRODE—In a *primary cell* (q.v.) the *cathode* (q.v.) which is the carbon, copper, etc., electrode, is the *negative electrode,* while the *pole* of this electrode is the positive pole, since it is positive in relation to the external circuit. In a *secondary* or *storage cell,* the spongy lead plate, which is the anode during discharge, is called the *negative electrode* and its pole the *negative pole.*

NEGATIVE ION—An atom, which is the smallest particle of an element capable of existing, plus an *electron* (q.v.) (See *Anion, Cathion, Electron Theory,* also *Ion.*)

NEGATIVE POLE—The south-seeking end of a magnet. In a generator, the terminal into which the current returns from the external circuit. In a storage cell, the terminal of the negative plate. In a primary cell, the pole of the positive plate.

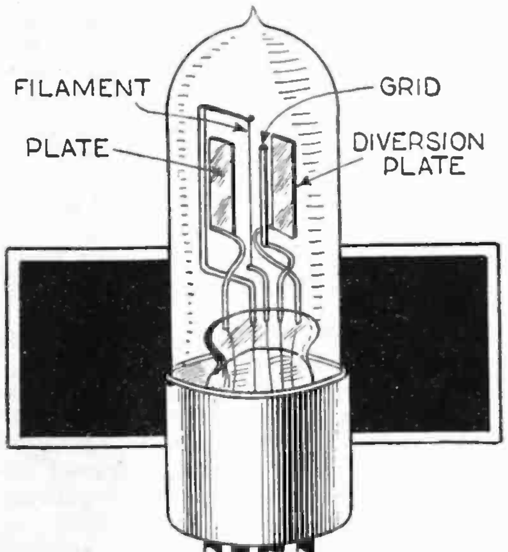
NEGATIVE RESISTANCE—A current path within a vacuum tube or an arc in which current decreases as voltage increases. The emission of electrons from cold electrodes under the impact of electrons (known as *secondary electron emission* (q.v.) or *delta rays*) results in a negative resistance or *falling characteristic.* The presence of sec-



At the left is a hook-up for demonstrating negative resistance. The curve at the right shows the decrease of grid current although grid potential is increased.

ondary electrons can be shown by referring to the illustration. The plate P is kept at a constant positive potential with respect to the filament F by means of the battery B. When there is no difference of potential between the filament and the grid G, the current in the circuit FGA is very small, since practically all the electrons emitted from the filament are drawn through the openings of the grid and thrown on to the plate. If the potential of the grid (positive with respect to the filament) is increased, the current to the grid at first increases, as shown by the part OC in the accompanying curve. When the grid potential reaches a certain value, the current as indicated by the ammeter begins to decrease, drops down to zero at D and then reverses its direction of flow. The reason for this is that while the difference of potential between the filament and the grid is small, the electrons that strike the grid enter it, but as the positive grid potential is increased the electrons on striking the grid emit *secondary electrons* from it and these are drawn to the plate which is maintained by the battery B at a positive potential, with respect to the grid. The net current as shown by the ammeter is the sum of the electrons entering the grid and those leaving it. When the velocity with which the electrons strike the grid increases beyond a certain value, one primary electron can knock out more than one secondary electron from the grid and the current in the filament-grid circuit reverses. When the positive grid potential is increased to such an extent that the grid becomes positive with respect to the plate, the secondary electrons are no longer drawn away to the plate, but are driven back to the grid so that the reversed current in the grid circuit again decreases as shown at E on the curve, and finally assumes the original direction. Hence, considering the current as indicated by the ammeter and the voltage between filament and grid, it can be seen that over the portion of the curve CDE, the current decreases as the voltage increases. Therefore CDE represents a *negative resistance* characteristic. It has been found that a device which possesses a negative resistance can function as an amplifier and also as a generator of continuous oscillations.

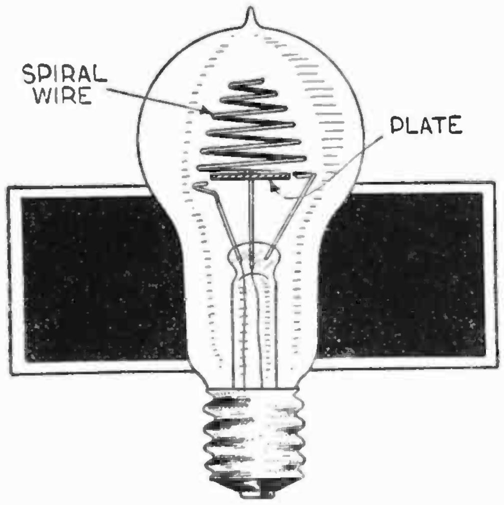
NEGATRON—An English vacuum tube



A negatron tube, showing the two plate construction.

containing a filament, a grid and two plates. This tube was devised by J. Scott-Taggart, who used it for obtaining *negative resistance* (q.v.) characteristics. The two plates are fixed one on each side of the filament. The accompanying illustration shows a typical negatron. The bulb is tubular in shape and the four electrodes are plainly shown. The grid, in this tube, is a metal rod.

NEON LAMP—An incandescent lamp in which a reddish light is produced by the incandescence of neon gas at low pressure. This lamp has very low current consumption and has been applied to pilot lights, signs, etc.



Neon Lamp

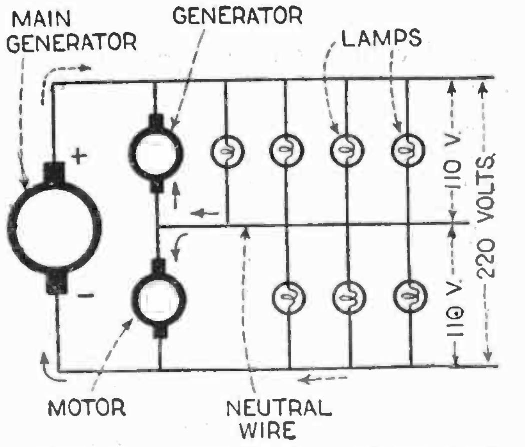
NEON TUBE—A vacuum tube containing the gas neon at low pressure used in the Fleming *Cynometer* (q.v.) etc. In this instrument, which is used to measure the frequency of electric waves, wave lengths, etc., a capacity formed by one brass tube sliding over another can be varied simultaneously with an inductance consisting of an air core solenoid and arranged so that the point at which resonance takes place is indicated by the glowing of the *neon tube* and can be read from a calibrated scale.

NERNST LAMP—An incandescent lamp in which the incandescent body consists of a strip of material composed of a mixture of oxides of metal such as zirconium, magnesium and other refractory oxides. The incandescent portion of the lamp is called the *glower* and is conductive only at a high temperature. Consequently it has to be heated by an auxiliary heating coil. The heating coil is automatically cut out of the circuit when the current starts to flow through the glower.

NEUTRAL BODY—A body void of electrification. A charged body which loses its electrification is said to be *discharged* or *neutralized*. All matter is capable of electrification.

NEUTRAL LINE OF MAGNET—The middle portion between the two magnetic poles of a bar magnet, where there is no manifestation of magnetism.

NEUTRAL WIRE—A middle wire, in a *three wire system* (q.v.) of power distribution, which is kept at a potential mid-way between the positive and the negative mains. In the three-phase system of alternating current distribution, the conductor connected to the neutral point of a "star" or "Y" connected alternator is also known as the neutral wire. The neutral wire is here also known as the *common return*.



A three wire system with unbalanced load, showing neutral wire.

NEUTRODYNE—See *Neutrodyne Circuit*, also *Hazeltine Neutrodyne Receiver*.

NEUTRODYNE CIRCUIT—A circuit

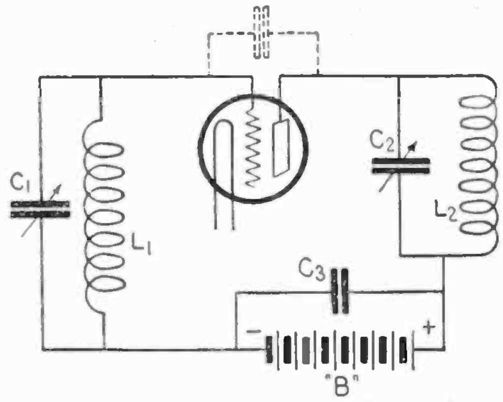


Fig. 1. A portion of a receiving circuit. Dotted line shows tube capacity represented by an equivalent condenser.

used in radio reception in which radio frequency amplification is used for neutralizing the effects of capacity of the tube and its socket. Figure 1 shows a portion of a receiving circuit. In this diagram the tube capacity is represented by a condenser shown in dotted lines. By studying this circuit, it can be seen that a closed oscillatory circuit exists, made up of the inductances and capacities in the plate and grid circuits. Just as radio frequency currents can pass through condensers in a receiving set, so they can pass through or across the vacuum tube from the plate to the grid, which forms a condenser. This condenser effect is the reason why radio frequency amplifiers oscillate. A difference of potential occurs in the plate side of the coil in the plate circuit. Instead of this being handed on to the next tube for additional amplification, a portion of this potential leaks through the capacity of the tube and its socket and affects the grid in such a way that trouble is experienced with self-oscillation. In the neutrodyne circuit, the

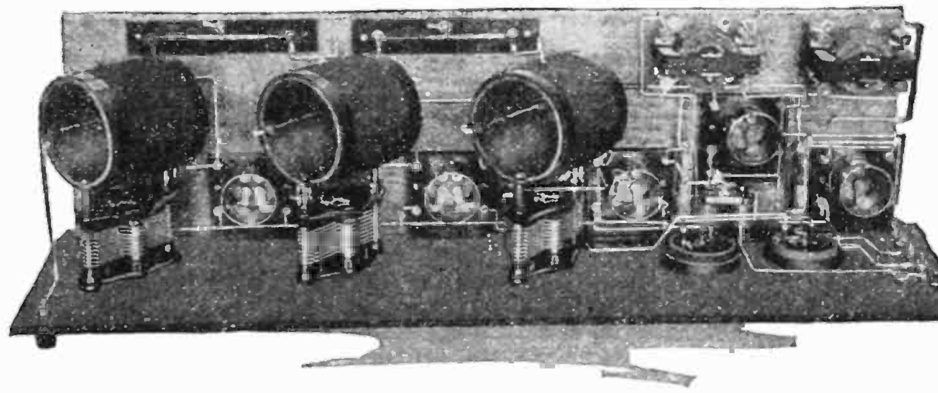


Fig. 2. A typical neutrodyne set.

inter-element capacity of the amplifier vacuum tubes is neutralized by means of special condensers called *neutrodons*. The capacity of these is very low, being approximately equal to the internal capacity of a vacuum tube. By reason of this equality, any tendency of a large amount of radio frequency current to pass back through the tube through the grid is defeated and instead is neutralized by the combination of the neutralizing capacities, the inter-element capacity of the vacuum tubes and the secondary windings of the tuned radio frequency transformers. This effect is in reality a bucking one, since the current is made to take two paths. Each neutralizing condenser must be adjusted so that its capacity will equal that of the vacuum tube it is connected with. Since it is impossible for a neutrodyne circuit to oscillate, there is no radiation of energy from the set, with consequent disturbance of other receiving sets in the vicinity.

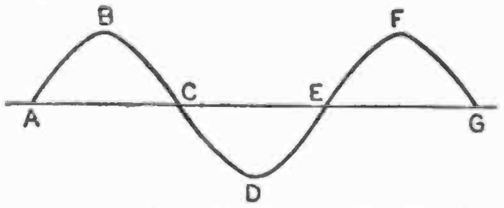
The neutrodyne circuit was invented by Professor L. A. Hazeltine. The typical neutrodyne receiving set uses five tubes, employing two stages of tuned and neutralized radio frequency amplification, with detector and two audio frequency stages. (See *Hazeltine Neutrodyne Receiver.*)

NICHROME WIRE—A nickel-chromium-steel alloy wire, which is able to withstand a bright red heat in the atmosphere without oxidizing. Nichrome is practically non-corrosive. It has a very high melting point, about 1550 degrees Centigrade and is used extensively in electrical heating appliances and resistance elements.

NIGHT EFFECT—Changes in the strength of radio signals noticeable especially at night. This effect is also known as *fading* (q.v.). Fading does not generally occur in the immediate vicinity of the transmitting station. It seems to happen more often on wave lengths below 400 meters. A certain station is being received with normal intensity, when suddenly the sounds become very faint and in a few minutes they may again become normal or may even become stronger than usual. In some cases the variations from strong signals to weak take place every few minutes while in other cases there may be an interval of several hours. It has been observed that fading takes place over land more often than in radio transmission at sea.

NOBLE, Sir William—British engineer. Born in 1861 and educated at Gordon's College, Aberdeen, he thereafter entered the Aberdeen telegraph office. In 1893 he was appointed engineer for the northeast area of Scotland, rising rapidly in the service until he became chief engineer in 1919. He retired from the Post Office in 1922, and became a director of the General Electric Company and of the British Broadcasting Company. Sir William Noble has written many articles on telegraphy and telephony and is considered to be an authority on these subjects.

NODES—In a wave form, such as shown in the illustration which represents an alternating current sine wave, the zero points. Thus in the alternating current sine wave, the points of zero current or potential, at A, C, E, and G, are nodes, and the points B, D, and F are the anti-nodes or *loops* (q.v.).



Sine wave illustrating nodes and anti-nodes.

NODEN VALVE—An *electrolytic rectifier* (q.v.) which allows only current in one direction to pass through it. This rectifier utilizes an aluminum rod or cylinder as a cathode and the anode may be of iron, lead or of carbon. Ammonium phosphate is used as the electrolyte. The principal of operation of this rectifier depends upon the

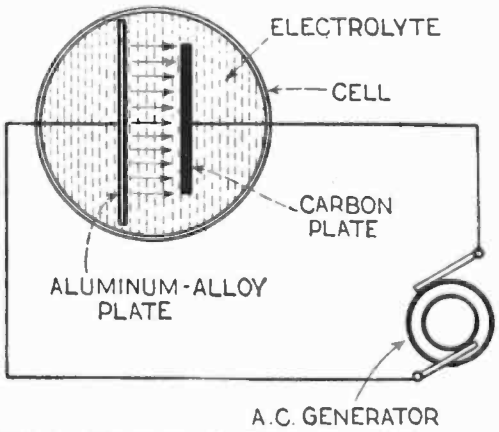


Fig. 1. Diagrammatic illustration of the principle of the Noden valve.

fact that the current in the positive direction is stopped at the aluminum plate through the formation of an in-

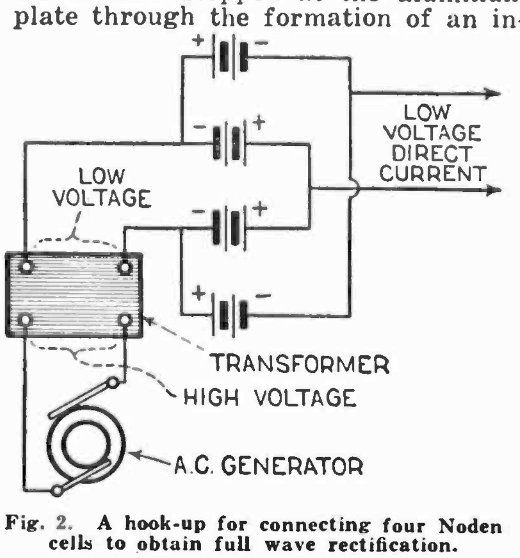


Fig. 2. A hook-up for connecting four Noden cells to obtain full wave rectification.

sulating crust of aluminum phosphate and aluminum oxide. These two substances present an extremely high resistance to the passage of the current in the positive direction, but the compounds dissolve again upon reversal of the current. By suitably combining two or more cells, both the half waves of an alternating current can be rectified. In Fig. 1 is shown the principle upon which the Noden Valve acts, and Fig. 2 shows a hook-up for connecting four cells to obtain full wave rectification. (See *Electrolytic Rectifier Full Wave*, also *Rectifier.*)

NON-CONDUCTOR—See *Insulator.*

NON-INDUCTIVE COIL—A coil having negligible inductance. Such a coil may be wound by doubling the wire upon itself and then winding the two parallel halves side by side.

NON-OSCILLATORY—Free from oscillations or vibrations. Without periodicity, that is to say, *aperiodic* (q.v.). A current which is uniform in direction and flow and free from oscillations is said to be a non-oscillatory current. A non-oscillatory circuit is one in which an impressed potential will produce current that gradually diminishes in amplitude without reversing its direction of flow. This is also called an *aperiodic circuit* (q.v.). Such a circuit can have no natural period of oscillation.

NON-PERIODIC—See *Aperiodic*, also *non-oscillatory.*

NON-RADIATIVE ANTENNA—A combination of capacity and inductance equivalent to that of an aerial, used to test transmitting apparatus without radiating waves. (See *Mute Antenna.*)

NORTH MAGNETIC POLE—A point on the earth at a latitude 70 degrees North, longitude 97 West. The north magnetic pole does not coincide with the north (geographic) pole. (See *Magnetic Poles.*)

NORTH POLE—See *Magnetic Poles*, also *North Magnetic Pole.*

NO-VOLT RELEASE—An electro-magnetically controlled device, inserted in the field circuit of a motor so that it holds the handle of the motor starter in place on the last stud, but if the supply current fails, the magnet becomes de-magnetized and allows the spring attached to the starter handle to pull the handle back to the "off" position. This prevents damage to the windings of the motor, in case the current comes on again, since it is then necessary to start up the motor in the usual way, using the starter and gradually increasing the voltage by cutting out the limiting resistances provided in the starter. (See *Overload Release.*)

NULL METHOD—An electrical method of testing in which adjustments are made so that zero deflection is obtained in a galvanometer, as for example when using a *Wheatstone Bridge* (q.v.). This is sometimes referred to as the *zero method.* (Null is also a German word meaning zero.)

O

OCTAHEDRITE—Chemical Symbol TiO_2—Titanium dioxide, an eight sided crystal which has been used as a crystal detector for detecting and rectifying radio currents. (See *Crystal.*)

OERSTED—The unit of *reluctance* (q.v.). The reluctance or in other words, the magnetic resistance offered by a cubic centimeter of vacuum. Unit *magneto-motive-force* (q.v.) will generate a unit of *magnetic flux* (q.v.) through unit reluctance. The oersted was named after the Danish physicist, H. C. Oersted.

OHM—Symbol Ω (Omega)—The unit of electrical resistance. It is the ratio of unit *electromotive force* (q.v.) to unit current. The ohm is the basis of the entire electrical system of units and the volt and the ampere are defined in relation to it. Very elaborate apparatus is required in order to determine the ohm absolutely. However, resistances can be compared easily and once the standard is determined it is a simple matter to make duplicates. In accordance with an act of Congress, the ohm was adopted as a legal unit and defined as follows: The unit of resistance shall be what is known as the international ohm, which is substantially equal to one thousand million units of resistance of the centimeter-second-gram system of electromagnetic units and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of the length of 106.3 centimeters. Stated in English units, the ohm is specified as the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice (32 degrees Fahrenheit), 0.5050 of an ounce in mass (approximately 3/100ths of a pound), of a constant cross-sectional area and of a length of 3.487 feet.

OHMMETER—An instrument used to measure resistance directly in ohms. It is particularly adapted for measuring high resistances, although certain types of ohmmeters are made for measuring lower resistances. In one form of ohmmeter, the moving system is deflected by forces due to currents in two coils at right angles to one another. These carry currents in one case proportional to the current through the conductor under test, and in the other case proportional to the potential drop across it. This is in effect, a special form of *galvanometer* (q.v.) and when combined with a hand driven generator gives the conventional *megger* (q.v.) The bridge type ohmmeter depends on the *Wheatstone Bridge* (q.v.) principle. In this instrument, however, the rheostat resistance remains constant and the bridge arms are formed by a wire, called a *slide wire*, resistances being varied by means of a moving contact as shown in the illustration. This type of instrument is often referred to as a *slide wire ohmmeter*. While a straight slide wire is used in some types, in others the wire is wound

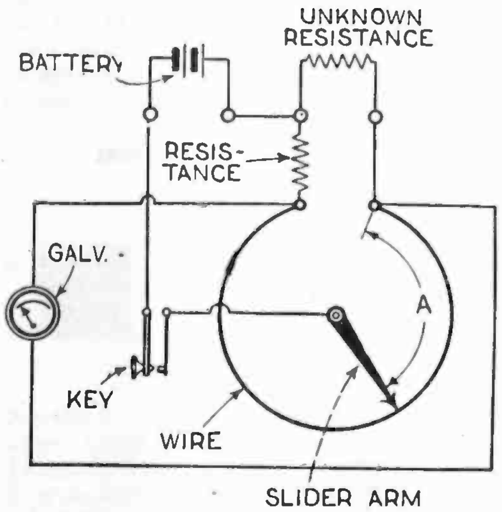


Diagram of connections of a slide wire ohmmeter.

on an insulating cylinder. In the Weston direct-reading ohmmeter, there is a permanent magnet and a moving coil having two windings and an adjustable magnetic shunt. Provisions are made for connecting an unknown resistance and an auxiliary battery in the circuit of the instrument. A checking plug is provided for checking the accuracy of the instrument before use. When the key is closed, the battery current is divided between two windings. The magnetic force exerted on the one winding, which is in series with a fixed resistance, tends to deflect the pointer up the scale, while the force exerted on the other winding tends to return it to zero. With the correct battery voltage the magnetic shunt may be adjusted to bring the pointer to full scale position. When the plug is shifted to the low range position, a resistance equal to that of the low range is removed from the circuit whose magnetic force tends to deflect the pointer towards the zero position. By connecting a resistance equal to that of the low range across the "unknown" binding posts, the previous condition is restored and the pointer will go back to the full scale position. For values of resistance lower than this the opposing force will be greater and hence the coil will be brought back to a lower position on the scale. At zero resistance across the "unknown" binding posts, the magnetic forces of the two windings will balance each other, thus causing the coil to stand at zero on the scale. The Vawter indicating ohmmeter is of the galvanometer type and utilizes two coils carried by a shaft and moving in the field of a permanent magnet. A specially shaped core is used to give the desired scale characteristics. By making connections to the coils through spirals of negligible torque, the position of the pointer does not depend upon the value of the current nor on the strength of the permanent magnet.

OHMIC COUPLING—See *Resistance Coupling*.

OHMIC DROP—The fall in potential which occurs when an electric current flows through a resistance. (See *IR Drop*.)

OHMIC LOSS—Power or energy loss due to the resistance which an electrical circuit offers to the flow of current. (See *I^2R Loss*.)

OHM'S LAW—Current flowing in a conductor will increase directly with increase of voltage and will decrease directly with increase of resistance. In other words, voltage is the cause, while current is the effect. The effect is directly dependent upon the cause and inversely dependent upon the opposition offered to the cause. Ohm's law is the fundamental law of electrical engineering. Ohm's law can be stated as an equation as follows:

$$\text{Current (in amperes)} = \frac{\text{Voltage (in volts)}}{\text{Resistance (in ohms)}}$$

or

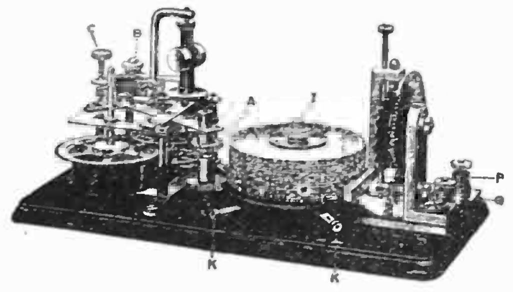
$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$$

The above three equations all mean the same thing and serve to express in various forms, the idea set forth above. Ohm's law can be applied to every conductor, provided that the conductor stays at a constant temperature, that there is no internal electromotive force in the conductor and that the distribution of the stream lines in the conductor remains unchanged. Ohm's law is easy to understand and easy to apply. Thus in a particular circuit, a certain voltage causes a certain current to flow. Double the voltage will cause double the current to flow, if the resistance is the same. If the resistance is doubled, however, the same voltage will result in only half the current flow. Double voltage and double resistance results in unchanged current flow. Ohm's law applies to a portion of an electrical circuit as well as to the entire circuit. Care must be taken when applying the law to only part of the circuit, to consider only the resistance, current and voltage of that part.

OMNIBUS BAR—A conducting bar of copper, mounted in back of a switchboard, or panel and serving as a common connector for two or more pieces of apparatus. This term is more usually shortened to *bus bar* (q.v.)

OMNIGRAPH—An intrument which sends code (dots and dashes) mechanically. It is usually operated by clockwork and is connected with a buzzer. It employs metal disc records



The omnigraph—an instrument which sends code mechanically.

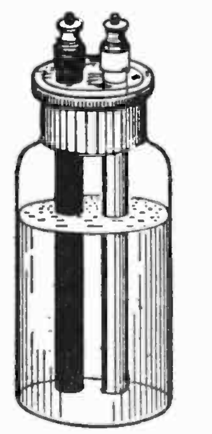
each of which has a series of notches which correspond to the dots and dashes of the telegraph code. The omnigraph is used by beginners in learning the code and is also used to test the speed of reception of applicants for radio operators' licenses.

ONDOGRAPH—An instrument for autographically recording the wave forms of varying currents, especially currents which are alternating rapidly. This form of curve tracer was invented by Hospitalier.

ONDOMETER—Another name for a *wave meter* (q.v.)

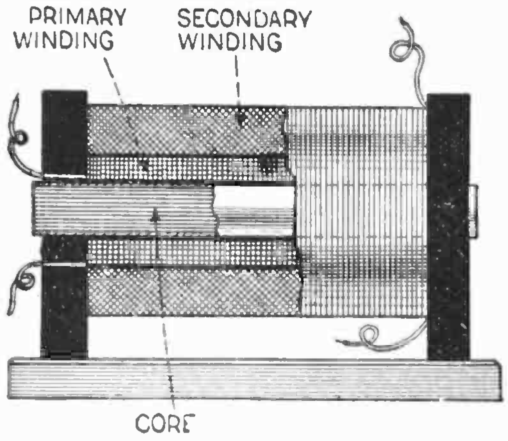
OPEN ANTENNA—According to the report of the Institute of Radio Engineers standardization committee, this is a condenser antenna, that is to say an antenna consisting of two capacity areas. Antennas may be subdivided into two general classes, those which act principally as condensers, usually simply called antennas, and those which act principally as inductances. These latter are *loop antennas* (q.v.), *coil antennas* (q.v.), etc. When electric waves reach a condenser antenna, they set up an alternating electromotive force between the wires forming the upper plate of the condenser and the ground or the other lower plate of the condenser. As a result of this alternating electromotive force, alternating current will flow in the antenna system. (See *Aerial*.)

OPEN CIRCUIT—An electrical circuit which does not offer a complete path for the flow of electricity. There may be one or more breaks in the path. An open circuit is often referred to as a *broken circuit*. Open circuits often cause trouble in radio apparatus. They may be due to the burning out of a winding, to a connection coming off a terminal, to a soldered connection breaking loose or to similar causes. The method of testing for an open circuit is to connect a battery and a headset in series with the circuit in question. If there is no click in the headset, there is evidently a break in the circuit.



An open circuit primary cell.

OPEN CIRCUIT PRIMARY CELL—A *primary cell* (q.v.) designed for intermittent use and normally kept on open circuit. Such cells usually have a *depolarizer* (q.v.) which acts slowly. In certain cases, no depolarizer whatsoever is employed. Open circuit cells are designed for use during short intervals of time only and must stand for long periods on open circuit, during which the hydrogen is gradually taken away from the negative plate. The operation of the open circuit cell will not be satisfactory if the rest periods are not long enough or are not at frequent intervals.



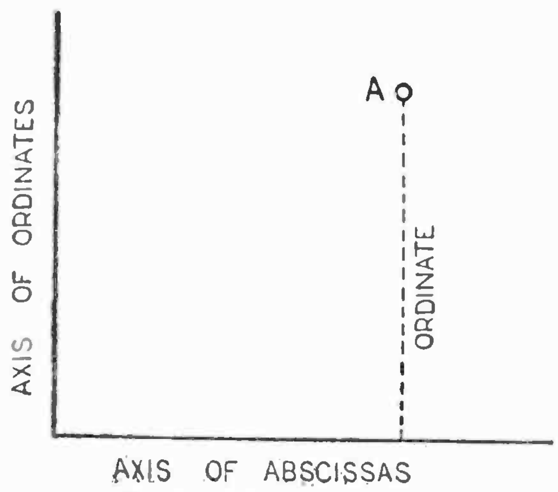
An open-core transformer.

OPEN-CORE TRANSFORMER—A transformer in which the (useful) magnetic circuit is partly through iron and partly through air, instead of entirely through iron as in the *closed-core transformer* (q.v.). It is sometimes referred to as a *polar* transformer. In one type of open-core transformer the arrangement is similar to that of an *induction coil* (q.v.), a hollow iron core, filled with soft iron wires being employed to concentrate the magnetic field.

OPPOSING ELECTROMOTIVE-FORCE—See *Back Electromotive-force.*

OPTOPHONE—An instrument utilizing a telephone receiver controlled by the variations of resistance of a *selenium cell* (q.v.) by means of which the blind are enabled to read ordinary type, through the sense of hearing.

ORDINATE—A mathematical term used in radio in making *logs* (q.v.) or other curves. Defined in mathematical language, the ordinate is that one of the coordinates of a point which is drawn parallel to a line (called the axis of ordinates) to the point from the other



The dotted line is an ordinate.

axis (called the axis of abscissas) or from the plane of the other axis of coordinates, assumed as a basis of reference. This definition will be clearer if reference is made to the accompanying illustration. The dotted line drawn from the point A to the axis of abscissas is the ordinate of the point A.

OSCILLATING CURRENT—An alternating current of high frequency, consisting of a succession of waves of constant length. In some cases, the term oscillating current refers particularly to a current where the amplitude is decreasing in constant proportion due to damping. (See *Oscillation, Oscillation Frequency,* also *Logarithmic Decrement.*)

OSCILLATING IMPULSE—*An oscillating current* set up for the purpose of producing electric waves.

OSCILLATING PERIOD—The time of one complete *oscillation* (q.v.).

OSCILLATION—Periodical surging first in one direction and then in the other. Electrical oscillations are the surgings backward and forward of current periodically, as, for example, in the case of a condenser being discharged in an oscillating circuit. The oscillating action in a discharging condenser is as follows: In the case of a condenser, positively charged, upon being discharged through an inductance, the charge rushes out of the condenser, the current increasing in strength until it reaches a maximum. Then, due to self-induction the current prolongs itself, and it continues until its energy is changed back into an electric charge of an opposite sign, current flowing into the condenser which is then charged negatively. The condenser again discharges giving a maximum current in the opposite direction. the current thereafter flowing back into the condenser with the same direction charge as at first. This action constitutes one complete swing or oscillation and the current continues to oscillate, each time becoming weaker and weaker as the energy is dissipated into heat and also partially into electric waves. It is important to note that the propagation of electric waves could not be accomplished without electrical oscillations. Thus at the transmitting station, the electrical oscillations are converted into electric waves and at the receiving station, the waves are re-converted back into oscillations.

OSCILLATION CONSTANT—The square root of the product of the capacity and the inductance of a circuit. The *natural period* of a circuit is determined by its inductance and capacity in the same manner as the natural period of a steel spring clamped at one end in a vise is determined by its mass and elasticity. Where a simple aerial is used it is an easy matter to calculate the length of a wave radiated from it, provided the oscillation constant has been found. The velocity of electric waves is approximately 3 x 10^{10}cm. per second, and hence the length of the wave radiated is about 60 times the oscillation constant where the wave length is measured in meters. (See *Aerial Tuning Condenser,* also *Isochronous.*)

OSCILLATION FREQUENCY—The number of complete oscillations or cycles flowing in a circuit per second. The oscillation frequency of a circuit varies inversely as the square root of the product of the inductance and capacity. The frequency is inversely proportional to the wave length, hence the addition of either *capacity* (q.v.) or *inductance* (q.v.) to the oscillatory circuit will result in an increase of *wave length* (q.v.). (See *Frequency.*)

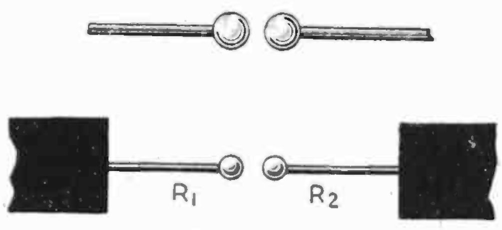
OSCILLATION POINT—That current value, known as the *critical current* (q.v.), at which the vacuum tube or tubes in a radio receiving set start to oscillate.

OSCILLATION TRANSFORMER—A high-frequency air-core transformer used for transferring electrical oscillations from one circuit to another. Either one or both the windings may be tuned to the frequency of the oscillations. The transformer used for coupling the oscillator of a transmitting set to the aerial is an example of an oscillation transformer. (See *Coupling, Inductive Coupler,* also *Transformer.*)

OSCILLATION VALVE—See *Oscillator,* also *Vacuum Tube.*

OSCILLATOR—A device or apparatus for producing electrical *oscillations.* The *vacuum tube* (q.v.) under correct conditions may be used to produce sustained oscillations of a definite amplitude and frequency. In order for a vacuum tube to act as an oscillation generator it must be capable of amplifying, part of its output energy must be returned to the input, an oscillation circuit must be combined with the tube, which possesses inductance, capacity and resistances of values such that the tube will oscillate with the desired frequency and finally the tube must have certain characteristics which when combined with the constants of the oscillatory circuit, will determine the amplitude of the oscillations. Oscillations may also be produced by means of a high frequency alternator and by a direct current generator and electric arc. (See *Alternator,* also *Alexanderson.*)

OSCILLATOR, HERTZIAN—Two insulated rods, with axes in line, with their nearer ends forming a spark gap and their outer ends bearing plates or balls to give the system the required capacity. The overall length is usually less than 6½ ft. and the whole constitutes an open oscillator. A Hertzian oscillator is sometimes called a



Typical Hertzian Oscillators.

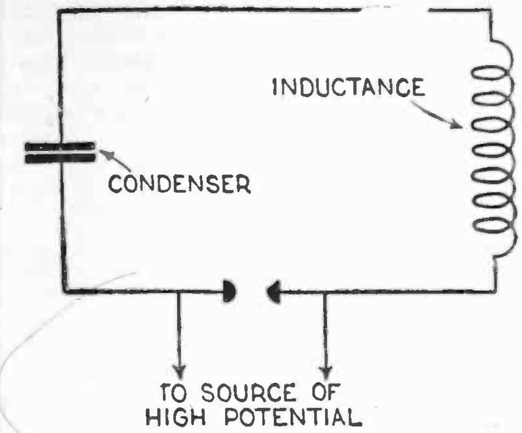
dipole. When the rods are brought near each other but not in actual contact and the conductors are connected to the terminals of an *induction coil* (q.v.) a succession of sparks can be caused to jump the gap and these set up electric waves in the *ether* (q.v.).

OSCILLATOR, LINEAR—The straight wires connected on either side of the spark gap of an induction coil, traversed by oscillations. Linear oscillators are of the open type. As used by Hertz, they consisted of two rods, having a spark gap between their adjusted ends, while their outer ends terminated in plates or balls in order to increase the capacity of the system.

OSCILLATOR, RIGHI—In this type of oscillator, the spark gap is established between two metal spheres placed between two smaller spheres. (See *Oscillator,* also *Oscillator, Hertzian.*)

OSCILLATOR, THERMIONIC—A vacuum tube used to generate continuous oscillations. (See *Oscillator.*)

OSCILLATORY CIRCUIT—A circuit possessing *inductance* (q.v.) and *capacity* (q.v.), the electrical constants being such that an oscillatory current can be set up. The accompanying figure shows a simple oscillatory circuit, consisting of a condenser, an inductance and a spark gap. When a source of high potential is connected across the spark gap and the latter is properly adjusted, the condenser is charged and there is a spark across the gap. Provided that there is not too much resistance in this circuit,



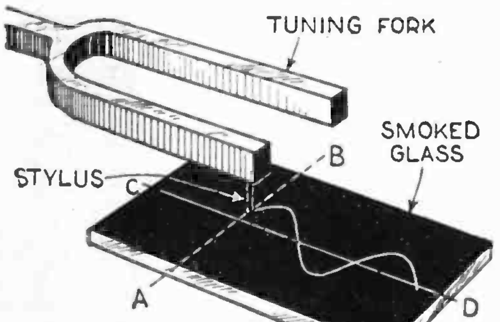
A simple oscillatory circuit.

there will be set up an *oscillating current* (q.v.) of high frequency, decreasing in amplitude according to a fixed ratio. Such a current can be used to set up electric waves. Oscillatory circuits are of two general classes, closed as shown in the illustration and open, as in the case of an aerial system. An aerial which has no tuning condenser or inductance in its circuit still has distributed inductance and capacity, whereas an aerial having a tuning inductance and a condenser in its circuit, has a combination of concentrated and distributed inductance and capacity.

OSCILLATORY CURRENT—See *Oscillating current.*

OSCILLION—Name which has been applied to the *vacuum tube* (q.v.) especially where used as an oscillation generator.

OSCILLOGRAM — A picture, graph or record of a wave form usually obtained by means of an *oscillograph* (q.v.).



An oscillogram obtained by means of a tuning fork.

The illustration shows an oscillogram obtained on smoked glass by means of a tuning fork. (See *Oscillagraph.*)

OSCILLOGRAPH — An instrument for recording photographically or showing visually the wave form of alternating currents or of other rapidly changing currents or voltages. The essential parts of such an instrument are a moving coil mirror galvanometer, a rotating or vibrating mirror and a moving photographic plate or film. Figure 1 illustrates the principle of the oscillograph and shows the curves it produces. The oscillograph was invented by M. A. Blondel in 1893. By means of the oscillograph the wave form of a current may be shown as a curve and its characteristics may thus be examined and studied. In order to form the curve, it is necessary to have simultaneous motion in two directions. The vibrator of the oscillograph which consists of a delicate coil of wire, with mirror attached, is made extremely light so that the moving system will have as little inertia as possible. The

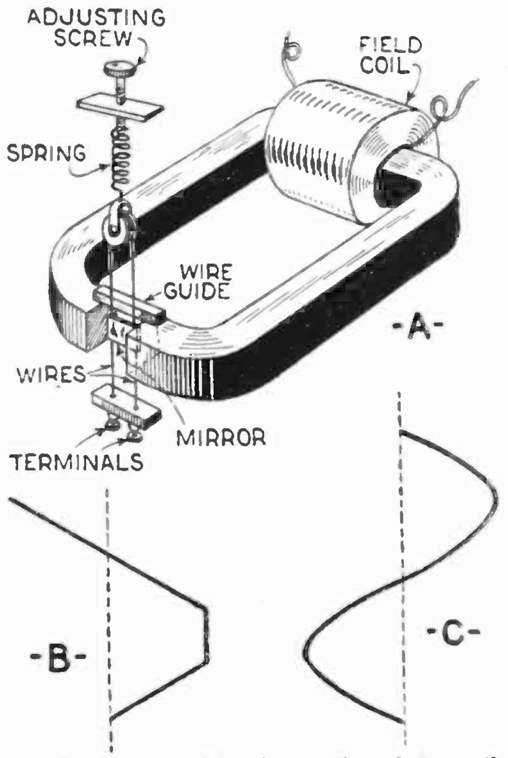


Fig. 1. The principle of operation of the oscillograph is shown at A. At B are shown diagonal and straight paths traced by the beam of light falling on a moving photographic plate. The type of curve which an oscillograph traces for alternating currents is shown at C.

coil is placed in a powerful magnetic field and when an oscillating current is passed through it, it oscillates in synchronism with the current. A spot of light focused on the mirror is made to fall on a screen at the predetermined distance from the vibrator. This spot of light traces out a straight line on the screen. Substituting a photographic film for the screen and arranging the film so that it will move in a vertical path across the moving beam of light (which is assumed to be moving from right to left across the screen) a curve is traced on the film. The commercial form of oscillographs are provided with apparatus whereby the curve may be examined without the necessity of photographing it. In these the beam of light is reflected from a rotating or vibrating mirror in

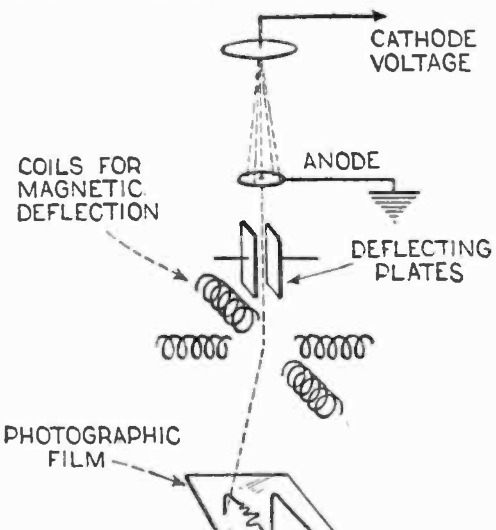


Fig. 2. A diagrammatic representation of the Dufour oscillograph.

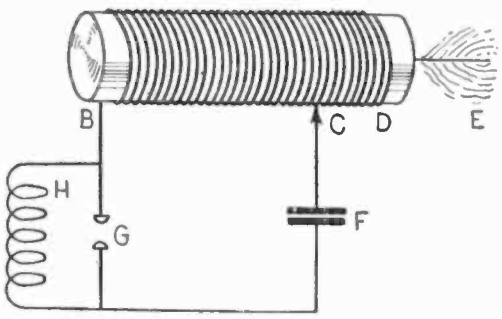
such a way that it receives a horizontal and an up and down motion and is focused onto a curved plate of glass. Tracing paper may be stretched over the glass so that the image of the spot of light traces a visible curve on it. The curve being repeated very rapidly appears to be standing still and hence it is possible to trace over it with a pencil or even to place a piece of photographic paper on the curved glass and make a record of the curve in this way. The motion picture camera has been applied to the oscillograph and is useful where longer records are required. It should be noted that oscillographs which utilize a moving coil, such as the Duddell or Blondin types, will work over a band of frequencies up to a maximum of about 300 cycles per second. Inasmuch as the oscillations common in radio work are of much higher frequency than 300 cycles, it has been found necessary to use an oscillograph whose moving parts are without appreciable weight. The use of electrons as moving parts has solved this problem. A Frenchman, Alexander Dufour has applied the Braun tube to the construction of an oscillograph which has no appreciable inertia and which is capable of operating at a frequency up to a million cycles per second. This device uses only minute amounts of energy in its operation and therefore does not disturb the original circuit. It is able to register both voltage and current simultaneously and is so arranged that a single impulse is sufficient for a photographic impression. The Dufour oscillograph consists essentially of two glass tubes fitted by means of a ground joint into a bronze chamber. The upper glass tube carries a cathode and an anode and the other tube has one pair of deflecting plates for electrostatic deflection of the electron stream. Two sets of coils perpendicular to each other are used for magnetic deflection and these are placed outside the tube and slightly below the deflecting plates. In order to photograph the oscillations, a drum is used which is provided with a film magazine allowing six films to be taken in succession. When visual examinations of the oscillations are to be made, a fluorescent screen is turned up into position covering the opening into the interior of the drum thus preventing the films from being exposed when using the screen. After the films are put into the drum, this is placed within the bronze chamber and locked into position. An air-tight door is used to close the opening and the film changing mechanism is operated by means of external controls. Glass windows on either side of the bronze chamber allow the fluorescent screen to be seen. The accompanying sketch shown at Figure 2, gives a diagrammatic representation of the operation of the Dufour oscillograph.

OSMOSIS, ELECTRIC—When an electric current is passed through an electrolyte having an anode on one side of a porous diaphragm and a cathode on the other side, there is a tendency for the liquid to pass through the diaphragm towards the cathode raising the level of the liquid on the cathode side. This phenomenon is known as electric osmosis.

OTOPHONE—A device for the hard of hearing, which utilizes an extremely sensitive microphone connected to a two-stage vacuum tube amplifier. The instrument uses dry cell tubes and the batteries are contained in the case with the microphone. A small telephone receiver completes the outfit.

OUDIN RESONATOR — A device used for obtaining high-frequency brush discharges. Discharges of this nature are used in the investigation of resonance effects and also in medical work. The accompanying diagram explains the principle of the Oudin resonator.

B D is an uninsulated coil of copper wire wound on an insulating core with each turn separated from the next adjacent one. At B, the helix is connected to an induction coil and it is tapped by means of a sliding contact at C. The sliding contact is connected through a condenser to the induction coil H, with a spark gap G in parallel



Connections of the Oudin resonator.

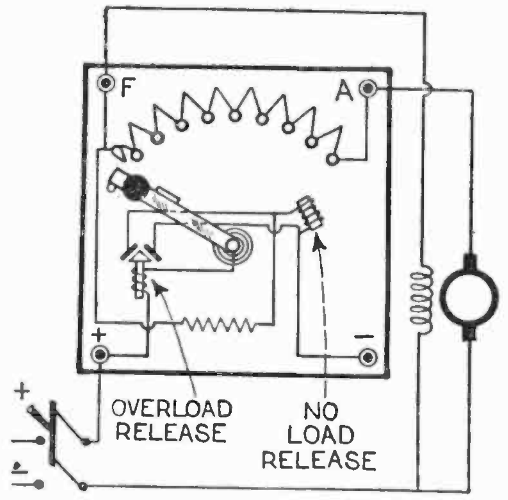
in the circuit as shown. The circuit BGFC is a closed oscillatory circuit receiving its excitation from the induction coil H. The circuit C D E is an open circuit in contact with the oscillatory circuit. By moving the sliding contact, C, a point is reached where a brush discharge appears at E, thus indicating that electric oscillations are being set up in the open circuit. (See *Brush Discharge, Corona,* also *Oscillator.*)

OUTPUT—The useful energy given out by a machine, circuit, vacuum tube or other device. (See *Input; Output, Transformer; Output Circuit of Vacuum Tube.*)

OUTPUT CIRCUIT OF VACUUM TUBE—The filament-plate circuit as differentiated from the filament-grid or input circuit. (See *Input Circuit of Vacuum Tube.*)

OUTPUT, TRANSFORMER—The product of the voltage at the secondary terminals of a transformer by the current flowing in the secondary winding. The output of any transformer is always less than the input by an amount equal to the losses. The *efficiency* of a transformer is the ratio of its useful output to the total *input.* (q.v.)

OVERLOAD RELEASE—An electromagnetic device which is used to cause a motor starter handle to return to



Overload Release.

the off position when the current exceeds a pre-determined overload value.

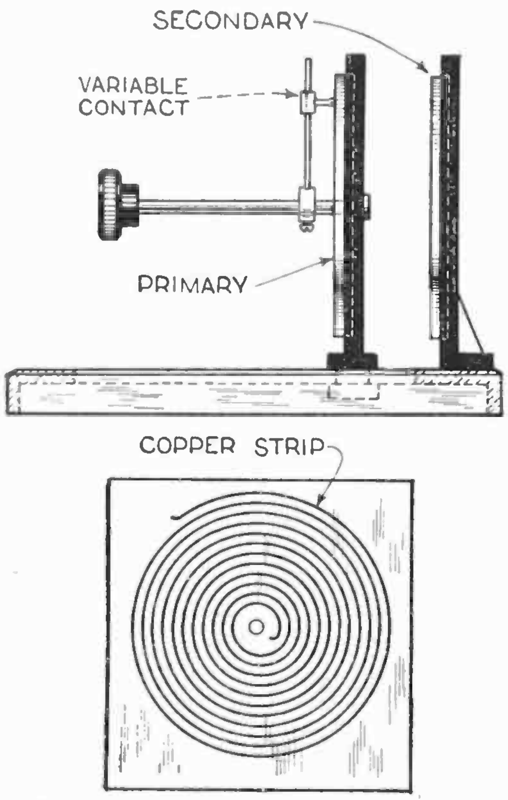
The overload magnet is usually arranged so that too strong a current will result in short-circuiting the no-volt release thus switching off the driving current. One form of overload release consists of a magnet in series with the line and the armature. This magnet is arranged to attract a pivoted iron keeper whenever excessive current flows. The pivoted arm, when attracted by the magnet, makes connection between two contacts, themselves connected so as to short circuit the holding magnet when the circuit is closed. Therefore, when more than the allowable current is drawn from the line, the overload magnet attracts its pivoted keeper which closes the circuit short-circuiting the holding magnet. The contact arm is then released by the holding magnet and the arm is pulled back to the off position, thus cutting the motor off the line. Another form of overload release utilizes an electromagnet to attract a pivoted arm, arranged so that this will break the circuit between the motor and the line. This results in operating the no-voltage release. (See *No-Volt Release.*)

OVERTONE CURRENTS—Alternating currents which have harmonic frequencies of a higher value than the fundamental or first harmonics.

OVERTONES—Higher harmonics associated with the first harmonic. This term particularly refers to sound waves. In various musical instruments, different overtones are brought out and this results in each instrument having its own tone characteristic.

P

PACKING—(referring to a *microphone*). The tendency of carbon granules in a microphone to settle or pack. In this position they are no longer sensitive and do not readily respond to the vibrations of the diaphragm. Packing may be caused by irregularity in the sizes of the carbon granules. It may be remedied by gently tapping the microphone.



Front and side view of a pancake coil.

PANCAKE COIL—A flat inductance coil. Coils of this type are used in radio receiving sets as radio frequency transformers, also as antenna couplers and oscillator couplers. They may be *basket wound* (q.v.), spider wound, etc. In wireless transmitting apparatus, aerial tuning inductances, loading inductances, and oscillation transformers (illustrated) are frequently of the pancake coil type. (See *Inductance, Antenna.*)

PANEL—A board of insulating material carrying the controlling or measuring devices of an electric circuit. The panel for controlling the charging of storage batteries is called a *charging panel.* A panel carrying generator controls is referred to as a *generator panel.* Where only a single panel is used this is usually called the *switchboard.* The usual switchboard comprises a number of panels. Switchboard panels are commonly made of marble. The usual varieties available are white Italian, pink or grey Tennessee and blue Vermont marbles. Plain slate is sometimes used for panels where the voltage is not too high. When the panels do not require a finish, soapstone is sometimes used. The front of a radio receiving set on which the dials and rheostat controls, etc., are mounted is also called a panel. These panels are usually made of Bakelite, hard rubber, composition or similar insulating substances, although a number of sets are being made with metal panels. The horizontal panel on which the sockets and transformers are usually mounted is known as the *sub-panel* (q.v.).

PANNILL, Charles Jackson—American radio pioneer. Born in Petersburg, Virginia, May 13, 1879. He entered the American Navy, 1898. In 1902 he took a post under Professor R. A. Fessenden and carried out a series of wireless experiments at Hampton Roads, later inaugurating wireless communication between New York and Philadelphia. Pannill was the first man to install wireless on the battleships of the U. S. Navy. Afterwards he carried out a series of communication experiments between various parts of the United States and erected a number of wireless stations. He joined the Marconi Wireless Telegraph Company in 1912 and became a radio adviser to the United States Government, 1914, and assistant director of Naval Communications, 1916. Pannill is a fellow of the Institute of Radio Engineers and a member of the Washington Society of Engineers.

PAPER CONDENSER—A fixed condenser, usually made of tin foil and utilizing a dielectric of paraffin-waxed paper. The 1 microfarad by-pass condenser is a typical example of a paper condenser. (See *Condenser, By-pass.*)

PARALLEL—See *Parallel Connection.*

PARALLEL CONNECTION—Two or more parts of an electrical circuit so connected that the current divides between them. This is also known as a *multiple* (q.v.) connection, *divided circuit,* or *shunt* circuit. Where a number of parts of a circuit are connected in parallel, the same potential is impressed on each part. The current flowing in each branch will depend upon the impressed voltage and the resistance of each branch. (See *Circuit, Parallel.*)

PARALLEL RESISTANCES—Resistances connected so that their terminals have the same difference of potential between them. The greater the number of resistances in parallel, the less will be the total resistance of the circuit. If there are three resistances in parallel of ½, ⅓ and ⅕ ohm, respectively, then the total resistance is equal to the reciprocal (one divided by a number) of the sum of the separate reciprocals. In this case the sum of the reciprocals is 2 plus 3 plus 5 equal to 10 and the reciprocal of this is equal to one-tenth, so that the total resistance of this parallel circuit is one-tenth of an ohm. It can be seen that the total resistance of any circuit having a number of resistances in parallel is less than the resistance of any *one* of the branches. (See *Circuits Parallel*, also *Parallel Connection*.)

PARALLEL RESONANCE—When a concentrated capacity and a concentrated inductance are connected in parallel between terminals to which an alternating electromotive force is applied, and the inductance or capacity or frequency is varied, the condition of parallel resonance exists when the current supplied by the source is a minimum. It should be noted that in series resonance, the total current supplied by the source flows through both the inductance and the capacity whereas in parallel resonance the current supplied by the source is the vectorial sum of the two currents, one flowing through the capacity and one through the inductance.

PARAMAGNETIC—Having a permeability greater than unity. Magnetic as opposed to diamagnetic. The term *paramagnetic* is used in some cases to apply to substances which have only a slightly greater permeability than air such as liquid oxygen, the rare metal erbium, etc. If used in this sense it does not include *ferro-magnetic substances* (q.v.). (See *Diamagnetic material.*)

PARTIAL—An acoustical term denoting any one of the natural vibrations of which a body is capable. An electrical *oscillator* (q.v.) possessing distributed capacity and inductance has, theoretically, an infinite number of possible frequencies, each of which is called a *partial*. The lowest frequency is called *the fundamental*. (See *Harmonics, Harmonic Current, Overtones,* also *Overtone Currents.*)

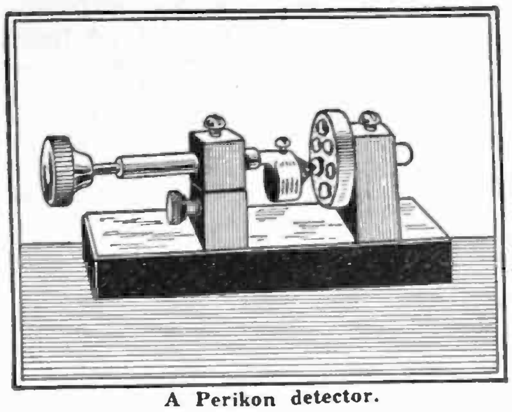
PARTITION INSULATOR—An ebonite tube having a metallic rod running through its center with wing nuts at each end. It is used for continuing a circuit through a wall or partition.

P.D.—Abbreviation for *potential difference.* (See *Potential, Difference of.*)

PELTIER EFFECT—The change in temperature, either heating or cooling, at the junction of two unlike metals, depending upon whether an electric current originating from an external electromotive force, is sent through the junction in one direction or the other. The Peltier effect is the opposite of the *thermo-electric* effect.

PERCENTAGE COUPLING—The coefficient of coupling between the primary and the secondary of an oscillation transformer in a wireless transmitting system. When the primary winding is placed close to the secondary, the coupling is said to be *close* or *tight*. When the two windings are apart the coupling is said to be *loose*. With the ordinary spark gap in the closed circuit, if the primary and the secondary windings are closely coupled a broad wave will be radiated from the aerial system. If they are loosely coupled, a *sharp* wave will be radiated.

PERIKON DETECTOR—A crystal rectifier utilizing a piece of zincite in firm contact with a piece of chalcopyrite. (See *Combination Detector,* also *Crystal Detector.*)



A Perikon detector.

PERIOD—The time required for one complete *cycle.* (q.v.) Referring to an *alternating current* (q.v.) it is the time required for the current or electromotive force to pass through the various values from zero to a positive maximum back to zero again, then to a negative maximum and finally to zero.

PERIODIC—A vibration is said to be periodic if all the phenomena are repeated regularly at equal intervals of time. This time is called *periodic time* or the *period.*

PERIODICITY—A synonym for frequency, or for angular velocity.

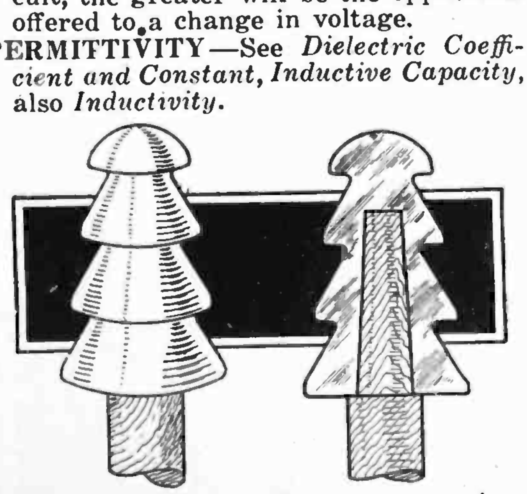
PERMANENT MAGNET—Hardened steel which when magnetized retains its magnetism after the removal of the magnetizing force. The usual method of making permanent magnets is to place the steel in a powerful electromagnetic field. They can also be made by stroking with another magnet. Permanent magnets are used in all electromagnetically operated headsets and *loud speakers.* (q.v.) (See *Magnet, Electromagnet,* also *Temporary Magnets.*)

PERMEABILITY—The *permeance* (q.v.) existing between the opposite faces of a cube of the substance each side of which is one centimeter in length. Since the permeability of air is assumed to be unity, the permeability of any substance is the ratio of the flux that passes through it to the flux that would exist in air if the magnetomotive and flux path remained unchanged.

PERMEANCE—That property of a magnetic circuit which allows the flow of magnetic flux. Its reciprocal is *reluctance* (q.v.) which is the property of a magnetic circuit by which it resists the flow of magnetic flux.

PERMITTANCE—A synonym for *capacity* (q.v.) or *capacitance* (q.v.). This property is possessed by every electrical circuit, but does not manifest itself unless there is a change in voltage. The greater the permittance of a circuit, the greater will be the opposition offered to a change in voltage.

PERMITTIVITY—See *Dielectric Coefficient and Constant, Inductive Capacity,* also *Inductivity.*

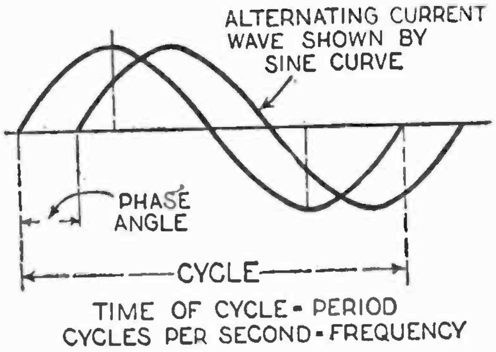


A petticoat insulator. Shown in cross-section at the right.

PETTICOAT INSULATOR—An insulator having two or more flanges or petticoats arranged one on top of the other for the purpose of reducing leakage and preventing accumulation of moisture. Petticoat insulators are usually made of porcelain. Insulators used on low tension lines are also of the petticoat type, in such cases being constructed of glass. (See *High Tension Insulator,* also *Insulator.*)

PHANTOM AERIAL—See *Mute antenna.*

PHASE—A particular state in a regularly recurring cycle of changes. In simple harmonic motion, uniform circular motion, or in periodic changes of any magnitude varying according to a simple harmonic law (as for example an alternating current) the point or stage in the period to which the rotation, oscillation or variation has advanced, considered in its relation to the position or instant of starting or to some other standard position. This relationship is usually expressed in angular measure. Defined in electrical terms, phase is the distance, usually measured as an angle, of the base of any *ordinate* (q.v.) of an alter-



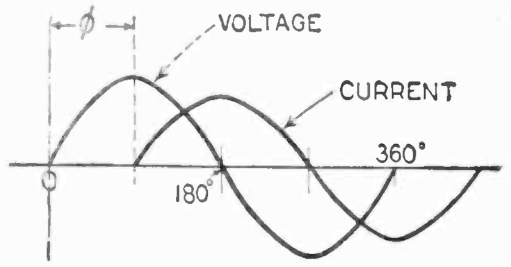
Phase displacement, cycle, etc., illustrated by means of sine curves.

nating wave from any chosen point on the time axis. This distance represents the phase of the ordinate with respect to the point. In any sinusoidal alternating current quantity, the phase at any instant may be shown by the corresponding position of a *vector* (q.v.) revolving about a point with such an angular velocity that its projection at each instant upon a chosen reference line is proportional to the value of the quantity at that instant. As an example, consider a conductor rotating in a magnetic field. The induced electromotive force, in one complete revolution, passes through the following values. It starts at zero and rises to a maximum positive value, then falls to zero and rises to a maximum positive value in the reverse direction, finally falling to zero again. The transitions through these various values constitute a *cycle* (q.v.). The time of this transition is called a *period*, the number of cycles per second being the *frequency* (q.v.). The angle at any instant through which the conductor has rotated since the electromotive force changed its sign from negative to positive is the *phase angle.* This is ordinarily designated by the Greek letter Φ (phi). If ω (omega) is the angular velocity of the rotating conductor and f the frequency, then $\omega = 2\pi f$ (since there are 2π radians in a complete revolution). If the time in seconds which has elapsed since the conductor last passed the point of zero electromotive force be represented by t, then the phase Φ at that particular instant is equal to $\omega t = 2\pi f t$. Periodic variations are conveniently expressed by sine curves and the relative phases are indicated by the relative positions of the *nodes* (q.v.) and *loops* (q.v.).

Magnitudes having maximum and minimum values occurring simultaneously are said to be *in phase.* If they do not occur simultaneously, they are *out of phase.* When the corresponding maximum or minimum values of two sinusoidal alternating quantities of the same frequency occur at different instances, the two quantities are said to differ in phase by the angle between their nearest negative maxima or their nearest positive maxima or any other nearest corresponding values. The quantity whose maximum value occurs first is said to *lead* (q.v.) the other. The quantity whose maximum value occurs later is said to *lag* (q.v.). Where one quantity lags behind another by 180 degrees, the values are said to be of *opposite phase.* An alternating current may be *single phase* or *polyphase.* Another term for polyphase is *multiphase.* In a three-phase alternating current system the three separate currents differ in phase from each other by 120 degrees. In a polyphase system, if the various phases each carry or supply equal current, the system is said to be *balanced.*

PHASE ANGLE—See *Phase.*

PHASE DISPLACEMENT—The difference in phase or the phase angle between two alternating quantities, such as voltage and current, of the



Sine curves of current and voltage, showing difference in phase.

same frequency. Such quantities do not pass through their respective maximum positive quantities or through their zero values at the same time. The instantaneous values of any sine-shaped wave can be represented as being proportional to the sine of an angle, a complete cycle being equal to 360 degrees. When two quantities are out of phase, the respective angles corresponding to each quantity at any given instant are unequal, the difference between the two angles being called the *phase displacement* or the *phase difference.* In the accompanying illustration, the current and voltage relationship in an alternating current circuit are shown by the two sine curves. As can be seen, the current and voltage are out of phase, the phase displacement being equal to the angle Φ, in this case 90 degrees ($\frac{\pi}{2}$ radians). The current reaches its maximum value at a later time than the voltage. In this case the current *lags* behind the voltage by the angle Φ, the voltage leading the current by this angle. Since the angle of lag of the current is 90 degrees, the current and voltage are said to be in *quadrature.* In an alternating current circuit having pure inductance and no resistance (a theoretical circuit, since all electrical conductors possess resistance), the current would lag by 90 degrees as in the example given. (See *Lag, Lead, Leading Current,* also *Phase.*)

PHENOMENA OF ELECTRIC WAVE PROPAGATION—Electric waves are created by electric *oscillations* (q.v.). They are often referred to as *radio waves.* Electric waves, light waves and radiated heat waves are included in the general term *electromagnetic waves* (q.v.). The velocity of electric waves is the same as that of light waves, 300,000,000 meters per second or 186,000 miles per second (appx.). Electric waves used for radio work have frequencies from about 10,000 to 3,000,000 cycles per second. Since the velocity of electric waves is known, it is possible to calculate the length of a wave if the frequency is known. Thus if the electric wave has a frequency of 10,000 cycles per second, the wavelength is found by dividing the velocity in meters per second by the frequency in cycles per second, which gives in this case a wavelength of 30,000 meters. Electric waves are in reality a combination of electromagnetic and electrostatic disturbances in space. The displacements are at right angles to the motion of the wave train. The electric field and the magnetic field are at right angles and travel together. They spread out or expand from the point of disturbance just as water waves spread out from a point where a stone strikes the surface of the water. Electric waves are propagated from an aerial when certain forms of alternating current flow in the aerial. Since the frequency of the propagated wave corresponds to the frequency of the current in the aerial, high frequency current must flow in the aerial to produce the high frequency electric waves used in radio. Such current may be produced by a high-frequency generator, by a direct current generator and an electric arc, or by means of vacuum tubes. The latter offer the simplest means of producing the rapidly reversing currents. Electric waves may be classified as *continuous* and *discontinuous.* Examples of the former are the waves produced by a high frequency alternator, an oscillating vacuum tube or a Poulsen arc. Examples of the latter are the waves produced by condenser discharges in a spark circuit. In these the amplitude of the waves diminishes in each wave train and the waves are referred to as *damped* waves. The high frequency current used to produce continuous waves used in radio telephony is *modulated* in accordance with the vibrations of a *microphone* (q.v.). As a result modulated waves are sent out from the aerial and these correspond in wave form to the variations of the sound waves. The sensitive apparatus at the distant receiving set picks up or intercepts the modulated electric waves, reconverts them to high frequency electric currents which are rectified into direct currents capable of actuating a 'phone and usually amplified so that they have energy enough to operate a loud speaker. (See *Oscillator, Carrier Wave,* also *Modulated Currents.*)

PHILLIPS, Raymond—British radio expert. Born October 6, 1879, he was educated at Edgebaston, Birmingham Schorne College, Buckinghamshire, and Windsor High School. For three years he was engaged on railway constructions and repairs, with special application to electric railways. In 1902 he invented a system of automatic train control and a number of appliances for electric railways which were widely adopted. In 1905 he took up the study of wireless and specialized in the control of mechanisms at a distance by electric waves. In 1910 he patented a system for controlling airships by radio and by means of a working model demonstrated how an airship could be thus controlled. During the World War he was inspector of ordnance machinery and in 1921 was appointed a member of the Inter-Allied Commission of Control in Germany. He is the author of many articles on the control of machines by electric waves.

PHONOGRAPHIC RECORDING—This refers to the amplifying of code signal currents by means of relays in tandem until the sounds produced in a telephone receiver are loud enough to cut a distinct record on the wax of a phonograph. The signals can be received at high speed and thereafter read at low speed. Instead of a phonograph a telegraphone may be used.

PHOTO-ELECTRIC EFFECT—A change in the electrical conductivity of a gaseous or solid substance when radiations of certain wavelengths come in contact with them. This refers particularly to rays of the visible spectrum and ultra-violet and infra-red rays.

PHOTOGRAPHIC RECORDER—A device for recording high-speed wireless messages by recording the deflections of a sensitive galvanometer on a moving photographic film. (See *Auto-Receiver.*)

PICKARD, Greenleaf Whittier—American radio expert. He was born at Portland, Maine, on February 14, 1877, and was educated at Westbrook Seminary, Lawrence Scientific School, Harvard and Massachusetts Institute of Technology. He made a special study of wireless telegraphy and telephony

Greenleaf Whittier Pickard.

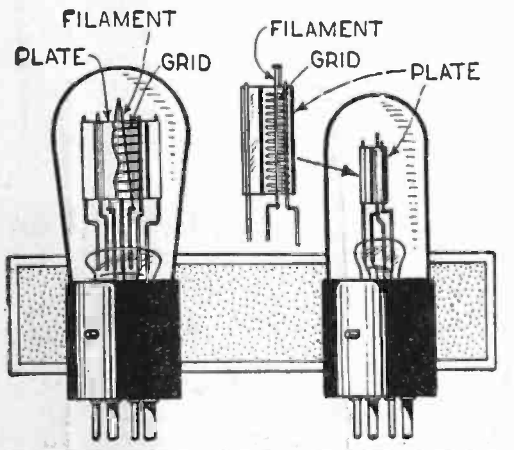
and has taken out many United States and foreign patents for radio inventions. He is noted for his pioneer work in radio telephony. Pickard began radio work in 1899 at Blue Hill observatory, Milton, Massachusetts, under a grant from the Smithsonian Institute. He was on the engineering staff of the American Telephone and Telegraph Company from 1902 to 1906. Later he was connected with the Wireless Specialty Apparatus Company as consulting engineer. He has an extensive practice as a patent expert in radio patent litigation. Pickard is a fellow of the American Institute of Electrical Engineers, a Member of the American Chemical Society and also is a Member of the Society of Chemical Industry.

PIG-TAIL—A flexible braided or stranded copper conductor used to carry the current to the rotor of a condenser or a coupler. Pig-tails are also used on the carbon brushes of motors and generators. (See *Flexible Lead.*)

PITCH—Frequency of vibration of a sound. A shrill note is said to be of high pitch, a bass note of low pitch. The pitch of an armature winding refers to the distance from the center of a winding to the center of the next winding.

PLAIN AERIAL—An aerial having the transmitting or receiving circuit connected directly to it without the utilization of inductive coupling or any intermediate tuned circuit. An example of a plain aerial is one used to transmit code, having a spark gap in series with the aerial and the ground.

PLATE—The anode or positive electrode of a vacuum tube. The vacuum tube plate is usually made of nickel. The shape of the plate varies according to the type and construction of the tube. In some tubes the plate is tubular; in others flat. When the cathode or filament is heated, it emits electrons which pass to the grid or through the grid to the plate, depending upon the grid charge. In power tubes (transmitting) it is necessary to use some cooling device to conduct away the heat dissipated at the plate. In some cases a liquid bath or a blast of air is used



Vacuum tubes, showing construction of plates.

or the plate may be constructed so that it can be cooled by water circulation. Other methods of preventing overheating of these tubes are increasing the area of the plate as for example increasing the diameter of a tubular plate, or blackening the surface of the plate to increase its heat emissivity.

PLATE BATTERY—A battery, usually referred to as the *"B" Battery* having its positive terminal connected to the plate of the three-electrode vacuum tube and its negative terminal leading to the filament. The purpose of this battery is to keep the plate voltage positive with respect to the filament so that the electrons will be attracted sufficiently to the plate. Plate batteries are usually dry cells although there are a number of storage plate or "B" batteries on the market, both of the acid and the alkaline types. It is possible to dispense with the plate battery by using a *"B" eliminator*, which is connected to the ordinary house-lighting circuit. (See *"B" Battery.*)

PLATE CIRCUIT—The circuit connected to the *plate* (q.v.) or anode of a three-electrode vacuum tube.

PLATE COMPONENT, HIGH FREQUENCY—The radio frequency current flowing in the *plate circuit* (q.v.) of a vacuum tube. (See *High Frequency Component of Plate.*)

PLATE CONSUMPTION—This refers to the current consumed in energizing the plate of a vacuum tube. Increasing the grid voltage tends to increase the plate consumption. An increasing plate voltage also increases the plate current, but tends to decrease the relatively small grid current. (See *Consumption, Current;* also *Consumption, Plate.*)

PLATE CONTROL—The vacuum tube starts oscillating at a plate voltage which will depend on the adjustments of the circuit. When the plate voltage is raised, the oscillation current becomes greater, increasing in direct proportion.

PLATE CURRENT—The current in the *plate circuit* (q.v.) of the three-electrode vacuum tube. The current passing between the plate and the heated cathode or filament.

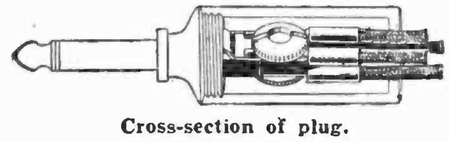
PLATE IMPEDANCE—The total resistance offered to alternating current between the filament and the plate in a vacuum tube. It is often referred to as the *tube impedance.* The impedance is independent of the alternating current input voltage.

PLATE VOLTAGE—The voltage of the plate of a vacuum tube above the filament. The potential difference between the plate and the filament. This term is usually used to refer to the voltage of the *"B" battery* (q.v.) connected to the plate, as for example, if the 22½-volt terminal of the "B" battery is connected to the plate of the detector tube, the plate voltage is said to be 22½ volts. Soft tubes, formerly used as detectors, operated best at this voltage. Most of the amplifier tubes now used as detectors operate best with 45 volts on the plate, although these tubes vary individually, some operating better with slightly increased voltage and others with a voltage less than 45. The plate voltage generally used on the amplifiers is 90 volts. The new power reception tubes use plate voltages up to 135 volts.

PLIODYNATRON—A special vacuum tube, designed by A. W. Hull, having two grids instead of one. This tube utilizes the normal amplifying property of the vacuum tube to obtain a very high voltage amplification, as high as 1,000 fold. When such high amplification is obtained, however, the operation is unstable and extremely careful adjustment is necessary.

PLIOTRON—A name given to a highly evacuated vacuum tube used for transmitting purposes. Large pliotrons are capable of developing as high as 500 watts output since they are so highly exhausted that several thousand volts may be applied to the plate and also since they can carry a plate current of nearly one-half an ampere.

PLUG—A connecting device used extensively in radio and telephone work for making connection or "plugging in" *loud speakers* (q.v.), head sets, power supply, microphone transmitters, etc. The plug has an insulating handle and the metal contact tip is designed to fit into a standard *jack* (q.v.). A flexible wire fits into terminals in the plug, the other end of the wire being connected to the apparatus such as the loud speaker, etc. The plug connection terminals may be of the conventional small binding post type or they may consist of internal spring clips.



Cross-section of plug.

PLUG-IN COIL—An interchangeable coil, often of the honey-comb type, which can be plugged into a socket, thus permitting it to be quickly and conveniently put into or taken out of a circuit. Plug-in coils are used in some cases in receiving sets designed for operation on widely varying wave bands.

PLUG-IN TRANSFORMER—*A plug-in coil* (q.v.) specifically used as a radio frequency transformer.

POLARITY—In magnets the differentiation between *North Pole* and *South Pole.* In electrical devices or circuits, the difference between *positive* and *negative poles.* It is often necessary to determine which is the positive pole or terminal of a direct current circuit, and which the negative. There are various methods of indicating polarity. A voltmeter or an ammeter will show the direction of current flow. An extremely simple method of determining polarity is to place the two terminals in a glass jar containing salt water or some other electrolyte. A much greater number of bubbles will be observed to collect around the terminal of negative polarity. A piece of used blue print paper can be utilized to indicate polarity. It is simply necessary to moisten the paper and place the terminals on it, at a distance of about ¼ of an inch apart. The paper will be whitened at the negative terminal.

POLARIZATION—In a primary cell, the current liberates hydrogen from the electrolyte in passing through it. The hydrogen is carried to the negative plate with the current and collects there. It thus increases the internal resistance of the cell. This makes it harder for the current to pass through it and as a result the electromotive force available at the terminals is materially lowered. In addition there is a slight difference of potential between the negative plate and the hydrogen and this acts in opposition to the electromotive force of the cell. This further reduces the effective voltage of the cell. The entire effect is known as polarization. Polarization may be carried to such an extent that current can no longer flow from the cell. It may be counteracted or prevented by the use of *depolarizers* (q.v.). There are three different kinds of depolarizers. Chemical depolarizers are placed in the cell near the cathode. Substances such as manganese dioxide, potassium bichromate, nitric acid or cuprous chloride are used. When the hydrogen reaches the depolarizer it combines with it to form a new compound. Electrochemical depolarizers depend for their action upon the use of a substance which will liberate a metal such as copper at the cathode instead of hydrogen. Thus with no hydrogen present there is no polarization. Of course it is necessary to use the proper electrodes and the correct electrolyte to obtain this result. Mechanical depolarizers merely blow or sweep the hydrogen away from the cathode. Being the least effective of the three methods, the latter is seldom used. (See *Local Action.*)

POLARIZATION, ELECTRIC—The state of a dielectric when subjected to electrostatic forces. Electric polarization is synonymous with electric displacement.

POLARIZED RELAY—A relay in which a magnetized swinging arm is placed between poles of two electromagnets. When current passes, one pole must change, so that the arm is attracted by one and repelled by the other. A polarized relay is much more sensitive to weak currents than the ordinary relay.

POLES—See *Magnetic Poles.*

POLYPHASE—Referring to an alternating current system in which the circuits are divided up into two or more branches having their currents displaced in phase from each other. The term *multiphase* has the same meaning as polyphase. (See *Phase.)*

POLYPHASE ALTERNATOR—An alternating current generator wound in such a way that it supplies two or more currents which differ in *phase* (q.v.) from each other by definite phase angles. The usual form of polyphase alternator is the three-phase alternator.

PORCELAIN CLEAT—See *Cleat.*

POSITIVE ELECTRODE—In a primary cell, the zinc plate or *anode* (q.v.) is the *positive electrode,* while the *pole* of this electrode is the *negative pole* (q.v.) because it is negative in relation to the external circuit. In a storage cell, the lead peroxide plate, which is the cathode during discharge, is called the *positive electrode* and its pole the *positive pole.*

POSITIVE TERMINAL POLE—The pole or terminal out of which current is considered to flow. This is more or less of a handy convention, but is contrary to the present day knowledge of electrical flow inasmuch as electrons move from negative to positive.

POTENTIAL—See *Potential, Electric.*

POTENTIAL, DIFFERENCE OF—abbreviation P.D.—Difference of electrical level. Theoretically the potential difference between two points in an electric field is measured by the work done by the electric field on a unit point charge of positive electricity moved from one point to another without disturbing the field. Potential difference is measured in volts. It may refer to any two points in a circuit, even though there is no source of electromotive force between these points. When applied to circuit between two points not possessing a source of electromotive force, the potential difference between the two points under consideration is equal to the product of the current flowing times the resistance of the circuit between the two points. In the case of an open circuit, such as the terminals of a cell, the potential difference is equal to the electromotive force. (See *Potential, Electromotive force,* also *Volt.)*

POTENTIAL DROP—The fall in voltage in a circuit due to the resistance of the conductor. (See *Potential, Electric;* also *Potential, Difference of.)*

POTENTIAL, ELECTRIC—Electrical pressure, or the degree of *electromotive force* (q.v.). Potential is electrical level. Electrical potential can be compared with the "head" of water. Thus it is customary to measure the height or head of water above sea level, which is taken as an arbitrary base. In a somewhat similar manner, the potential of the earth is taken as zero and all potential is measured from this as an arbitrary base. With this understood, it is no longer necessary to refer to the degree of electromotive force, but simply to the electromotive force or the potential. See *Potential, Difference of,* also *Volt.)*

POTENTIAL ENERGY—Energy of position. When energy is available for the production of work, it is referred to as potential energy. Energy at work is *kinetic energy* (q.v.).

POTENTIAL RECTIFIER—A *crystal* (q.v.) or other form of rectifier which requires an initial current to pass through it to become sensitive.

POTENTIOMETER (Potential Divider)—A resistance connected across a battery or other source of electromotive force and equipped with a slider so that the voltage on another circuit may be varied from zero to the full potential of the battery. Where a gas content detector vacuum tube is used, the purpose of the potentiometer is to permit a close adjustment of the *plate battery* (q.v.) potential. The potentiometer is shunted around the filament heating or "A" battery, its resistance being so high that its power consumption is practically negligible. In tuned radio frequency sets, a potentiometer is used to control the tube oscillation. The advantage of being able to make a system oscillate is obvious, as the greatest amplification is obtained when the circuits are operated just at the point before self-oscillation starts. This condition is easily found in operation, since the instant self-oscillation starts, a whistle is heard in the phone or loud speaker when tuning to any station it is desired to receive. The use of a potentiometer to control oscillations in a tuned radio frequency circuit is illustrated in the diagram shown

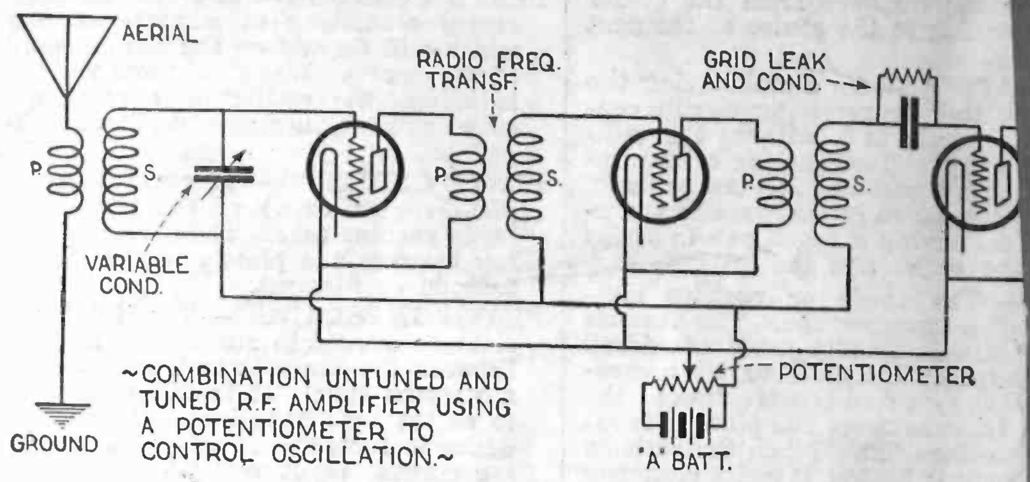


Fig. 1. Tuned radio frequency circuit showing use of potentiometer to control oscillatio

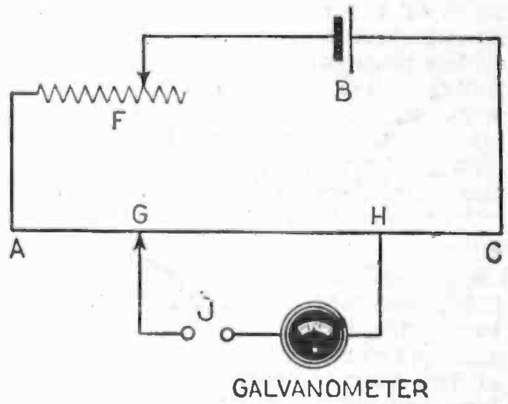


Fig. 2. A simple form of potentiometer used for electrical measurements.

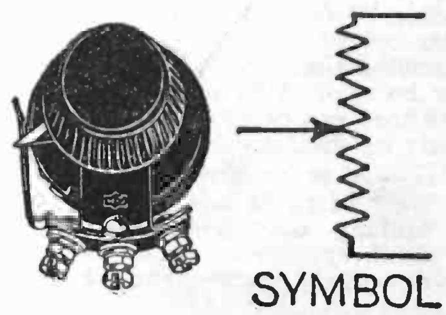


Illustration of a radio potentiometer, showing symbol at the right.

at Fig. 1. Potentiometers use apparatus are usually ma from high resistance wire carbon granules. In electri neering work, the term pote means, in general, an arrang circuits for measuring potenti ference.

Using certain accessories, labo potentiometers can be used to m voltages over all ranges, and by ing's *Ohm's law* (q.v.) the m ments obtained can be used to mine a wide range of current va

The simplest form of potenti used for electrical measureme shown in Fig. 2. AC is a res in which a constant current fr battery B is flowing. F is a r ing resistance used to compens the variations of the electro force of the battery. The cur AC is checked for constancy by that the drop in potential betw two points selected in it is equal electromotive force of a standa The standard cell is connected circuit GHJ at J and the regu resistance is adjusted until the tive galvanometer shows no defl With the assumption that AC uniform resistance throughou length, and the current in it r ing constant, it is obvious tha other voltage not greater tha drop between A and C can be ured by connecting it in the circ J and shifting the points G a until the galvanometer again co a balance.

A direct reading scale may be between A and C. For ordinary tiometer measurements, the dro tween A and C is made about 1½ as this is approximately the el motive force of a standard Clar

POULSEN ARC—An arc u burned in hydrogen between a ing carbon cathode and a water- copper anode in a magnetic field. arc is connected to an oscillatin cuit, and due to its instability it tains continuous oscillations whic utilized for the production of co ous waves for radio telegraphy telephony.

POULSEN, Valdemar—Danish r pioneer. Born in Copenhagen, No ber 23, 1869; he was educate Copenhagen University and in he joined the Copenhagen Tele Company. In 1903 he invente famous system of arc transmis Poulsen is a fellow of the D Society of Sciences. In 1900 he awarded the Grand Prix at Pari