Radio Call Book Magazine and Technical Review

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SERVICE - ENGINEERING - SALES


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Accepted as standard it can be installed in all types of motor vehicles within an hour. MOTOMASTER is a genuine contribution to the motoring world.
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HERE IS YOUR OPPORTUNITY TO CASH IN ON THIS VAST MARKET—Some valuable territories still open. Consult the nearest MOTOMASTER distributor or wire for liberal franchise plan immediately.
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R.C.A. AUTO RADIO
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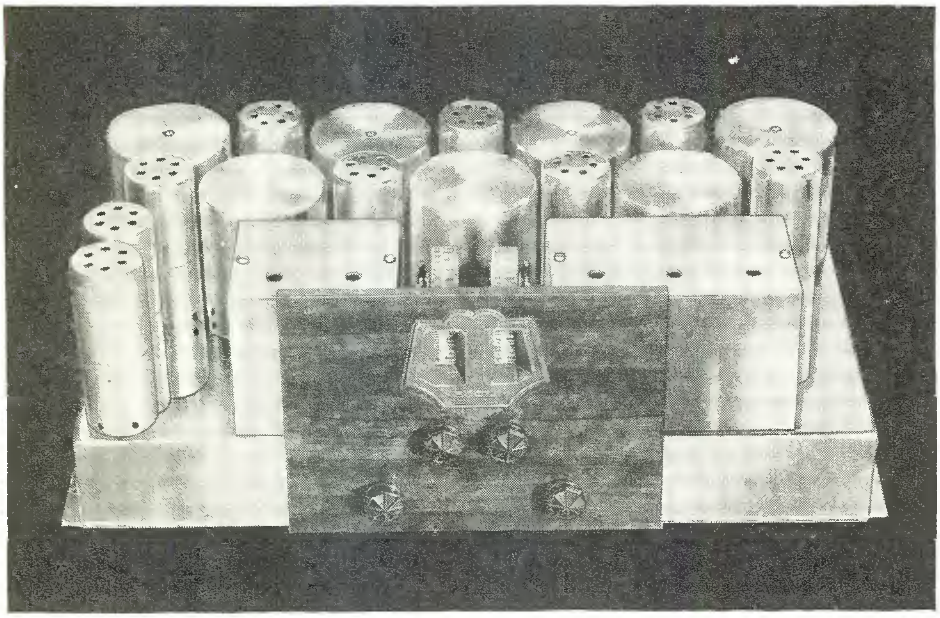
The SCOTT 15-550 METER ALL•WAVE *is the only*



living in 63 foreign countries have voluntarily written their testimony of the Scott All-Wave's prowess as a dependable 'round the world receiver. Six big volumes of unsolicited praise from over 600 owners—and there are hundreds more Scott All-Wave users who are too busy listening to the whole world, to write us!

ZEESEN GERMANY

JOAK JAPAN

Expect Great Things

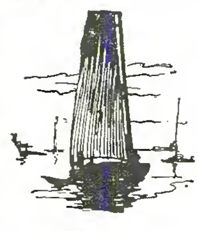
SINCE the advent of the Scott All-Wave 15-550 meter superheterodyne, this receiver has become the preference of extremely particular listeners, the world over. It has become the radio of Kings and Presidents—of American Consuls abroad and of Foreign Consuls here—of music masters—of broadcasting stations who use it to pick up short wave transmissions for re-broadcast—and it has become the dependable instrument of radio broadcast advertisers who need a receiver with a wide daytime range and with tonal capability by which the quality of advertising broadcasts may be accurately checked. And its owners have written enough praising letters about this receiver to fill six big volumes! Think! Not six volumes of ordinary testimonial letters, expressing mere satisfaction, but rampantly enthusiastic letters that tell of loud, clear, perfect reception from stations 7,000 to 10,000 miles away. They're letters from American owners who tune in Europe and the Orient as fancy dictates. And there are letters from foreign owners, men and women located at all points of the globe, who listen to America and other far-off lands with their Scott All-Wave receivers.

E. H. SCOTT
Pioneer Builder of World Record Receivers

Scott owners living in every state in the Union have written, just to tell us that the Scott All-Wave they purchased, gives them more than the results we promised them—more than we are promising you here. And people

SPECIFICATIONS

Custom built in the laboratory—by laboratory experts and entirely to laboratory standards. Superheterodyne circuit. Covers all wave lengths 15-550 meters. Twelve tubes. Pre-selector R. F. stage. Three I. F. stages. Double push-pull audio. Perfectly matched speaker. All coils treated to withstand climatic extremes. Chassis and amplifier chromium plated.



VK3ME AUSTRALIA

If you live in the United States, order your Scott All-Wave in full anticipation of hearing London, Paris or Rome! Your set will be tested on actual reception from one of the stations in these countries before shipping. Order it too, in full belief that you will hear Germany, France, Holland, Australia, Indo-China, South America, Central America, Cuba, and the other strange places you've always wondered about. You'll *hear* them with your Scott All-Wave—and with perfect clarity and exact tone! Then remember, your Scott All-Wave is guaranteed for five full years against defect in material or workmanship—the broadest, most completely protective guarantee ever placed on radio equipment.

Result of Round-the-World Research

The Scott All-Wave was not designed to be just a good receiver for domestic reception. Instead, it was designed and built especially for foreign reception, by an engineer who has made 3 complete trips around the globe to study radio conditions—and overcomes the difficulties heretofore encountered in such work. Perfected for reception of foreign stations, the Scott All-Wave automatically became the most efficient receiver possible to buy, for domestic work.

The E. H. SCOTT RADIO LABORATORIES, INC.

(*Formerly Scott Transformer Co.*) • 4450 Ravenswood Avenue • Dept. CB3 • Chicago, Ill.

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MARCH, 1932

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Editorial

In answer to many requests received every day for voltage analyses charts for broadcast receivers, we have incorporated this feature beginning this issue. We plan on running the charts for the receivers published for the month, but occasionally they are not immediately available. Now the receiver reports are complete with curves, schematic wiring diagram, and socket voltage chart, all in one issue. We hope this service will find all of the needs our readers may have. Tell us about it.

The feature article this month is the use of linear amplifiers in broadcasting. This comprehensive treatment should give a clear understanding of the subject. Another deals with all phases of automobile radio receivers from the commercial angle and should be of help to the dealer in mapping out his campaign for the next season.

Three television articles will appeal to the television enthusiast and he will always find the latest information on the subject as it is issued to us. For our friends with a mathematical turn of mind, we recommend the notes on distortion in this issue. The history of the development of loud speakers is treated in a general manner on the pages devoted to radio engineering, and of special interest to the service man is the intermediate-broadcast frequency wavemeter write-up given on page 37.

—Editor.

American Broadcasting Stations

Station assignments shown in the following pages were made by the Federal Radio Commission. This list is revised from issue to issue and is therefore up-to-the-minute. Initials such as E, C, M, and P denote Eastern, Central, Mountain and Pacific time.

KABC—1420 kc, San Antonio, Texas, Alamo Broadcasting Co., 100 w, C.

KARK—890 kc, Little Rock, Ark., First Church of the Nazarene, 250 w.

KBPS—1420 kc, Portland, Ore., Benson Polytechnic School, 100 w, P.

KBTM—1200 kc, Paragould, Ark., Beard's Temple of Music, 100 w, C.

KCRC—1370 kc, Enid, Okla., Champlin Refining Co., 100 w, C.

KCRJ—1310 kc, Jerome, Ariz., C. C. Robinson, 100 w.

KDB—1500 kc, Santa Barbara, Calif., Santa Barbara Broadcasters, Ltd., 100 w, P.

KDFN—1210 kc, Casper, Wyo., D. L. Hathaway, 100 w, P.

KDKA—980 kc, Pittsburgh, Pa., Westinghouse E. & M. Co., 50,000 w, E.

KDLR—1210 kc, Devils Lake, N. D., KDLR, Inc., 100 w.

KDYL—1290 kc, Salt Lake City, Utah, Intermountain Broadcasting Corp., 1000 w, M.

KECA—1430 kc, Los Angeles, Calif., Earle C. Anthony, Inc., 1000 w, P.

KELW—780 kc, Burbank, Calif., Magnolia Park, Ltd., 500 w, P.

KEX—1180 kc, Portland, Ore., Western Broadcasting Co., 5000 w, P.

KFAB—770 kc, Lincoln, Nebr., KFAB Broadcasting Co., 5000 w, C.

KFAC—1300 kc, Los Angeles, Calif., L. A. Bdcstg. Co., 1000 w, P.

KFBB—1280 kc, Great Falls, Mont., Buttrey Broadcast, Inc., 1000 w, M.

KFBK—1310 kc, Sacramento, Calif., James McClatchy Co., 100 w, P.

KFBL—1370 kc, Everett, Wash., Leese Bros., 50 w, P.

KFDM—560 kc, Beaumont, Tex., Magnolia Petroleum Co., 500 w, C.

KFDY—550 kc, Brookings, S. D., State College, 500 w, C.

KFEL—920 kc, Denver, Colo., Eugene P. O'Fallon, Inc., 500 w, M.

KFEQ—680 kc, St. Joseph, Mo., Scroggin & Co., 2500 w, C.

GFGQ—1310 kc, Boone, Iowa, Boone Biblical College, 100 w, C.

KFH—1300 kc, Wichita, Kan., Radio Station KFH Co., 1000 w, C.

KFI—640 kc, Los Angeles, Calif., Earl C. Anthony, Inc., 50,000 w, P.

KFIO—1120 kc, Spokane, Wash., Spokane Broadcasting Corp., 100 w, P.

KFIU—1310 kc, Juneau, Alaska, Alaska Elec. Light & Power Co., 10 w.

KFIZ—1420 kc, Fond du Lac, Wis., Reporter Printing Co., 100 w, C.

KFJB—1200 kc, Marshalltown, Iowa, Marshall Electric Co., 100 w, C.

KFJF—1480 kc, Oklahoma City, Okla., National Radio Mfg. Co., 5000 w, C.

KFJI—1210 kc, Klamath Falls, Ore., KFJI Broadcasters, Inc., 100 w, P.

KFJM—1370 kc, Grand Forks, N. D., University of North Dakota, 100 w, C.

KFJR—1300 kc, Portland, Ore., Ashley C. Dixon, KFJR, Inc., 500 w, P.

KFJY—1310 kc, Ft. Dodge, Iowa, Cedar Rapids Broadcast Co., w, C.

KFJZ—1370 kc, Ft. Worth, Texas, Henry Clay Meacham, 100 w, C.

KFKA—880 kc, Greeley, Colo., Mid-Western Radio Corp., 500 w, M.

KFKB—1050 kc, Milford, Kan., KFKB Brdcstg. Assn., 5000 w, C.

KFKU—1220 kc, Lawrence, Kan., University of Kansas, 500 w, C.

KFKX—See under KYW.

KFLV—1410 kc, Rockford, Ill., Rockford Broadcasters, Inc., 500 w, C.

KFLX—1370 kc, Galveston, Texas, Geo. Roy Clough, 100 w, C.

KFMX—1250 kc, Northfield, Minn., Carleton College, 1000 w, C.

KFNF—890 kc, Shenandoah, Iowa, Henry Field Seed Co., 500 w, C.

KFOR—1210 kc, Lincoln, Neb., Howard A. Shuman, 100 w, C.

KFOX—1250 kc, Long Beach, Calif., Nichols & Warriner, Inc., 1000 w, P.

KFPL—1310 kc, Dublin, Texas, C. C. Baxter, 100 w, C.

KFPM—1310 kc, Greenville, Texas, The New Furniture Co., 15 w, C.

KFPW—1340 kc, Ft. Smith, Ark., John Brown Schools, 50 w, C.

KFPY—1340 kc, Spokane, Wash., Symons Broadcasting Co., 1000 w, P.

KFQD—1230 kc, Anchorage, Alaska, Anchorage Radio Club, 100 w.

KFQU—1420 kc, Holy City, Calif., W. E. Riker, 100 w, P.

KFQW—1420 kc, Seattle, Wash., KFQW, Inc., 100 w, P.

KFRC—610 kc, San Francisco, Calif., Don Lee, Inc., 1000 w, P.

KFRU—630 kc, Columbia, Mo., Stephens College, 500 w, C.

KFSD—600 kc, San Diego, Calif., Airfan Radio Corp., 500 w, P.

KFSG—1120 kc, Los Angeles, Calif., Echo Park Evan. Assn., 500 w, P.

KFUL—1290 kc, Galveston, Texas, W. H. Ford, 500 w, C.

KFUO—550 kc, St. Louis, Mo., Concordia Theological Seminary, 500 w, C.

KFUP—1310 kc, Denver, Colo., Fitzsimmons General Hospital, 100 w, M.

KFVD—1000 kc, Culver City, Calif., Los Angeles Broadcasting Co., 250 w, P.

KFVS—1210 kc, Cape Girardeau, Mo., Hirsch Battery & Radio Co., 100 w, C.

KFWB—950 kc, Hollywood, Calif., Warner Bros. Broadcasting Corp., 1000 w, P.

KFWF—1200 kc, St. Louis, Mo., St. Louis Truth Center, Inc., 100 w.

KFWI—930 kc, San Francisco, Calif., Radio Entertainments, Inc., 500 w, P.

KFXD—1420 kc, Nampa, Idaho, Frank E. Hurt, 100 w, M.

KFXF—920 kc, Denver, Colo., Colorado Radio Co., 500 w, M.

KFXJ—1310 kc, Edgewater, Colo., Western Slope Broadcasting Co., 50 w, M.

KFXM—1210 kc, San Bernardino, Calif., Lee Bros. Broadcasting Co., 100 w, P.

KFXR—1310 kc, Oklahoma City, Okla., Exchange Avenue Baptist Church, 100 w, C.

KFXY—1420 kc, Flagstaff, Ariz., Mary M. Costigan, 100 w, M.

KFYO—1420 kc, Abilene, Texas, Kirksey Bros., 100 w, C.

KFYR—550 kc, Bismarck, N. D., Meyer Broadcasting Co., 1000 w, C.

KGA—1470 kc, Spokane, Wash, Northwest Broadcasting System, Inc., 5000 w, P.

KGAR—1370 kc, Tucson, Ariz., Tucson Motor Service Co., 100 w, M.

KGB—1330 kc, San Diego, Calif., Don Lee, Inc., 500 w, P.

KGBU—900 kc, Ketchikan, Alaska, Alaska Radio & Service Co., 500 w.

KGBX—1310 kc, St. Joseph, Mo., KGBX, Inc., 100 w.

KGBZ—930 kc, York, Nebr., Geo. R. Miller, 500 w, C.

KGCA—1270 kc, Decorah, Iowa, Chas. W. Greenley, 50 w, C.

KGCR—1210 kc, Watertown, S. D., Greater Kampeska Radio Corp., 100 w.

KGCU—1200 kc, Mandan, N. D., Mandan Radio Association, 100 w, M.

KGCX—1310 kc, Wolf Point, Mont., First State Bank of Vida, 100 w, M.

KGDA—1370 kc, Mitchell, S. D., Mitchell Broadcasting Corp., 100 w, M.

KGDE—1200 kc, Fergus Falls, Minn., Jaren Drug Co., 100 w, C.

KGDM—1100 kc, Stockton, Calif., E. F. Peffer, 250 w.

KGDY—1200 kc, Huron, S. D., J. A. Loesch, 15 w, C.

KGEF—1300 kc, Los Angeles, Calif., Trinity Methodist Church, 1000 w, P.

KGEK—1200 kc, Yuma, Colo., Beehler Elec. Equip. Co., 100 w, M.

KGER—1360 kc, Long Beach, Calif., Consolidated Bdcstg. Corp., 1000 w, P.

KGEW—1200 kc, Ft. Morgan, Colo., City of Ft. Morgan, 100 w, P.

KGEZ—1310 kc, Kalispell, Mont., Chamber of Commerce, 100 w, M.

KGFF—1420 kc, Shawnee, Okla., KGFF Bdcstg. Corp., 100 w, C.

KGFG—1370 kc, Oklahoma City, Okla., Oklahoma Broadcasting Co., Inc., 100 w, C.

KGFI—1500 kc, Corpus Christi, Texas, Eagle Broadcasting Co., 100 w, C.

KGFJ—1200 kc, Los Angeles, Calif., Ben S. McGlashan, 100 w, P.

KGFK—1500 kc, Moorhead, Minn., Red River Broadcasting Co., Inc., 50 w, C.

KGFL—1370 kc, Raton, N. Mex., KGFL, Inc., 50 w, M.

KGFW—1310 kc, Kearney, Neb., Central Neb. Bdcstg. Co., 100 w.

KGFX—580 kc, Pierre, S. D., Dana McNeil, 200 w, C.

KGGC—1420 kc, San Francisco, Calif., Golden Gate Broadcasting Co., 100 w, P.

KGGF—1010 kc, South Coffeyville, Okla., Powell & Platz, 500 w.

KGGM—1230 kc, Albuquerque, N. Mex., New Mexico Broadcasting Co., 250 w.

KGHF—1320 kc, Pueblo, Colo, Ritchie & Finch, 250 w, M.

KGHI—1200 kc, Little Rock, Ark., O. A. Cook, 100 w.

KGHL—950 kc, Billings, Mont., Northwestern Auto Supply Co., 1000 w, M.

KGIQ—1320 kc, Twin Falls, Idaho, Radio Broadcasting Corp.

KGIR—1360 kc, Butte, Mont., KGIR, Inc., 500 w, M.

KGIW—1420 kc, Trinidad, Colo., Leonard E. Wilson, 100 w, M.

KGIX—1420 kc, Las Vegas, Nev., J. M. Heaton, 100 w.

KGIZ—1500 kc, Grant City, Mo., Grant City Park Corp., 100 w, C.

KGKB—1500 kc, Tyler, Tex., Tyler Commercial College, 100 w, C.

KGKL—1370 kc, San Angelo, Tex., KGKL, Inc., 100 w, C.

KGKO—570 kc, Wichita Falls, Tex., Wichita Falls Broadcasting Co., 250 w, C.

KGKX—1420 kc, Sandpoint Idaho, W. W. von Cannon, 100 w, P.

KGKY—1500 kc, Scottsbluff, Nebr., Hilliard Co., Inc., 100 w, C.

KGMB—1320 kc, Honolulu, Hawaii, Honolulu Broadcasting Co., 250 w, P.

KGMP—1210 kc, Elk City, Okla., Bryant Radio & Elec. Co., 100 w, C.

KGNF—1430 kc, North Platte, Nebr., H. L. Spencer, 500 w, M.

KGNO—1210 kc, Dodge City, Kans., Dodge City Broadcasting Co., Inc., M.

KGO—790 kc, San Francisco, Calif., National Broadcasting Co., Inc., 7500 w, P.

KGRS—1410 kc, Amarillo, Texas, Gish Radio Service, 1000 w, C.

KGU—940 kc, Honolulu, Hawaii, Marion Mulrony, Advertising Publ. Co., 1000 w.

KGVO—1420 kc, Missoula, Mont., Mosby's, Inc.

KGW—620 kc, Portland, Ore., Oregonian Pub. Co., 1000 w, P.

KGY—1200 kc, Lacey, Wash., St. Martins College, 10 w, P.

KHJ—900 kc, Los Angeles, Calif., Don Lee, Inc., 1000 w, P.

KHQ—590 kc, Spokane, Wash., Louis Wasmer, Inc., 1000 w, P.

KICK—1420 kc, Red Oak, Iowa, Red Oak Radio Corp., 100 w.

KID—1320 kc, Idaho Falls, Ida., KID Broadcasting Co., 250 w, M.

KIDO—1350 kc, Boise, Idaho, Boise Broadcasting Station, 1000 w, P.

KIT—1310 kc, Yakima, Wash., C. E. Haymond, 100 w, P.

KJBS—1070 kc, San Francisco, Calif., Julius Brunton & Sons Co., 100 w, P.

KJR—970 kc, Seattle, Wash., Northwest Broadcasting System, Inc., 5000 w, P.

KLCN—1290 kc, Blytheville, Ark., C. L. Lintzenich, 50 w, C.

KLO—1400 kc, Ogden, Utah, Interstate Bdcstg. Corp., 500 w, M.

KLPM—1420 kc, Minot, N. D., John B. Cooley, 100 w, C.

KLRA—1390 kc, Little Rock, Ark., Arkansas Broadcasting Co., 1000 w.

KLS—1440 kc, Oakland, Calif., Warner Bros., 250 w, P.

KLX—880 kc, Oakland, Calif., Tribune Pub. Co., 500 w, P.

KLZ—560 kc, Denver, Colo., Reynolds Radio Co., Inc., 1000 w, M.

KMA—930 kc, Shenandoah, Iowa, May Seed & Nursery Co., 500 w, C.

KMAC—1370 kc, San Antonio, Texas, W. W. McAllister, 100 w, C.

KMBC—950 kc, Kansas City, Mo., Midland Broadcasting Co., 1000 w, C.

KMED—1310 kc, Medford, Ore., Mrs. W. J. Virgin, 100 w, P.

KMJ—1210 kc, Fresno, Calif., J. McClatchy Co., 100 w, P.

KMLB—1200 kc, Monroe, La., Liner's Bdcstg. Station, Inc., 100 w, C.

KMMJ—740 kc, Clay Center, Neb., The M. M. Johnson Co., 1000 w, C.

KMO—860 kc, Tacoma, Wash., KMO, Inc., 500 w, P.

KMOX—1090 kc, St. Louis, Mo., Voice of St. Louis, Inc., 50,000 w, C.

KMPC—710 kc, Beverly Hills, Calif., R. S. Macmillan, 500 w, P.

KMTR—570 kc, Los Angeles, Calif., KMTR Radio Corp., 500 w, P.

KNX—1050 kc, Hollywood, Calif., Western Broadcast Co., 5000 w, P.

KOA—830 kc, Denver, Colo., National Broadcasting Co., Inc., 12,500 w, M.

KOAC—550 kc, Corvallis, Ore., Oregon State Agricultural College, 1000 w, P.

KOB—1180 kc, State College, N. M., N. M. College of Agri. & Mech. Arts, 20,000 w, M.

KOCW—1400 kc, Chickasha, Okla., Oklahoma College for Women, 250 w, C.

KOH—1370 kc, Reno, Nevada, Jay Peters, Inc., 500 w.

KOIL—1260 kc, Council Bluffs, Iowa, Mona Motor Oil Co., 1000 w, C.

KOIN—940 kc, Portland, Ore., KOIN, Inc., 1000 w, P.

KOL—1270 kc, Seattle, Wash., Seattle Broadcasting Co., 1000 w, P.

KOMO—920 kc, Seattle, Wash., Fisher's Blend Station, Inc., 1000 w, P.

KONO—1370 kc, San Antonio, Tex., Mission Broadcasting Co., 100 w, C.

KOOS—1370 kc, Marshfield, Ore., H. H. Hanseth, Inc., 100 w, P.

KORE—1420 kc, Eugene, Ore., Eugene Broadcast Station, 100 w, P.

KOY—1390 kc, Phoenix, Ariz., Nielsen Radio & Sporting Goods Co., 500 w, M.

KPCB—650 kc, Seattle, Wash., Queen City Broadcasting Co., 100 w, P.

KPJM—1500 kc, Prescott, Ariz., A. P. Miller, 100 w, M.

KPO—680 kc, San Francisco, Calif., Hale Bros. & The Chronicle, 5000 w, P.

KPOF—880 kc, Denver, Colo., Pillar of Fire, Inc., 500 w, M.

KPPC—1210 kc, Pasadena, Calif., Pasadena, Presbyterian Church, 50 w, P.

KPQ—1500 kc, Wenatchee, Wash., Wescoast Broadcasting Co., 50 w, P.

KPRC—920 kc, Houston, Texas, Houston Printing Co., 1000 w, C.

KQV—1380 kc, Pittsburgh, Pa., KQV Bdcstg. Co., 500 w, E.

KQW—1010 kc, San Jose, Calif., Pacific Agric. Foundation, 500 w, P.

KRE—1370 kc, Berkeley, Calif., First Congregational Church, 100 w, P.

KREG—1500 kc, Santa Ana, Calif., Pacific-Western Broadcasting Federation, 100 w, P.

KRGV—1260 kc, Harlingen, Texas, KRGV, Inc., 500 w.

KRLD—1040 kc, Dallas, Texas, KRLD, Inc., 10,000 w, C.

KRMD—1310 kc, Shreveport, La., Robert M. Dean, 50 w, C.

KROW—930 kc, Oakland Calif., Educational Broadcasting Corp., 500 w, M.

KRSC—1120 kc, Seattle, Wash., Radio Sales Corp., 50 w, P.

KSAC—580 kc, Manhattan, Kan., Kansas State Agricultural College, 500 w, C.

KSCJ—1330 kc, Sioux City, Iowa, Perkins Bros. Co., 1000 w, C.

KSD—550 kc, St. Louis, Mo., Pulitzer Pub. Co., 500 w, C.

KSEI—900 kc, Pocatello, Idaho, Radio Service Corp., 250 w, M.

KSL—1130 kc, Salt Lake City, Utah, Radio Service Corp., 5000 w, M.

KSMR—1200 kc, Santa Maria, Calif., Santa Maria Radio Co., 100 w, P.

KSO—1380 kc, Clarinda, Iowa, Iowa Bdcstg. Co., 500 w, C.

KSOO—1110 kc, Sioux Falls, S. D., Sioux Falls Broadcasting Assn., 2000 w, C.

KSTP—1460 kc, St. Paul, Minn., National Battery Broadcasting Co., 10,000 w, C.

KTAB—560 kc, San Francisco, Calif., Associated Broadcasters, 1000 w, P.

KTAR—620 kc, Phoenix, Ariz., KTAR Broadcasting Co., 500 w, M.

KTAT—1240 kc, Ft. Worth, Tex., S. A. T. Broadcasting Co., 1000 w, C.

KTBR—1300 kc, Portland, Ore., M. E. Brown, 500 w, P.

KTBS—1450 kc, Shreveport, La., Tri-State Broadcasting Co., 1000 w, E.

KTFI—1320 kc, Twin Falls, Idaho, Radio Broadcasting Corp., 250 w, M.

KTHS—1040 kc, Hot Springs, Ark., Chamber of Commerce, 10,000 w, C.

KTLC—1310 kc, Houston, Tex., Houston Broadcasting Co., 100 w, C.

KTM—780 kc, Los Angeles, Calif., Pickwick Broadcasting Corp., 500 w, P.

KTRH—1120 kc, Houston, Tex., Rice Hotel, 500 w, C.

KTSA—1290 kc, San Antonio, Texas, Lone Star Broadcast Co., 1000 w, C.

KTSL—1310 kc, Shreveport, La., Houseman Sheet Metal Works, Inc., 100 w, C.

KTSM—1310 kc, El Paso, Tex., W. S. Bledsoe and W. T. Blackwell, 100 w, C.

KTW—1220 kc, Seattle, Wash., First Presbyterian Church, 1000 w, P.

KUJ—1370 kc, Walla Walla, Wash., Paul R. Heitmeyer, Inc., 100 w, P.

KUOA—1390 kc, Fayetteville, Ark., University of Arkansas, 1000 w, C.

KUSD—890 kc, Vermilion, S. Dak., University of South Dakota, 500 w, C.

KUT—1500 kc, Austin, Tex., KUT Bdcstg. Co., 100 w, C.

KVI—760 kc, Tacoma, Wash., Puget Sound Radio Broadcasting Co., 1000 w, P.

KVL—1370 kc, Seattle, Wash., KVL, Inc., 100 w, P.

KVOA—1260 kc, Tucson, Ariz., R. M. Riculfi, 500 w.

KVOO—1140 kc, Tulsa, Okla., Southwestern Sales Corp., 5000 w, C.

KVOR—1270 kc, Colorado Springs, Colo, W. D. Corley, 1000 w, M.

KVOS—1200 kc, Bellingham, Wash., KVOS, Inc., 100 w, P.

KWCR—1310 kc, Cedar Rapids, Iowa, Cedar Rapids Bdcst. Co., 100 w, C.

KWEA—1210 kc, Shreveport, La., Hello World Broadcasting Corp., 100 w, C.

KWG—1200 kc, Stockton, Calif., Portable Wireless Tel. Co., 100 w, P.

KWJJ—1060 kc, Portland, Ore., KWJJ Broadcasting Co., Inc., 500 w, P.

KWK—1350 kc, Kirkwood, Mo., Thos. Patrick, Inc., 1000 w, C.

KWKC—1370 kc, Kansas City, Mo., Wilson Duncan Broadcasting Co., 100 w.

KWKH—850 kc, Shreveport, La., Hello World Broadcasting Corp., 10,000 w, C.

KWLC—1270 kc, Decorah, Iowa, Luther College, 100 w, C.

KWSC—1220 kc, Pullman, Wash., State College of Washington, 1000 w, P.

KWWG—1260 kc, Brownsville, Texas, Brownsville Herald Publishing Co., 500 w, C.

KXA—570 kc, Seattle, Wash., American Radio Tel. Co., 500 w, P.

KXL—1420 kc, Portland, Ore., KXL Broadcasters, Inc., 100 w, P.

KXO—1500 kc, El Centro, Calif., Irey & Bowles, 100 w, P.

KXRO—1310 kc, Aberdeen, Wash., KXRO, Inc., 75 w, P.

KXYZ—1420 kc, Houston, Texas, Harris County Broadcasting Co., 100 w, C.

KYA—1230 kc, San Francisco, Calif., Pacific Broadcasting Corp., 1000 w, P.

KYW—1020 kc, Chicago, Ill., Westinghouse E. & M. Co., 10,000 w, C.

NAA—690 kc, United States Navy Department, Washington, D. C., 1000 w, E.

WAAB—1410 kc, Quincy, Mass., Bay State Bdcstg. Corp.

WAAF—920 kc, Chicago, Ill., Drovers Journal Pub. Co., 500 w daytime, C.

WAAM—1250 kc, Newark, N. J., WAAM, Inc., 1000 w, E.

WAAT—940 kc, Jersey City, N. J., Bremer Broadcasting Corp., 300 w, E.

WAAW—660 kc, Omaha, Neb., Omaha Grain Exchange, 500 w daytime, C.

WABC—860 kc, New York City, N. Y., Atlantic Broadcasting Corp., 50,000 w, E.

WABI—1200 kc, Bangor, Maine, Pine Tree Broadcasting Co., 100 w, E.

WABO—See under WHEC.

WABZ—1200 kc, New Orleans, La., Coliseum Place Baptist Church, 100 w, C.

WACO—1240 kc, Waco, Tex., Central Texas Broadcasting Co., Inc., 1000 w, C.

WADC—1320 kc, Tallmadge, Ohio, Allen T. Simmons, 1000 w, E.

WAGM—1420 kc, Mars Hill, Me., Aroostook Bdcstg. Corp., 100 w.

WAIU—640 kc, Columbus, Ohio, Associated Radiocasting Corp., 500 w, E.

WALR—1210 kc, Zanesville, O., Roy W. Waller, 100 w, E.

WAPI—1140 kc, Birmingham, Ala., Alabama Polytechnic Institute, 5000 w, C.

WASH—1270 kc, Grand Rapids, Mich., Kunsky-Trendle Bdcstg. Corp., 500 w, C.

WAWZ—1350 kc, Zarepath, N. J., Pillar of Fire, 250 w, E.

WBAA—1400 kc, Lafayette, Ind., Purdue University, 500 w, C.

WBAK—1430 kc, Harrisburg, Pa., Pennsylvania State Police, 500 w, E.

WBAL—1060 kc, Baltimore, Md., Consolidated Gas, Elec. Co., 10,000 w, E.

WBAP—800 kc, Ft. Worth, Tex., Carter Publications, Inc., 10,000 w, C.

WBAX—1210 kc, Wilkes-Barre, Pa., John H. Stenger, Jr., 100 w, E.

WBBC—1400 kc, Brooklyn, N. Y., Brooklyn Broadcasting Corp., 500 w.

WBBL—1210 kc, Richmond, Va., Grace Covenant Presbyterian Church, 100 w, E.

WBBM—770 kc, Chicago, Ill., WBBM Bdcstg. Corp., 25,000 w, C.

WBBR—1300 kc, Brooklyn, N. Y., People's Pulpit Association, 1000 w, E.

WBBZ—1200 kc, Ponca City, Okla., C. L. Carrell, 100 w, C.

WBCM—1410 kc, Bay City, Mich., James E. Davidson, 500 w, E.

WBCN—See under WENR.

WBEN—900 kc, Buffalo, N. Y., WBEN, Inc., 1000 w, E.

WBEO—1310 kc, Marquette, Mich., Lake Superior Bdcstg. Co.

WBGF—1370 kc, Glens Falls, N. Y., W. Parker & N. Metcalf, 50 w, E.

WBHS—1200 kc, Huntsville, Ala., Hutchens Co., 50 w.

WBIG—1440 kc, Greensboro, N. C., North Carolina Broadcasting Co., 500 w, E.

WBIS—See under WNAC.

WBMS—1450 kc, Hackensack, N. J., WBMS Broadcasting Corp., 250 w.

WBNX—1350 kc, New York, N. Y., Standard Cahill Co., Inc., 250 w, E.

WBOQ—See under WABC.

WBOW—1310 kc, Terre Haute, Ind., Banks of Wabash Broadcasting Assn., 100 w, C.

WBRC—930 kc, Birmingham, Ala., Birmingham Broadcasting Co., 500 w, C.

WBRE—1310 kc, Wilkes-Barre, Pa., Louis G. Baltimore, 100 w, E.

WBSO—920 kc, Needham, Mass., Bdcstg. Service Org., Inc., 250 w, E.

WBT—1080 kc, Charlotte, N. C., Station WBT, Inc., 5000 w, E, shared.

WBTM—1370 kc, Danville, Va., Piedmont Bdcstg. Corp., 100 w, E.

WBZ—990 kc, Boston, Mass., Westinghouse E. & M. Co., 15,000 w, E.

WBZA—990 kc, Springfield, Mass., Westinghouse E. & M. Co., 1000 w, E.

WCAC—600 kc, Storrs, Conn., Connecticut Agricultural College, 250 w, E.

WCAD—1220 kc, Canton, N. Y., St. Lawrence University, 500 w, E.

WCAE—1220 kc, Pittsburgh, Pa., WCAE, Inc., 1000 w, E.

WCAH—1430 kc, Columbus, Ohio, Commercial Radio Service Co., 500 w, E.

WCAJ—590 kc, Lincoln, Neb., Nebraska Wesleyan University, 500 w, C.

WCAL—1250 kc, Northfield, Minn., St. Olaf College, 1000 w, C.

WCAM—1280 kc, Camden, N. J., City of Camden, 500 w, E.

WCAO—600 kc, Baltimore, Md., Monumental Radio, Inc., 250 w, E.

WCAP—1280 kc, Asbury Park, N. J., Radio Industries Broadcast Co., 500 w, E.

WCAT—1200 kc, Rapid City, S. D., South Dakota State School of Mines, 100 w, M.

WCAU—1170 kc, Philadelphia, Pa., Universal Broadcasting Co., 10,000 w, E.

WCAX—1200 kc, Burlington, Vt., Burlington Daily News, 100 w, E.

WCAZ—1070 kc, Carthage, Ill., Superior Broadcasting Co., 50 w.

WCBA—1440 kc, Allentown, Pa., B. B. Musselman, 250 w, E.

WCBD—1080 kc, Zion, Ill., Wilbur Glen Voliva, 5000 w, C.

WCBM—1370 kc, Baltimore, Md., Baltimore Broadcasting Corp., 100 w, E.

WCBS—1210 kc, Springfield, Ill., Dewing & Meester, 100 w, C.

WCCO—810 kc, Minneapolis, Minn., Northwestern Broadcasting Inc., 5000 w, C.

WCDA—1350 kc, New York, N. Y., Italian Educational Broadcasting Co., 250 w, E.

WCFL—970 kc, Chicago, Ill., Chicago Federation of Labor, 150 w, C.

WCGU—1400 kc, Brooklyn, N. Y., U. S. Broadcasting Corp., 500 w, E.

WCHI—1490 kc, Chicago, Ill., People's Pulpit Association, 5000 w, C.

WCKY—1490 kc, Covington, Ky., L. B. Wilson, 500 w, E.

WCLB—1500 kc, Long Beach, N. Y., Arthur Faske, 100 w, E.

WCLO—1200 kc, Janesville, Wis., WCLO Radio Corp., 100 w, C.

WCLS—1310 kc, Joliet, Ill., WCLS, Inc., 100 w, C.

WCMA—1400 kc, Culver, Ind., General Broadcasting Co., 500 w, C.

WCOA—1340 kc, Pensacola, Fla., City of Pensacola, 500 w, E.

WCOC—880 kc, Meridian, Miss., Mississippi Broadcasting Co., 500 w, C.

WCOD—1200 kc, Harrisburg, Pa., Keystone Broadcasting Corp., 100 w, E.

WCOH—1210 kc, Yonkers, N. Y., Westchester Broadcasting Corp., 100 w, E.

WCRW—1210 kc, Chicago, Ill., Clinton R. White, 100 w, C.

WCSC—1360 kc, Charleston, S. C., Lewis Burk, 500 w, E.

WCSH—940 kc, Portland, Me., Congress Square Hotel Co., 1000 w, E.

WDAE—1220 kc, Tampa, Fla., Tampa Publishing Co., 1000 w, E.

WDAF—610 kc, Kansas City, Mo., Kansas City Star Co., 1000 w, C.

WDAG—1410 kc, Amarillo, Texas, National Radio & Broadcasting Corp., 250 w, C.

WDAH—1310 kc, El Paso, Texas, W. S. Bledsoe, 100 w, M.

WDAS—1370 kc, Philadelphia, Pa., WDAS Broadcasting Station, Inc., 100 w, E.

WDAY—940 kc, Fargo, N. D., WDAY, Inc., 1000 w, C.

WDBJ—930 kc, Roanoke, Va., Times-World Corp., 250 w, E.

WDBO—1120 kc, Orlando, Fla., Orlando Broadcasting Co., 1000 w, E.

WDEL—1120 kc, Wilmington, Del., WDEL, Inc., 250 w, E.

WDEV—1420 kc, Waterbury, Vt., H. C. Whitehill, 50 w.

WDGY—1180 kc, Minneapolis, Minn., Dr. Geo. W. Young, 1000 w, C.

WDIX—1420 kc, Texarkana, Ark., North Mississippi Broadcasting Corp., 100 w, C.

WDOD—1280 kc, Chattanooga, Tenn., WDOD Broadcasting Co., Inc., 1000 w, C.

WDRC—1330 kc, Hartford, Conn., Doolittle Radio Corp., 500 w, E.

WDSU—1250 kc, New Orleans, La., Jos. H. Uhalt, 1000 w, C.

WDZ—1070 kc, Tuscola, Ill., James L. Bush, 100 w.

WEAF—660 kc, New York, N. Y., National Broadcasting Co., Inc., 50,000 w, E.

WEAI—1270 kc, Ithaca, N. Y., Cornell Univ., 1000 w, E.

WEAN—780 kc, Providence, R. I., Shepard Broadcasting Service, 250 w, E.

WEAO—570 kc, Columbus, Ohio, Ohio State University, 750 w, E.

WEBC—1290 kc, Superior, Wis., Head of The Lakes Broadcasting Co., 1000 w, C.

WEBQ—1210 kc, Harrisburg, Ill., First Trust & Savings Bank, 100 w, C.

WEBR—1310 kc, Buffalo, N. Y., Howell Broadcasting Co., 100 w, E.

WEDC—1210 kc, Chicago, Ill., Emil Denemark, Inc., 100 w.

WEDH—1420 kc, Erie, Pa., Erie Dispatch-Herald, 30 w, E.

WEEI—590 kc, Boston, Mass., Edison Elec. Illum. Co., 1000 w, E.

WEEU—830 kc, Reading, Pa., Berks Bdcstg. Co., 1000 w.

WEHC—1350 kc, Emory, Va., Emory and Henry College, 500 w, E.

WEHS—1420 kc, Evanston, Ill., WEHS, Inc., 100 w, C.

WELL—1420 kc, Battle Creek, Mich., Enquirer-News Co., 100 w, E.

WENR—870 kc, Chicago, Ill., Great Lakes Radio Broadcasting Co., 50,000 w, C.

WEPS—See under WORC.

WEVD—1300 kc, Brooklyn, N. Y., Debs Memorial Radio Fund, 500 w, E.

WEW—760 kc, St. Louis, Mo., St. Louis University, 1000 w, C.

WEXL—1310 kc, Royal Oak, Mich., Royal Oak Broadcasting Co., 50 w, E.

WFAA—800 kc, Dallas, Texas, Dallas News and Journal, 50,000 w, C.

WFAM—1200 kc, La Porte, Ind., South Bend Tribune, 100 w, C.

WFAN—610 kc, Philadelphia, Pa., Keystone Broadcasting Co., Inc., 500 w, E.

WFBC—1200 kc, Knoxville, Tenn., First Baptist Church, 50 w, E.

WFBE—1200 kc, Cincinnati, Ohio, Post Publ. Co., 100 w, E.

WFBG—1310 kc, Altoona, Pa., William F. Gable Co., 100 w, E.

WFBL—1360 kc, Syracuse, N. Y., The Onondaga Co., Inc., 1000 w, E.

WFBM—1230 kc, Indianapolis, Ind., Indianapolis, Power & Light Co., 1000 w, C.

WFBR—1270 kc, Baltimore, Md., Baltimore Radio Show, Inc., 250 w, E.

WFDF—1310 kc, Flint, Mich., Frank D. Fallain, 100 w, E.

WFDV—1310 kc, Rome, Ga., Dolies Goings, 100 w, E.

WFDW—1420 kc, Talladega, Ala., R. C. Hammett. 100 w, C.

WFEA—1430 kc, Manchester, N. H., Rines Hotel Co., 500 w.

WFI—560 kc, Philadelphia, Pa., Strawbridge & Clothier, 500 w, E.

WFIW—940 kc, Hopkinsville, Ky., WFIW, Inc., 1000 w, C.

WFLA—620 kc, Clearwater, Fla., Clearwater Chamber of Commerce and St. Petersburg Chamber of Commerce, 250 w, E.

WFOX—1400 kc, Brooklyn, N. Y., Paramount Broadcasting Corp., 500 w.

WGAL—1310 kc, Lancaster, Pa., WGAL, Inc., 100 w, E.

WGAR—1450 kc, Cleveland, Ohio, WGAR Broadcasting Co., 500 w, E.

WGBB—1210 kc, Freeport, N. Y., Harry H. Carman, 100 w, E.

WGBC—See under WNBR.

WGBF—630 kc, Evansville, Ind., Evansville on the Air, Inc., 500 w, E.

WGBI—880 kc, Scranton, Pa., Scranton Broadcasters, Inc., 250 w, E.

WGBS—1180 kc, New York, N. Y., American Radio News Corp., 500 w, E.

WGCM—1210 kc, Gulfport, Miss., Great Southern Land Co., Inc., 100 w, C.

WGCP—1250 kc, Newark, N. J., May Radio Broadcast Corp., 250 w.

WGES—1360 kc, Chicago, Ill., Oak Leaves Broadcasting Corp., 500 w, C.

WGH—1310 kc, Newport News, Va., Hampton Roads Broadcasting Corp., Inc., 100 w, E.

WGL—1370 kc, Ft. Wayne, Ind., Allen-Wayne Co., 100 w, C.

WGMS—See under WLB.

WGN—720 kc, Chicago, Ill., Tribune Co., 25,000 w, C.

WGR—550 kc, Buffalo, N. Y., Buffalo Broadcasting Corp., 1000 w, E.

WGST—890 kc, Atlanta, Ga., Georgia School of Technology, 250 w, E.

WGY—790 kc, Schenectady, N. Y., General Electric Co., 50,000 w, E.

WHA—940 kc, Madison, Wis., University of Wisconsin, 750 w, C.

WHAD—1120 kc, Milwaukee, Wis. Marquette University, 250 w, C.

WHAM—1150 kc, Rochester, N. Y., Stromberg-Carlson Tel. Mfg. Co., 5000 w, E.

WHAP—1300 kc, New York, N. Y., Defenders of Truth Society, Inc., 1000 w, E.

WHAS—820 kc, Louisville, Ky., The Courier Journal Co. & Louisville Times Co., 10,000 w, C.

WHAT—1310 kc, Philadelphia, Pa., Independence Broadcasting Co., 100 w, E.

WHAZ—1300 kc, Troy, N. Y., Rensselaer Polytechnic Institute, 500 w, E.

WHB—860 kc, Kansas City, Mo., WHB Broadcasting Co., 500 w, C.

WHBC—1200 kc, Canton, Ohio, St. John's Catholic Church, 10 w, E.

WHBD—1370 kc, Mt. Orab, Ohio, F. P. Moler, 100 w, E.

WHBF—1210 kc, Rock Island, Ill., Beardsley Specialty Co., 100 w, C.

WHBL—1410 kc, Sheboygan, Wis., Press Pub. Co., 500 w, C.

WHBQ—1370 kc, Memphis, Tenn., Station WHBQ, Inc., 100 w, C.

WHBU—1210 kc, Anderson, Ind., Anderson Bdcstg. Corp., 100 w, C.

WHBY—1200 kc, Green Bay, Wis., St. Norbert's College, 100 w, C.

WHDF—1370 kc, Calumet, Mich., Upper Michigan Brdcstg. Co., 100 w, C.

WHDH—830 kc, Boston, Mass., Matheson Radio Co., Inc., 1000 w, E.

WHDI—1180 kc, Minneapolis, Minn., Dr. G. W. Young, 500 w, C.

WHDL—1420 kc, Tupper Lake, N. Y., Tupper Lake Broadcasting Corp., 100 w, E.

WHEC—1440 kc, Rochester, N. Y., Hickson Electric Co., Inc., 500 w, E.

WHFC—1420 kc, Cicero, Ill., WHFC, Inc., 100 w, C.

WHIS—1410 kc, Bluefield, W. Va., Daily Telegraph Printing Co., 250 w, E.

WHK—1390 kc, Cleveland, Ohio, Radio Air Service Corp., 1000 w, E.

WHN—1010 kc, New York, N. Y., Marcus Loew Booking Review, 250 w, E.

WHO—1000 kc, Des Moines, Iowa, Central Broadcasting Co., 5000 w, C.

WHOM—1450 kc, Jersey City, N. J., New Jersey Broadcasting Corp., 250 w, E.

WHP—1430 kc, Harrisburg, Pa., WHP, Inc., 500 w, E.

WIAS—1420 kc, Ottumwa, Iowa, Poling Electric Co., 100 w, C.

WIBA—1280 kc, Madison, Wis., Capital Times Co., 500 w, C.

WIBG—930 kc, Elkins Park, Pa., WIBG, Inc., 25 w, E.

WIBM—1370 kc, Jackson, Mich., WIBM, Inc., 100 w.

WIBO—560 kc, Chicago, Ill., Nelson Bros. Bond and Mortgage Co., 1000 w, C.

WIBU—1210 kc, Poynette, Wis., W. C. Forrest, 100 w, C.

WIBW—580 kc, Topeka, Kan., Topeka Broadcasting Assn., Inc., 1000 w, C.

WIBX—1200 kc, Utica, N. Y., WIBX, Inc., 100 w, E.

WICC—600 kc, Bridgeport, Conn., Bridgeport Broadcasting Station, Inc., 500 w, E.

WIL—1200 kc, St. Louis, Mo., Missouri Broadcasting Co., 100 w, C.

WILL—890 kc, Urbana, Ill., University of Illinois, 250 w, C.

WILM—1420 kc, Wilmington, Del., Delaware Broadcasting Co., Inc., 100 w, E.

WIOD—1300 kc, Miami, Fla., Isle of Dreams Broadcasting Co., 1000 w, E.

WIP—610 kc, Philadelphia, Pa., Gimbel Bros., Inc., 500 w, E.

WIS—1010 kc, Columbia, S. C., South Carolina Broadcasting Co., Inc., 500 w, E.

WISJ—See under WIBA.

WISN—1120 kc, Milwaukee, Wis., Evening Wisconsin Co., 250 w, C.

WJAC—1310 kc, Johnstown, Pa., Johnstown Automobile Co., 100 w, E.

WJAG—1060 kc, Norfolk, Neb., Norfolk Daily News, 1000 w, C.

WJAK—1310 kc, Marion, Ind., The Truth Pub. Co., Inc., 50 w.

WJAR—890 kc, Providence, R. I., The Outlet Co., 250 w, E.

WJAS—1290 kc, Pittsburgh, Pa., Pittsburgh Radio Supply House, 1000 w, E.

WJAX—900 kc, Jacksonville, Fla., City of Jacksonville, 1000 w, E.

WJAY—610 kc, Cleveland, Ohio, Cleveland Radio Broadcasting Corp., 500 w, E.

WJBC—1200 kc, LaSalle, Ill., Kaskaskia Broadcasting Co., 100 w, C.

WJBI—1210 kc, Red Bank, N. J., Monmouth Broadcasting Co., 100 w, E.

WJBK—1370 kc, Highland Park, Mich., J. F. Hopkins, 50 w, C.

WJBL—1200 kc, Decatur, Ill., Commodore Broadcasting Co., 100 w, C.

WJBO—1420 kc, New Orleans, La., Valdemar Jensen, 100 w, C.

WJBT—See under WBBM.

WJBU—1210 kc, Lewisburg, Pa., Bucknell University, 100 w, E.

WJBW—1200 kc, New Orleans, La., C. Carlsen, Jr., 30 w, C.

WJBY—1210 kc, Gadsden, Ala., Gadsden Broadcasting Co., 100 w, C.

WJDX—1270 kc, Jackson, Miss., Lamar Life Ins. Co., 1000 w, C.

WJJD—1130 kc, Chicago, Ill., Loyal Order of Moose, 20,000 w, C.

WJKS—1360 kc, Gary, Ind., Johnson-Kennedy Radio Corp., 1000 w, C.

WJMS—1420 kc, Ironwood, Mich., Johnson Music Store, 100 w.

WJR—750 kc, Detroit, Mich., The Goodwill Station, Inc., 10,000 w, E.

WJSV—1460 kc, Alexandria, Va., Independent Publishing Co., 10,000 w.

WJTL—1370 kc, Oglethorpe University, Ga., 100 w, E.

WJW—1210 kc, Mansfield, Ohio, Mansfield Broadcasting Association, 100 w, E.

WJZ—760 kc, New York City, N. Y., National Broadcasting Co., 30,000 w, E.

WKAQ—890 kc, San Juan, Porto Rico, Radio Corp. of Porto Rico, 250 w, E.

WKAR—1040 kc, East Lansing, Mich., Michigan State College, 1000 w, E.

WKAV—1310 kc, Laconia, N. H., Laconia Radio Club, 100 w, E.

WKBB—1310 kc, Joliet, Ill., Sanders Bros., 100 w, C.

WKBC—1310 kc, Birmingham, Ala., R. B. Broyles Furniture Co., 100 w, C.

WKBF—1400 kc, Indianapolis, Ind., Indianapolis Broadcasting Corp., 500 w, C.

WKBH—1380 kc, LaCrosse, Wis., WKBH, Inc., 1000 w, C.

WKBI—1420 kc, Chicago, Ill., WKBI, Inc., 100 w, C.

WKBN—570 kc, Youngstown, Ohio, WKBN Bdcstg. Corp., 500 w, E.

WKBO—1450 kc, Jersey City, N. J., Camith Corp., 250 w, E.

WKBS—1310 kc, Galesburg, Ill., Permil N. Nelson, 100 w, C.

WKBV—1500 kc, Connersville, Ind., Knox Battery & Electric Co., 100 w, C.

WKBW—1480 kc, Buffalo, N. Y., WKBW, Inc., 5000 w, E.

WKBZ—1500 kc, Ludington, Mich., K. L. Ashbacker, 50 w.

WKJC—1200 kc, Lancaster, Pa., Lancaster Bdcstg. Service, Inc., 100 w, E.

WKRC—550 kc, Cincinnati, Ohio, WKRC, Inc., 1000 w, E.

WKY—900 kc, Oklahoma City, Okla., WKY Radiophone Co., 1000 w, C.

WKZO—590 kc, Kalamazoo, Mich., WKZO, Inc., 1000 w, C.

WLAC—1470 kc, Nashville, Tenn., Life & Casualty Ins. Co., 5000 w, C.

WLAP—1010 kc, Louisville, Ky., American Broadcasting Corp. of Kentucky, 1259 w, C.

WLB—1250 kc, Minneapolis, Minn., University of Minnesota, 1000 w, C.

WLBC—1310 kc, Muncie, Ind., Donald A. Burton, 50 w.

WLBF—1420 kc, Kansas City, Kan., WLBF Broadcasting Co., 100 w, C.

WLBG—1200 kc, Petersburg, Va., WLBG, Inc., 100 w, E.

WLBL—900 kc, Ellis, Wis., Wisconsin Department of Markets, 2000 w, daytime, C.

WLBW—1260 kc, Oil City, Pa., Radio-Wire Program Corp., 500 w, E.

WLBX—1500 kc, Long Island City, N. Y., John N. Brahy, 100 w.

WLBZ—620 kc, Bangor, Me., Maine Broadcasting Co., 500 w, E.

WLCI—1210 kc, Ithaca, N. Y., Lutheran Assn. of Ithaca, 50 w, E.

WLEY—1370 kc, Lexington, Mass., Lexington Air Station, 100 w, E.

WLIB—See under WGN.

WLIT—560 kc, Philadelphia, Pa., Lit Brothers, 500 w, E.

WLOE—1500 kc, Boston, Mass., Boston Broadcasting Co., 100 w.

WLS—870 kc, Chicago, Ill., Agricultural Broadcasting Co., 5000 w, C.

WLSI—See under WPRO.

WLTH—1400 kc, Brooklyn, N. Y., Voice of Brooklyn, Inc., 500 w, E.

WLVA—1370 kc, Lynchburg, Va., Lynchburg Broadcasting Corp., 100 w, E.

WLW—700 kc, Cincinnati, Ohio, Crosley Radio Corp., 50,000 w, E.

WLWL—1100 kc, New York, N. Y., Missionary Society of St. Paul, 5000 w, E.

WMAC—See under WSYR.

WMAL—630 kc, Washington, D. C., M. A. Leese Co., 250 w, E.

WMAQ—670 kc, Chicago, Ill., National Broadcasting Co., 5000 w, C.

WMAZ—1180 kc, Macon, Ga., Southeastern Broadcasting Co., 500 w, E.

WMBA—1500 kc, Newport, R. I., LeRoy Joseph Beebe, 100 w, E.

WMBC—1120 kc, Detroit, Mich., Michigan Broadcasting Co., Inc., 100 w, E.

WMBD—1440 kc, Peoria Heights, Ill., Peoria Bdcstg. Co., 500 w.

WMBF—See under WIOD.

WMBG—1210 kc, Richmond, Va., Havens & Martin, Inc., 100 w, E.

WMBH—1420 kc, Joplin, Mo., Edwin Dudley Aber, 100 w, C.

WMBI—1080 kc, Chicago, Ill., Moody Bible Institute Radio Station, 5000 w, C, shared.

WMBJ—1500 kc, Wilkinsburg, Pa., Rev. John W. Sproul, 100 w, E.

WMBO—1310 kc, Auburn, N. Y., WMBO, Inc., 100 w, E.

WMBQ—1500 kc, Brooklyn, N. Y., Paul J. Gollhofer, 100 w.

WMBR—1370 kc, Tampa, Fla., F. J. Reynolds, 100 w, E.

WMC—780 kc, Memphis, Tenn., Memphis Commercial Appeal, Inc., 500 w, C.

WMCA—570 kc, New York, N. Y., Knickerbocker Broadcasting Co., Inc., 500 w, E.

WMIL—1500 kc, Brooklyn, N. Y., Arthur Faske, 100 w, E.

WMMN—890 kc, Fairmont, W. Va., Holt Rowe Novelty Co., 250 w, E.

WMPC—1500 kc, Lapeer, Mich., First Methodist Protestant Church, 100 w, E.

WMRJ—1210 kc, Jamaica, N. Y., Peter J. Prinz, 10 w, E.

WMSG—1350 kc, New York, N. Y., Madison Square Garden Broadcast Co., 250 w, E.

WMT—600 kc, Waterloo, Iowa, Waterloo Broadcasting Co., 500 w, C.

WNAC—1230 kc, Boston, Mass., The Shepard Broadcasting Service, 1000 w, E.

WNAD—1010 kc, Norman, Okla., University of Oklahoma, 500 w, C.

WNAX—570 kc, Yankton, S. Dak., Gurney Seed & Nursery Co., 1000 w, C.

WNBF—1500 kc, Binghamton, N. Y., Howitt-Wood Radio Co., 100 w, E.

WNBH—1310 kc, New Bedford, Mass., New Bedford Broadcasting Co., 100 w, E. shared.

WNBO—1200 kc, Silver Haven, Pa., J. B. Spriggs, 100 w, E.

WNBR—1430 kc, Memphis, Tenn., Memphis Broadcasting Co., 500 w, C.

WNBW—1200 kc, Carbondale, Pa., Home Cut Glass & China Co., 10 w, E.

WNBX—1200 kc, Springfield, Vt., First Congregational Church Corp., 10 w, E.

WNBZ—1290 kc, Saranac Lake, N. Y., Smith & Mace, 50 w, E.

WNJ—1450 kc, Newark, N. J., Radio Investment Co., 250 w, E.

WNOX—560 kc, Knoxville, Tenn., WNOX, Inc., 1000 w, C.

WNYC—570 kc, New York, N. Y. Department of Plant & Structures, 500 w, E.

WOAI—1190 kc, San Antonio, Texas, Southern Equipment Co., 50,000 w, C.

WOAN—See WREC.

WOAX—1280 kc, Trenton, N. J., WOAX, Inc., 500 w, E.

WOBU—580 kc, Charleston, W. Va., WOBU, Inc., 250 w, E.

WOC—1000 kc, Davenport, Iowa, Central Broadcasting Co., 5000 w, C.

WOCL—1210 kc, Jamestown, N. Y., A. E. Newton, 50 w, E.

WODA—1250 kc, Paterson, N. J., Richard E. O'Dea, 1000 w, E.

WODX—1410 kc, Mobile, Ala., Mobile Brdcstg. Corp., 500 w, C.

WOI—640 kc, Ames, Iowa, Iowa State College, 5000 w, C.

WOKO—1440 kc, Albany, N. Y., WOKO, Inc., 500 w, E.

WOL—1310 kc, Washington, D. C., American Broadcasting Co., 100 w, E.

WOMT—1210 kc, Manitowoc, Wis., Francis M. Kadow, 100 w.

WOOD—1270 kc, Grand Rapids, Mich., Walter B. Stiles, Inc., 500 w, C.

WOPI—1500 kc, Bristol, Tenn., Radiophone Broadcasting Co., 100 w, E.

WOQ—1300 kc, Kansas City, Mo., Unity School of Christianity, 1000 w, C.

WOR—710 kc, Newark, N. J., J. Bamberger Broadcasting Service, Inc., 5000 w, E.

WORC—1200 kc, Worcester, Mass., A. F. Kleindienst, 100 w, E.

WOS—630 kc, Jefferson City, Mo., State Marketing Bureau, 500 w, C.

WOV—1130 kc, New York, N. Y., International Broadcasting Corp., 1000 w, E.

WOW—590 kc, Omaha, Neb., Woodmen of the World, 1000 w, C.

WOWO—1160 kc, Ft. Wayne, Ind., Main Auto Supply Co., 10,000 w, C.

WPAD—1420 kc, Paducah, Ky., Paducah Broadcasting Co., 100 w, C.

WPAP—See under WQAO.

WPAW—1210 kc, Pawtucket, R. I., Shartenberg & Robinson, 100 w, E.

WPCC—560 kc, Chicago, Ill., North Shore Congregational Church, 500 w, C.

WPCH—810 kc, New York, N. Y., Eastern Broadcasters, Inc., 500 w, E.

WPEN—1500 kc, Philadelphia, Pa., Wm. Pen Broadcasting Co., 100 w, E.

WPG—1100 kc, Atlantic City, N. J., WPG Broadcasting Corp., 5000 w, E.

WPOE—1370 kc, Patchogue, N. Y., Nassau Broadcasting Corp., 100 w, E.

WPOR—See under WTAR.

WPRO—1210 kc, Providence, R. I., Cherry & Webb Bdcstg. Co., 100 w, E.

WPSC—1230 kc, State College, Pa., Pennsylvania State College, 500 w, day, E.

WPTF—680 kc, Raleigh, N. C., Durham Life Insurance Co., 1000 w, E.

WQAM—560 kc, Miami, Fla., Miami Broadcasting Co., 1000 w, E.

WQAN—880 kc, Scranton, Pa., Scranton Times, 250 w, E.

WQAO—1010 kc, New York, N. Y., Calvary Baptist Church, 250 w, E.

WQBC—1360 kc, Vicksburg, Miss., Delta Broadcasting Co., 300 w, C.

WQDM—1370 kc, St. Albans, Vt., A. J. St. Antoine, 100 w, E.

WQDX—1210 kc, Thomasville, Ga., Stevens Luke, 100 w, E.

WRAK—1370 kc, Williamsport, Pa., C. R. Cummins, 50 w, E.

WRAM—1370 kc, Wilmington, N. C., Wilmington Radio Association, 100 w, E.

WRAW—1310 kc, Reading, Pa., Reading Broadcasting Co., 50 w, E.

WRAX—1020 kc, Philadelphia, Pa., WRAX Broadcasting Co., 250 w, E.

WRBJ—1370 kc, Hattiesburg, Miss., Hattiesburg Bdcstg. Co., 10 w, C.

WRBL—1200 kc, Columbus, Ga., WRBL Radio Station, Inc., 50 w, E.

WRBQ—1210 kc, Greenville, Miss., J. Pat Scully, 250 w, C.

WRBX—1410 kc, Roanoke, Va., Richmond Development Corp., 250 w, E.

WRC—950 kc, Washington, D. C., National Broadcasting Co., 500 w, E.

WRDO—1370 kc, Augusta, Me., Albert S. Woodman, 100 w, E.

WRDW—1500 kc, Augusta, Ga., Davenport's Musicove, Inc., 100 w, E.

WREC—600 kc, Memphis, Tenn., WREC, Inc., 500 w.

WREN—1220 kc, Lawrence, Kan., Jenny Wren Co., 1000 w, C.

WRHM—1250 kc, Minneapolis, Minn., Minnesota Broadcasting Corp., 1000 w, C.

WRJN—1370 kc, Racine, Wis., Racine Broadcasting Corp., 100 w, C.

WRNY—1010 kc, New York, N. Y., Aviation Radio Station, 250 w, E.

WROL—1310 kc, Knoxville, Tenn., Stuart Broadcasting Corp., 100 w, C.

WRR—1280 kc, Dallas, Texas, City of Dallas, 500 w, C.

WRUF—830 kc, Gainesville, Fla., University of Florida, 5000 w, E.

WRVA—1110 kc, Richmond, Va., Larus Bros. & Co., Inc., 5000 w, E.

WSAI—1330 kc, Mason, Ohio, Crosley Radio Corp., 500 w, E.

WSAJ—1310 kc, Grove City, Pa., Grove City College, 100 w, E.

WSAN—1440 kc, Allentown, Pa., Allentown Call Pub. Co., 250 w, E.

WSAR—1450 kc, Fall River, Mass., Doughty & Welch Electrical Co., Inc., 250 w, E.

WSAZ—580 kc, Huntington, W. Va., WSAZ, Inc., 250 w, E.

WSB—740 kc, Atlanta, Ga., Atlanta Journal Co., 5000 w, E.

WSBC—1210 kc, Chicago, Ill., World Battery Co., 100 w, C.

WSBT—1230 kc, South Bend, Ind., South Bend Tribune, 500 w, C.

WSEN—1210 kc, Columbus, Ohio, Columbus Broadcasting Corp., 100 w, E.

WSFA—1410 kc, Montgomery, Ala., Montgomery Brdcstg. Co., 500 w, C.

WSIX—1210 kc, Springfield, Tenn., 638 Tire & Vulcanizing Co., 100 w, C.

WSJS—1310 kc, Winston-Salem, N. C., The Journal Co., 100 w, E.

WSM—650 kc, Nashville, Tenn., National Life & Accident Ins. Co., 5000 w, C.

WSMB—1320 kc, New Orleans, La., WSMB, Inc., 500 w, C.

WSMK—1380 kc, Dayton, Ohio, Stanley M. Krohn, Jr., 200 w, C.

WSOC—1210 kc, Gastonia, N. C., A. J. Kirby Music Co., 100 w, E.

WSPA—1420 kc, Spartanburg, S. C., 100 w, E.

WSPD—1340 kc, Toledo, Ohio, Toledo Broadcasting Co., 1000 w, E.

WSUI—880 kc, Iowa City, Iowa, State Univ. of Iowa, 500 w, C.

WSUN—See under WFLA.

WSVS—1370 kc, Buffalo, N. Y., Seneca Vocational High School, 50 w, E.

WSYB—1500 kc, Rutland, Vt., Weiss Music Co., 100 w, E.

WSYR—570 kc, Syracuse, N. Y., Clive B. Meredith, 250 w, E.

WTAD—1440 kc, Quincy, Ill., Illinois Broadcasting Corp., 500 w.

WTAG—580 kc, Worcester, Mass., Worcester Telegram Pub. Co., Inc., 250 w, E.

WTAM—1070 kc, Cleveland, Ohio, National Broadcasting Co., 50,000 w, E.

WTAQ—1330 kc, Eau Claire, Wis., Gillette Rubber Co., 1000 w, C.

WTAR—780 kc, Norfolk, Va., WTAR Radio Corp., 500 w, E.

WTAW—1120 kc, College Station, Texas, Agri. & Mech. College of Texas, 500 w, C.

WTAX—1210 kc, Springfield, Ill., WTAX, Inc., 100 w.

WTBO—1420 kc, Cumberland, Md., Associated Brdcstg. Corp., 100 w, E.

WTEL—1310 kc, Philadelphia, Pa., Foulkrod Radio Eng. Co., 50 w, E.

WTFI—1450 kc, Athens, Ga., Toccoa Falls Bdcstg. Co., 500 w, E.

WTIC—1060 kc, Hartford, Conn., Travelers Broadcasting Service Corp., 50,000 w, E.

WTJS—1310 kc, Jackson, Tenn., Sun Publishing Co., 100 w, C.

WTMJ—620 kc, Milwaukee, Wis., Milwaukee Journal, 1000 w, C.

WTNT—1470 kc, Nashville, Tenn., Life and Casualty Ins. Co. of Tenn., 5000 w, C.

WTOC—1260 kc, Savannah, Ga., Savannah Broadcasting Corp., 500 w, E.

WTSL—Laurel, Miss.

WWAE—1200 kc, Hammond, Ind., Hammond-Calumet Broadcasting Corp., 100 w, C.

WWJ—920 kc, Detroit, Mich., Evening News Assn., 1000 w, E.

WWL—850 kc, New Orleans, La., Loyola University, 10,000 w, C.

WWNC—570 kc, Asheville, N. C., Citizens Broadcasting Co., 1000 w, E.

WWRL—1500 kc, Woodside, N. Y., Long Island Broadcasting Corp., 100 w.

WWSW—1500 kc, Pittsburgh, Pa., Walker & Downing Radio Corp.

WWVA—1160 kc, Wheeling, W. Va., West Virginia Broadcasting Corp., 5000 w, E.

WXYZ—1240 kc, Detroit, Mich., Kunsky Trendle Broadcasting Co., 1000 w, E.

U. S. Broadcasting Stations by Frequencies

550 Kilocycles, 545.1 Meters:
KOAC, WGR, WKRC, KFUO, KSD, KFDY, KFYR

560 Kilocycles, 535.4 Meters.
WLIT, WFI, KFDM, WNOX KTAB, KLZ, WIBO, WPCC, WQAM

570 Kilocycles, 526.0 Meters:
WNYC, WMCA, WSYR, WMAC, WKBN, WWNC, KGKO, WNAX, KXA, KMTR, WEAO

580 Kilocycles, 516.9 Meters—Canadian Shared:
WTAG, WOBU, WSAZ, KGFX, KSAC, WIBW

590 Kilocycles, 508.2 Meters:
WEEI, WCAJ, WOW, KHQ, WKZO

600 Kilocycles, 499.7 Meters—Canadian Shared:
WCAO, WREC, WOAN, KFSD, WCAC, WMT WICC

610 Kilocycles, 491.5 Meters:
WFAN, WIP, WDAF, KFRC, WJAY

620 Kilocycles, 483.6 Meters:
WLBZ, WTMJ, KGW, WFLA, WSUN, KTAR

630 Kilocycles, 475.9 Meters—Canadian Shared:
WMAL, WOS, KFRU, WGBF

640 Kilocycles, 468.5 Meters:
WAIU, KFI, WOI

650 Kilocycles, 461.3 Meters:
WSM, KPCB

660 Kilocycles, 454.3 Meters:
WEAF, WAAW

670 Kilocycles, 447.5 Meters:
WMAQ

680 Kilocycles, 440.9 Meters:
WPTF, KPO, KFEQ

690 Kilocycles, 434.5 Meters—Canadian Wave:

700 Kilocycles, 428.3 Meters:
WLW

710 Kilocycles, 422.3 Meters:
WOR, KMPC

720 Kilocycles, 416.4 Meters:
WGN, WLIB

730 Kilocycles, 410.7 Meters—Canadian Wave:

740 Kilocycles, 405.2 Meters:
WSB, KMMJ

750 Kilocycles, 399.8 Meters:
WJR

760 Kilocycles, 394.5 Meters:
WJZ, WEW, KVI

770 Kilocycles, 389.4 Meters:
KFAB, WBBM, WJBT

780 Kilocycles, 384.4 Meters—Canadian Shared:
WTAR, WPOR, KELW, KTM, WMC, WEAN

790 Kilocycles, 379.5 Meters:
WGY, KGO

800 Kilocycles, 374.8 Meters:
WBAP, WFAA

810 Kilocycles, 370.2 Meters:
WPCH, WCCO

820 Kilocycles, 365.6 Meters:
WHAS

830 Kilocycles, 361.2 Meters:
KOA, WHDH, WRUF, WEEU

840 Kilocycles, 356.9 Meters—Canadian Wave:

850 Kilocycles, 352.7 Meters:
KWKH, WWL

860 Kilocycles, 348.6 Meters:
WBOQ, WABC, KMO, WHB

870 Kilocycles, 344.6 Meters:
WLS, WENR, WBCN

880 Kilocycles, 340.7 Meters—Canadian Shared:
WQAN, WGBI, WCOC, KLX, KPOF, KFKA, WSUI

890 Kilocycles, 336.9 Meters—Canadian Shared:
WJAR, WMMN, WGST, KARK, WILL, KUSD, KFNF, WKAQ

900 Kilocycles, 331.1 Meters:
WKY, WLBL, KHJ, KSEI, KGBU, WJAX, WBEN

910 Kilocycles, 329.5 Meters—Canadian Wave:

920 Kilocycles, 325.9 Meters:
WWJ, KPRC, WAAF, WBSO, KOMO, KFXF, KFEL

930 Kilocycles, 322.4 Meters—Canadian Shared:
WIBG, WDBJ, WBRC, KGBZ, KMA, KFWI, KROW

940 Kilocycles, 319 Meters:
WCSH, WFIW, KOIN, KGU, WHA, WDAY, WAAT

950 Kilocycles, 315.6 Meters:
WRC, KMBC, KFWB, KGHL

960 Kilocycles, 312.3 Meters—Canadian Wave:

970 Kilocycles, 309.1 Meters:
KJR, WCFL

980 Kilocycles, 305.9 Meters:
KDKA

990 Kilocycles, 302.8 Meters:
WBZ, WBZA

1000 Kilocycles, 299.8 Meters:
WHO, WOC, KFVD

1010 Kilocycles, 296.9 Meters—Canadian Shared:
WQAO, WPAP, WHN, WRNY, KGGF, WNAD, KQW, WIS, WLAP

1020 Kilocycles, 293.9 Meters:
KYW, KFKX, WRAX

1030 Kilocycles, 291.1 Meters—Canadian Wave:

1040 Kilocycles, 288.3 Meters:
WKAR, KTHS, KRLD

1050 Kilocycles, 285.5 Meters:
KNX, KFKB

1060 Kilocycles, 282.8 Meters:
WBAL, WJAG, KWJJ, WTIC

1070 Kilocycles, 280.2 Meters:
WTAM, WCAZ, WDZ, KJBS

1080 Kilocycles, 277.6 Meters:
WBT, WCBD, WMBI

1090 Kilocycles, 275.1 Meters:
KMOX

1100 Kilocycles, 272.6 Meters:
WPG, WLWL, KGDM

1110 Kilocycles, 270.1 Meters:
WRVA, KSOO

1120 Kilocycles, 267.7 Meters—Canadian Shared:
WTAW, WISN, WHAD, KFSG, KRSC, WDEL, WDBO, KFIO, KTRH, KMSC, KMBC

1130 Kilocycles, 265.3 Meters:
WOV, KSL, WJJD

1140 Kilocycles, 263.0 Meters:
WAPI, KVOO

1150 Kilocycles, 260.7 Meters:
WHAM

1160 Kilocycles, 258.5 Meters:
WWVA, WOWO

1170 Kilocycles, 256.3 Meters:
WCAU

1180 Kilocycles, 254.1 Meters:
KEX, KOB, WHDI, WDGY, WMAZ, WGBS

1190 Kilocycles, 252.0 Meters:
WOAI

1200 Kilocycles, 249.9 Meters: Canadian Shared:
WABI, WNBX, WORC, WIBX, WHBC, WBHS, WLBG, WNBO, WKJC, WNBW, WABZ, WJBW, WBBZ, WFBC, WRBL, KGCU, WJBC, WJBL, WWAE, WFAM, KFJB, WCAT, KGDY, KFWF, KGDE, WCLO, WHBY, KSMR, WIL, KVOS, KGY, KGEK, KGEW, KGHI, WCAX, WCOD, WFBE, KBTM, WEPS, KMLB, KGFJ, KWG

1210 Kilocycles, 247.8 Meters—Canadian Shared:
WIBI, WGBB, WCOH, WOCL, WLCI, WPAW, WPRO, WLSI, WJW, WBAX, WJBU, WMBG, WSIX, WJBY, WRBQ, WGCM, KWEA, KDLR, KGCR, KFOR, WHBU, KFVS, WEBQ, WQDX, WCRW, WEDC, WCBS, WTAX, WHBF, WOMT, WSBC, KDFN, KMJ, KFXM, KPPC, WALR, WBBL, WMRJ, KGMP, KGNO, WSEN, WSOC, WIBU, KFJI

1220 Kilocycles, 245.6 Meters:
WCAD, WCAE, WREN, KFKU, WDAE, KWSC, KTW

1230 Kilocycles, 243.8 Meters:
WNAC, WBIS, WPSC, WSBT, WFBM, KFQD, KYA, KGGM

1240 Kilocycles, 241.8 Meters:
WACO, KTAT, WXYZ

1250 Kilocycles, 239.9 Meters:
WGCP, WODA, WAAM, WLB, WGMS, WRHM, KFMX, WCAL, KFOX, WDSU

1260 Kilocycles, 238.0 Meters:
WLBW, KWWG, KRGV, KOIL, KVOA, WTOC

1270 Kilocycles, 236.1 Meters:
WEAI, WASH, WOOD, KWLC, KGCA, KOL, KVOR, WFBR, WJDX

1280 Kilocycles, 234.2 Meters:
WCAM, WCAP, WOAX, WDOD, WRR, KFBB, WIBA, WISJ

1290 Kilocycles, 232.4 Meters:
WNBZ, WJAS, KTSA, KFUL, KLCN, KDYL, WEBC

1300 Kilocycles, 230.6 Meters:
WBBR, WHAP, WEVD, WHAZ, KFH, KGEF, KFAC, KFJR, KTBR, WIOD, WMBF, WOQ

1310 Kilocycles, 228.9 Meters:
WKAV, WEBR, WNBH, WOL, WGH, WHAT, WFBG, WRAW, WGAL, WSAJ, WBRE, WKBC, WTJS, KRMD, KFPM, WDAH, KFPL, KFXR, WKBS, WCLS, WKBB, KWCR, KFJY, KFGQ, WBOW, WJAK, WLBC, KTSL, KFUP, KFXJ, KFBK, KGEZ, KMED, KTSM, KGCX, WJAC, WSJS, KXRO, KGFW, KFIU, KGBX, KIT, WMBO, KCRJ, KTLC, WEXL, WROL, WTEL, WBEO, WFDV

1320 Kilocycles, 227.1 Meters:
WADC, WSMB, KID, KTFI, KGHF, KGMB, KGIQ

1330 Kilocycles, 225.4 Meters:
WDRC, WTAQ, KSCJ, WSAI, KGB

1340 Kilocycles, 223.7 Meters:
KFPW, WCOA, KFPY, WSPD

1350 Kilocycles, 222.1 Meters:
WMSG, WCDA, WBNX, KWK, WAWZ, WEHC KIDO

1360 Kilocycles, 220.4 Meters:
WOBC, WGES, KGIR, KGER, WFBL, WCSC WJKS

1370 Kilocycles, 218.8 Meters:
WSVS, WCBM, WHBD, WJBK, WIBM, WRAK, WDAS, WHBQ, WRAM, KGFG, KFJZ, KGKL, KFLX, KGDA, KRE, WPOE, KFBL, KWKC, WRJN, KGAR, KVL, KGFL, WHDF, KOOS, WGL, KFJM, KCRC, WMBR, WRBJ, WLEY, WBGF, WBTM, WLVA, WQDM, WRDO, KONO, KMAC, KUJ, WJTL, KOH

1380 Kilocycles, 217.3 Meters:
KQV, KSO, WKBH, WSMK

1390 Kilocycles, 215.7 Meters:
WHK, KLRA, KUOA, KOY

1400 Kilocycles, 214.2 Meters:
WCGU, WFOX, WLTH, WBBC, WCMA, WKBF, KOCW, WBAA, KLO

1410 Kilocycles, 212.6 Meters:
KGRS, WDAG, KFLV, WHBL, WBCM, WODX, WSFA, WAAB, WRBX, WHIS

1420 Kilocycles, 211.1 Meters:
WTBO, WKBI, WEDH, WMBC, KGFF, KABC, KFYO, KICK, WIAS, KGGC, WLBF, WMBH, KFIZ, KORE, WILM, KGIW, KGKX, KFOW, KLPM, KXL, WHDL, WHFC, WEHS, KFQU, KFXD, KGIX, WJBO, WELL, WFDW, WPAD, WSPA, KBPS, KFXY, KXYZ, WAGM, WDEV, KGVO, WJMS, WDIX

1430 Kilocycles, 209.7 Meters:
WHP, WCAH, WGBC, WNBR, WBAK, KECA, KGNF, WFEA

1440 Kilocycles, 208.2 Meters:
WHEC, WABO, WOKO, WCBA WTAD, WMBD, KLS, WSAN, WBIG

1450 Kilocycles, 206.8 Meters:
WBMS, WNJ, WKBO, WSAR, WGAR, WTFI, KTBS, WHOM

1460 Kilocycles, 205.4 Meters:
WJSV, KSTP

1470 Kilocycles, 204.0 Meters:
KGA, WTNT, WLAC

1480 Kilocycles, 202.6 Meters:
KFJF, WKBW

1490 Kilocycles, 201.6 Meters:
WCKY, WCHI

1500 Kilocycles, 199.9 Meters:
WMBA, WLOE, WNBF, WMBQ, WLBX, WWRL, WKBZ, WMPC, WOPI, WPEN, KGKB, WKBV, KPJM, KDB, KGFI, WMBJ, KREG, WCLB, WRDW, KGIZ, KGKY, KPQ, KUT, KXO, KGFK, WSYB, WWSW

LIST OF POLICE BROADCASTING STATIONS

Call	Kilocycles	Meters	Location	Call	Kilocycles	Meters	Location
WPDO	2,458	122.05	Akron, Ohio	KGPE	2,422	123.86	Kansas City, Mo.
WPDY	2,452	122.34	Atlanta, Ga.	WPDT	2,470	121.50	Kokomo, Ind.
KGPS	2,416	124.17	Bakersfield, Calif.	WPDL	2,440	123.00	Lansing, Mich.
KGPJ	1,712	175.23	Beaumont, Tex.	KGPL	1,712	175.23	Los Angeles, Calif.
KSW	2,410	124.50	Berkeley, Calif.	WPDE	2,440	123.00	Louisville, Ky.
WEY	1,596	187.97	Boston, Mass.	WPEC	2,470	121.50	Memphis, Tenn.
WRDU	1,596	187.97	Brooklyn, N. Y.	WPDK	2,452	122.34	Milwaukee, Wis.
WMJ	2,422	123.86	Buffalo, N. Y.	KGPB	2,416	124.17	Minneapolis, Minn.
WBR	257	1,165.00	Butler, Pa.	WPY	438	685.00	New York, N. Y.
KGOZ	2,470	121.50	Cedar Rapids, Iowa	WPY	500	600.00	New York, N. Y.
WPDV	2,458	122.05	Charlotte, N. C.	WCF	1,596	187.97	New York, N. Y.
WPDB	1,712	175.23	Chicago, Ill.	KGPH	2,452	122.34	Oklahoma City, Okla.
WPDC	1,712	175.23	Chicago, Ill.	KGPI	2,470	121.50	Omaha, Neb.
WPDD	1,712	175.23	Chicago, Ill.	KGJX	1,712	175.23	Pasadena, Calif.
WKDU	1,712	175.23	Cincinnati, Ohio	WPDP	2,440	123.00	Philadelphia, Pa.
WRBH	2,452	122.34	Cleveland, Ohio	WPDU	1,712	175.23	Pittsburgh, Pa.
WPDI	2,416	124.17	Columbus, Ohio	KGPP	2,416	124.17	Portland, Ore.
KVP	1,712	175.23	Dallas, Tex.	WPDH	2,416	124.17	Richmond, Ind.
KGPN	2,470	121.50	Davenport, Iowa	WPDR	1,712	175.23	Rochester, N. Y.
WPDM	2,416	124.17	Dayton, Ohio	KGPC	1,712	175.23	St. Louis, Mo.
KGPV	2,506	180.51	Des Moines, Iowa	WPDS	2,416	124.17	St. Paul, Minn.
WKDT	1,596	187.97	Detroit, Mich.	KGPW	2,470	121.50	Salt Lake City, Utah.
WCK	2,410	124.50	Detroit, Mich.	KGPD	1,596	187.97	San Francisco, Calif.
WPDX	2,410	124.50	Detroit, Mich.	KGPD	2,410	124.50	San Francisco, Calif.
WPDF	2,440	123.00	Flint, Mich.	KGPM	2,470	121.50	San Jose, Calif.
KGPR	1,712	175.23	Ft. Worth, Tex.	KGPA	2,416	124.17	Seattle, Wash.
WMP	1,662	180.51	Framingham, Mass.	KGPK	2,470	121.50	Sioux City, Iowa
WPEB	2,440	123.00	Grand Rapids, Mich.	WRDQ	2,470	121.50	Toledo, Ohio
WJL	257	1,165.00	Greensburg, Pa.	WPDA	2,416	124.17	Tulare, Calif.
WRDR	2,410	124.50	Grosse Point Village, Mich.	KGPG	2,410	124.50	Vallejo, Calif.
WBA	257	1,165.00	Harrisburg, Pa.	WPDW	2,410	124.50	Washington, D. C.
WMO	2,410	124.50	Highland Park, Mich.	WMB	257	1,165.00	West Reading, Pa.
KGPQ	2,452	122.35	Honolulu, T. H.	KGPZ	2,450	122.4	Wichita, Kans.
WMDZ	2,440	123.00	Indianapolis, Ind.	WDX	257	1,165.00	Wyoming, Pa.
WRDS	1,662	180.51	Ingham, Mich.	WPDG	2,458	122.05	Youngstown, Ohio

U. S. VISUAL BROADCASTING STATIONS

Call	Kilocycles	Meters	Owner	Call	Kilocycles	Meters	Owner
W1XAU	1,500	193.6	Short Wave & Television, Boston, Mass.	W3XAD	48,500	6.18	RCA-Victor, Camden, N. J.
1XAV	2,850	105.30	Short Wave & Television, Boston, Mass.	W3XAD	60,000	5.00	RCA-Victor, Camden, N. J.
W2XAB	2,750	109.10	Atlantic Broadcasting, New York, N. Y.	W3XAD	2,100	142.90	RCA-Victor, Camden, N. J.
W2XBC	2,750	109.10	United Research Corp., Long Island City, N. Y.	W3XK	2,000	150.00	Jenkins Laboratories, Wheaton, Md.
W2XBU	2,000	150.00	Harold E. Smith, Beacon, N. Y.	W6X4H	2,000	150.00	Pioneer Mercantile Co., Bakersfield, Calif.
W2XCD	2,000	150.00	DeForest Radio Co., Passaic, N. J.	W6XAO	43,000	6.97	Don Lee, Inc., Los Angeles, Calif.
W2XCR	2,100	142.90	Jenkins Television, Jersey City, N. J.	W6XS	2,100	142.90	Don Lee, Inc., Los Angeles, Calif.
W2XCR	2,000	150.00	Jenkins Television, Jersey City, N. J.	W8XAV	2,100	142.90	Westinghouse, East Pittsburgh, Pa.
W2XCW	2,100	142.90	General Electric, Schenectady, N. Y.	W9XAA	2,750	109.10	Federation of Labor, Chicago, Ill.
W2XDA	1,544	194.30	Atlantic Broadcasting, New York, N. Y.	W9XAB	1,564	191.82	Federation of Labor, Chicago, Ill.
W2XDS	43,000	6.98	Jenkins Television, New York, N. Y.	W9XAO	2,000	150.00	Western Television Corp., Chicago, Ill.
W2XDS	48,500	6.19	Jenkins Television, New York, N. Y.	W9XAP	2,100	142.90	Daily News, Chicago, Ill.
W2XDS	60,000	5.00	Jenkins Television, New York, N. Y.	W9XD	43,000	6.97	Journal Company, Milwaukee, Wis.
W2XF	43,000	6.97	National Broadcasting, New York, N. Y.	W9XD	48,500	6.18	Journal Co., Milwaukee, Wis.
W2XF	48,500	6.18	National Broadcasting, New York, N. Y.	W9XD	60,000	6.00	Journal Co., Milwaukee, Wis.
W2XF	60,000	5.00	National Broadcasting, New York, N. Y.	W9XG	2,750	109.10	Purdue University, W. Lafayette, Ind.
W2XR	2,850	105.30	Radio Pictures, Inc., Long Island City, N. Y.	W9XR	2,850	105.30	Great Lakes Broadcasting, Chicago, Ill.
W3XAD	43,000	6.97	RCA-Victor, Camden, N. J.				

U. S. RELAY BROADCASTING STATIONS

Call	Kilocycles	Meters	Owner	Call	Kilocycles	Meters	Owner
W1XAL	6,040	49.67	Short Wavo Bdcstg. Corp., Boston, Mass.	W6XAF	2,938	112.10	Dept. Agriculture, Sacramento, Calif.
W1XAL	11,800	25.42	Short Wavo Bdcstg. Corp., Boston, Mass.	W6XAF	5,870	51.11	Dept. Agriculture, Sacramento, Calif.
W1XAL	15,250	19.67	Short Wavo Bdcstg. Corp., Boston, Mass.	W6XAL	6,080	49.34	Pacific-Western Broadcasting, Westminster, Calif.
W1XAL	21,460	13.97	Short Wavo Bdcstg. Corp., Boston, Mass.	W6XAL	15,250	19.67	Pacific-Western Broadcasting, Westminster, Calif.
W1XAZ	9,570	31.35	Westinghouse Elec., East Springfield, Mass.	W6XAL	21,500	13.95	Pacific-Western Broadcasting, Westminster, Calif.
W2XAD	15,340	19.56	General Electric, Schenectady, N. Y.	W6XN	12,850	23.35	General Electric, Oakland, Calif.
W2XAF	9,530	31.48	General Electric, Schenectady, N. Y.	W8XAL	6,060	49.50	Crosley Radio Corp., Cincinnati, Ohio
W2XAG	550	545.00	General Electric, Schenectady, N. Y.	W8XK	6,140	48.86	Westinghouse, East Pittsburgh, Pa.
W2XAG	660	455.00	General Electric, Schenectady, N. Y.	W8XK	9,570	31.35	Westinghouse, East Pittsburgh, Pa.
W2XAG	790	380.00	General Electric, Schenectady, N. Y.	W8XK	11,880	25.25	Westinghouse, East Pittsburgh, Pa.
W2XAG	1,150	260.90	General Electric, Schenectady, N. Y.	W8XK	15,210	19.72	Westinghouse, East Pittsburgh, Pa.
W2XAG	1,500	200.00	General Electric, Schenectady, N. Y.	W8XK	17,780	16.87	Westinghouse, East Pittsburgh, Pa.
W2XE	6,120	49.02	Atlantic Broadcasting, Jamaica, N. Y.	W8XK	21,540	13.93	Westinghouse, East Pittsburgh, Pa.
W2XE	11,840	25.34	Atlantic Broadcasting Co., Jamaica, N. Y.	W9XAA	6,080	49.34	Federation of Labor, Chicago, Ill.
W2XE	15,280	19.63	Atlantic Broadcasting Co., Jamaica, N. Y.	W9XAA	11,840	25.34	Federation of Labor, Chicago, Ill.
W2XZ	610	491.50	National Broadcasting, Bellmore, N. Y.	W9XAA	17,780	16.87	Federation of Labor, Chicago, Ill.
W3XAL	6,100	49.18	National Broadcasting, New York, N. Y.	W9XF	6,020	49.83	Great Lakes Broadcasting, Chicago, Ill.
W3XAU	6,060	49.50	Universal Broadcasting, Newton Township, Pa.	W9XF	11,800	25.42	Great Lakes Broadcasting, Chicago, Ill.
W3XAU	9,590	31.28	Universal Broadcasting, Newton Township, Pa.	W9XF	21,500	13.95	Great Lakes Broadcasting, Chicago, Ill.
W3XL	6,425	46.70	National Broadcasting, New York, N. Y.	W9XU	6,060	49.50	Mona Motor Oil Co., Council Bluffs, Iowa

SIMPLE TIME CHART

(Time changes every 15 degrees of Longitude East or West)

← WEST

LONGITUDE WEST OF GREENWICH	180°	165°	150°	135°	120°	105°	90°	75°	60°	45°	30°	15°	0°
PLACES ON, OR NEARLY ON, THE MERIDIAN INDICATED.	FIJI ISLANDS	UNALASKA	SEWARD	JUNEAU	LOS ANGELES	DENVER	CHICAGO	NEW YORK	BUENOS AIRES	RIO JANEIRO	AZORES	ICELAND	LONDON (GREENWICH)
TIME	Midnight	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon

↑ International date line. When it's Monday East of 180° it is Tuesday West of 180°. ↓

EAST →

LONGITUDE EAST OF GREENWICH	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
PLACES ON, OR NEARLY ON, THE MERIDIAN INDICATED.	LONDON (GREENWICH)	BERLIN	ODESSA CAIRO	ADEN	MAURITIUS ISL.	LAHORE	CALCUTTA	BATAVIA	MANILA	KOBE	EASTERN AUSTRALIA	NEW CALEDONIA	FIJI ISLANDS
TIME	Noon	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.	Midnight

FOREIGN BROADCAST STATIONS

ALGERIA

Call	Location	Kc.
......	Algiers	824

ARGENTINA

Call	Location	Kc.
LP4	Buenos Aires	670
LR1	Buenos Aires	790
LR2	Buenos Aires	870
LR3	Buenos Aires	950
LR4	Buenos Aires	990
LR5	Buenos Aires	830
LR6	Buenos Aires	910
LR7	Buenos Aires	750
LR8	Buenos Aires	1150
LR9	Buenos Aires	1030
LS1	Buenos Aires	710
LS2	Buenos Aires	1190
LS3	Buenos Aires	1270
LS5	Buenos Aires	1070
LS6	Buenos Aires	1350
LS8	Buenos Aires	1230
LS9	Buenos Aires	1390
LT2	Concordia	810
J2	Concordia	1327
LV2	Cordoba	911
LT7	General Pico	...
LT2	La Plata	685
LV8	Los Molinos	...
LT4	Mendoza	759
LT5	Parana	1249
LT3	Rosario	1090
LV5	Rosario	1369
LV6	Rosario	1079
LT6	San Juan	730
LP2	Villaguay	1140

AUSTRALIA

Call	Location	Kc.
5CL	Adelaide	730
5DN	Adelaide	960
5KA	Adelaide	1200
5AD	Adelaide	1310
5AD	Adelaide	720
2AY	Albury	1320
2AY	Albury	1480
3BA	Ballarat	1300
3BO	Bendigo	1450
3BO	Bendigo	980
4QG	Brisbane	760
4BC	Brisbane	1145
4BC	Brisbane	880
4BK	Brisbane	1290
2CA	Canberra	1050
3KZ	Carlton	1350
4CH	Charleville	1170
3GL	Geelong	1400
2GN	Goulburn	1490
2MO	Gunnedah	1500
2MO	Gunnedah	1330
7ZL	Hobart	580
7HO	Hobart	890
7HO	Hobart	1160
7LA	Launceston	1080
7LA	Launceston	1100
2XN	Lismore	1340
4MK	Mackay	1190
3AR	Melbourne	610
3LO	Melbourne	800
3UZ	Melbourne	930
3DB	Melbourne	1180
3KZ	Melbourne	1350
2MV	Moss Vale	1220
2MV	Moss Vale	1460
2NC	Newcastle	1245
2HD	Newcastle	1415
2HD	Newcastle	1110
6WF	Perth	690
6ML	Perth	1010
6ML	Perth	1180
4RK	Rockhampton	930
2FC	Sydney	665
2BL	Sydney	855
2GB	Sydney	950
2UE	Sydney	1025
2KY	Sydney	1070
2UW	Sydney	1125
4GR	Toowoomba	1020
4TO	Townsville	1260
3TR	Trafalgar	1280
3WR	Wangaratta	1260

AUSTRIA

Call	Location	Kc.
......	Graz	851
......	Innsbruck	1058
......	Innsbruck	1376
......	Klagenfurt	662
......	Linz	1220
......	Vienna	581

BELGIUM

Call	Location	Kc.
EB4ED	Antwerp	1200
EB4GT	Bruxells	1150
ON4RB	Bruxells	590
EB4RC	Bruxells	1395
EB4FO	Bruxells	1305
EB4CE	Chatelineau	1365
EB4FG	Dampremy	1430
EB4RG	Gand	1090
EB4RW	Liege	1070
EB4BQ	Marchienne	1035
EB4EX	Ottomont	1335
EB4CF	Verviers	1395

BERMUDA

Call	Location	Kc.
TJW	Hamilton	1480

BOLIVIA

Call	Location	Kc.
......	La Paz	1713
CPX	La Paz	1000

BRAZIL

Call	Location	Kc.
PRAM	Amparo	1304
PRAH	Bahia	857
PRAF	Belem	1363
PRAQ	Bello Horizonte	1090
PRAN	Curvtiba	882
PRAZ	Franca	1111
PRAJ	Juiz de Fora	857
PRAY	Mogy das Cruzes	1000
PRAD	Pelotas	920
PRAG	Porto Alegre	1090
PRAP	Recife	750
PRAI	Ribeirao Preto	1153
PRAA	Rio de Janeiro	750
PRAB	Rio de Janeiro	934
PRAC	Rio de Janeiro	833
PRAX	Rio de Janeiro	1364
PRAK	Rio de Janeiro	1153
PRAS	Santos	1000
PRAE	Sao Paulo	857
PRAR	Sao Paulo	1016
PRAL	Sao Paolo	750
PRAO	Sao Paolo	934

CANADA

Call	Location	Kc.
CKGW	Bowmanville	910
CJBC	Bowmanville	910
CJSC	Bowmanville	910
CPRY	Bowmanville	910
10AE	Bowmanville	1199
10BQ	Brantford	1199
CKX	Brandon	540
CNRC	Calgary	690
CFCN	Calgary	985
CJCJ	Calgary	690
CHCA	Calgary	690
CFAC	Calgary	690
10BU	Canora	1199
CHCK	Charlottetown	960
CFCY	Charlottetown	580
CFCO	Chatham	1210
CHWK	Chilliwack	665
CKMC	Cobalt	1210
CHMA	Edmonton	580
CKUA	Edmonton	580
CJCA	Edmonton	930
CNRE	Edmonton	930
CJRW	Fleming	665
CFNB	Fredericton	1210
CHNS	Halifax	930
CNRH	Halifax	930
CHCS	Hamilton	1010
CHML	Hamilton	880
CKOC	Hamilton	1010
CFJC	Kamloops	1120
10AY	Kelowna	1199
CKOV	Kelowna	1200
CFRC	Kingston	930
CFRB	King, York Co.	960
CNRX	King, York Co.	960
CJOC	Lethbridge	1120
10BU	Liverpool	1199
CJGC	London	910
CNRL	London	910
CKPR	Midland	930
CNRA	Moncton	630
CFCF	Montreal	1030
CJRM	Moose Jaw	665
10AB	Moose Jaw	1199
CFCH	North Bay	930
CKCO	Ottawa	890
CNRO	Ottawa	600
CHWC	Pilot Butte	960
CKPR	Port Arthur	...
CFLC	Prescott	930
CKPC	Preston	1210
10BI	Prince Albert	1199
CHRC	Quebec	880
CKCI	Quebec	645
CKCV	Quebec	880
CNRQ	Quebec	880
CNRD	Red Deer	840
CKLC	Red Deer	840
CHCT	Red Deer	840
CKCK	Regina	960
CIBR	Regina	960
CNRR	Regina	960
CFQC	Saskatoon	910
CNRS	Saskatoon	910
CJOR	Sea Island	1210
CKAC	St. Hyacinthe	730
CHYC	St. Hyacinthe	730
CNRM	St. Hyacinthe	730
CFBO	St. John	890
10AK	Stratford	1199
CHGS	Summerside	1120
CJCB	Sydney	880
CNRT	Toronto	840
CPRY	Toronto	...
CFCA	Toronto	840
CKOW	Toronto	840
CKCL	Toronto	580
CKNC	Toronto	580
CFCL	Toronto	580
CNRV	Vancouver	1030
CKCD	Vancouver	730
CHLS	Vancouver	730
CKFC	Vancouver	730
CKMO	Vancouver	730
CKWX	Vancouver	730
CFCT	Victoria	630
CKCR	Waterloo	645
10BP	Wingham	1199
CKY	Winnipeg	780
CNRW	Winnipeg	780
CK1C	Wolfville	930
CJGX	Yorkton	630

CANAL ZONE

Call	Location	Kc.
NBA	Panama	845

CANARY ISLANDS

Call	Location	Kc.
EAR5	Las Palmas	1071

CEYLON

Call	Location	Kc.
VPB	Colombo	700

CHILE

Call	Location	Kc.
......	Asuncion	...
CMA1	Concepcion	870
CMAB	Santiago	625
CMAC	Santiago	804
CMAD	Santiago	938
CMAE	Santiago	1070
CMAF	Santiago	750
CMAK	Santiago	1333
CMAO	Santiago	1016
CMAQ	Santiago	1224
CMAT	Tacna	545
CMAJ	Valparaiso	1034

CHINA

Call	Location	Kc.
CAB	Canton	689
XGY	Chekiang	977
COHB	Harbin	674
COMK	Mukden	731.3
XGZ	Nanking	1071
XOPP	Peiping	952.3
KRC	Shanghai	869.5
KSMS	Shanghai	1083
NKS	Shanghai	952
RSC	Shanghai	1276.5
XGX	Shanghai	1071
XGAH	Shanghai	937.5
COTN	Tientsin	625
GEC	Tientsin	1000

CHOSEN

Call	Location	Kc.
JODK	Keijo	690

COLOMBIA

Call	Location	Kc.
HJN	Bogota	684.9

COSTA RICA

Call	Location	Kc.
TI4NRH	Heredia	980
TICR	San Jose	911
TIFB	San Jose	714
TIGP	San Jose	666
TISO	San Jose	600
TITR	San Jose	1333
TITV	San Jose	999

CUBA

Call	Location	Kc.
CM11D	Caibarien	905
CMJA	Camaguey	1200
CMJC	Camaguey	1382
CMJE	Camaguey	856
CMJF	Camaguey	930
CMGE	Cardenas	1375
CMJA	Ciego de Avila	1017
CMHJ	Cienfuegos	645
CMGA	Colon	834
CMCG	Guanabacoa	1345
CMBR	Havana	1500
CMCW	Havana	1285
CMCQ	Havana	1150
CMBL	Havana	1500
CMCU	Havana	1285
CMBY	Havana	1225
CMCD	Havana	925
CMBC	Havana	965
CMBG	Havana	1070
CMQ	Havana	1150
CMCA	Havana	1225
CMK	Havana	730
CMCJ	Havana	620
CMBZ	Havana	1010
CMBI	Havana	1405
CMCB	Havana	1070
CMCH	Havana	1405
CMX	Havana	890
CMC	Havana	840
CMBT	Havana	790
CMBS	Havana	790
CMCF	Havana	890
CMCY	Havana	1345
CMW	Havana	588
CMBD	Havana	965
CMCR	Havana	1345
CMBN	Havana	1405
CMCM	Havana	1405
CMDC	Marianao	660
CMBW	Marianao	1010
CMBQ	Marianao	1500
CMCN	Marianao	925
CMCO	Marianao	660
CMGB	Matanzas	1205
CMGF	Matanzas	977
CMGH	Matanzas	1370
CMAB	Pinar del Rio	1249
CMAC	Pinar del Rio	1375
CMHI	Santa Clara	1110
CMKC	Santiago de Cuba	1034
CMHC	Tuinicu	790

CZECHOSLOVAKIA

Call	Location	Kc.
OKR	Bratislava	1075
OKB	Brunn	878
OKK	Kosice	1024
......	Moravska-Ostrava	1141
OKP	Prague	616

DANZIG

Call	Location	Kc.
PTB	Danzig	662

DENMARK

Call	Location	Kc.
......	Copenhagen	1067
OXO	Kalundborg	260

DOMINICAN REPUBLIC

Call	Location	Kc.
HIX	Santo Domingo	625

DUTCH EAST INDIES

Call	Location	Kc.
......	Bandoeng	968
PFC	Batavia	1364

EGYPT

Call	Location	Kc.
......	Cairo	869
......	Cairo	909

ESTONIA

Call	Location	Kc.
......	Tallinn	1013
......	Tallinn	747
......	Tartu	1050

FINLAND

Call	Location	Kc.
......	Abo	1219
......	Bjorenborg	1219
OFA	Helsingfors	1357
OFC	Jakobstad	1031
OFB	Lahti	167
OFD	Pori	1373
OFE	Tampere	662
OFG	Turku	1220
OFH	Viipuri	1031

FRANCE

Call	Location	Kc.
F2BD	Agen	963
......	Beziers	1413
......	Bordeaux	986
......	Grenoble	915
......	Juan les Pino	1206
......	Lille	1132
......	Limoges	1020
YN	Lyon	644
YR	Lyon	1051
......	Marsan	750
......	Marseille	949
......	Montpellier	1049
......	Montpellier	1195
......	Nimes	1250
FL	Paris	207
FPTT	Paris	671
......	Paris	919
......	Paris	174
......	Paris	1265
......	Rennes	1103
MRD	Toulouse	1175
......	Toulouse	787
......	Vitus	971

GERMANY

Call	Location	Kc.
......	Aachen	1319
......	Aix la Chapelle	662
......	Augsburg	1112
......	Berlin I	717
......	Berlin II	1059
......	Bremen	950
......	Breslau	923
......	Cologne	1319
......	Dresden	940
......	Flensburg	1373
......	Frankfurt	769
......	Freiburg	524
......	Gleiwitz	1184

Call	Location	Kc.
......	Hamburg	806
......	Hanover	535
......	Kassel	1220
......	Kaiserslantern	536
......	Kiel	1292
......	Konigsberg	1382
......	Langenberg	634
......	Leipzig	1158
......	Magdeburg	1060
......	Muehlacker	833
......	Munich	563
......	Munster	1319
......	Nurnberg	1255
......	Stettin	1060
......	Stuttgart	833

GREAT BRITAIN

Call	Location	Kc.
2BD	Aberdeen	995
2BE	Belfast	1238
6BM	Bournemouth	1040
2LS	Bradford	1040
5WA	Cardiff	968
......	Daventry, Regional	626
......	Daventry, National	193
2DE	Dundee	1040
2EH	Edinburgh	1040
5SC	Glasgow	752
6KH	Hull	1040
2LS	Leeds	1500
6LV	Liverpool	1040
......	London, Regional	842
......	London, National	1150
2ZY	Manchester	796
5NO	Newcastle	1148
5PY	Plymouth	1040
6FL	Sheffield	1040
6ST	Stoke-on-Trent	1040
5SX	Swansea	1040

GUATEMALA

Call	Location	Kc.
TGW	Guatemala City	571

HAITI

Call	Location	Kc.
HHK	Port au Prince	920

HOLLAND

Call	Location	Kc.
......	Bloemendaal	1220
PFBI	Hilversum	280
......	Hilversum	1004
PH9	Huizen	160
PCF	Scheveningen	280

HONDURAS

Call	Location	Kc.
HRB	Tegucigalpa	1370

HONG KONG

Call	Location	Kc.
ZBW	Victoria	845

HUNGARY

Call	Location	Kc.
HAL	Budapest	550

ICELAND

Call	Location	Kc.
......	Akureyri	1563
TFA	Reykjavik	1999
TFU	Reykjavik	250

INDIA

Call	Location	Kc.
VUB	Bombay	840
VUC	Calcutta	810
VUL	Lahore	882
VUM	Madras	769

IRISH FREE STATE

Call	Location	Kc.
6CK	Cork	750
2RN	Dublin	940

ITALY

Call	Location	Kc.
1BA	Bari	...
1BZ	Bolzano	662
1FI	Firenze	...
1GE	Genoa	779
1MI	Milan	599
1NA	Naples	905
1PA	Palermo	1410
1RO	Rome	680
2RO	Rome	...
1TO	Torino	1094
1TR	Trieste	1211

JAPAN

Call	Location	Kc.
JOLK	Fukuoka	680
JOFK	Hiroshima	850
JOJK	Kanazawa	710
JODK	Keijyo	820
JOGK	Kumamoto	790
JONK	Nagano	635
JOCK	Nagoya	810
JOKK	Okayama	700
JOBK	Osaka	750
JOIK	Sapporo	830
JOHK	Sendai	770
JOPK	Shizuoka	780
JFAK	Taihoku	670
JOAK	Tokyo	870
JOAK	Tokyo	590

KENYA

Call	Location	Kc.
7LO	Nairobi	750

KWANTUNG

Call	Location	Kc.
JQAK	Darien	759

LATVIA

Call	Location	Kc.
YLZ	Riga	571

LITHUANIA

Call	Location	Kc.
RYK	Kaunas	155

LUXEMBURG

Call	Location	Kc.
LOAA	Luxemburg	1344

MEXICO

Call	Location	Kc.
XFC	Aguascalientes	805
XEFI	Chihuahua	1000
XFF	Chihuahua	923
XEJ	Ciudad Juarez	1000
XETZ	Coyoacan	1500
XEQ	Ciudad Juarez	750
XEA	Guadalajara	1000
XETC	Jalapa	1000
XEY	Merida	1000
XEFC	Merida	1050
XEX	Mexico City	1190
XEN	Mexico City	711
XEB	Mexico City	1030
XFG	Mexico City	683
XEG	Mexico City	1360
XFI	Mexico City	818
XEO	Mexico City	940
XFX	Mexico City	860
XEW	Mexico City	910
XEX	Mexico City	1210
XEZ	Mexico City	780
XFZ	Mexico City	860
XEK	Mexico City	990
XEM	Mexico City	1300
XETA	Mexico City	1140
XEFA	Mexico City	1250
XETQ	Mexico City	1230
XET	Monterrey	690
XEH	Monterrey	1132
XEFB	Monterrey	1270
XEI	Morelia	1000
XEFE	Nuevo Laredo	1000
XEP	Nuevo Laredo	1400
XEE	Oaxaca	1000
XEV	Puebla	1000
XEFS	Queretaro	1000
XED	Reynosa	965
XEL	Saltillo	1000
XFA	Tacubaya	500
XFA	Tacubaya	600
XES	Tampico	890
XEFD	Tiajuana	1020
XEC	Toluca	1000
XETG	Torreon	1000
XETB	Torreon	1380
XEU	Vera Cruz	1000
XETF	Vera Cruz	630
XFE	Villahermosa	804
XER	Villa Acuna	735

MONACO

Call	Location	Kc.
......	Monaco	1266

MOROCCO

Call	Location	Kc.
CNO	Casablanca	983
......	Rabat	414

NEWFOUNDLAND

Call	Location	Kc.
VOGT	Bell Island	890
VONA	St. Johns	959
VOWR	St. Johns	675
VOX	St. Johns	1400
SWMC	St. Johns	682
8RA	St. Johns	550

NEW ZEALAND

Call	Location	Kc.
1YA	Auckland	900
1ZR	Auckland	1090
1ZJ	Auckland	1320
1ZQ	Auckland	1188
3YA	Christchurch	980
3ZC	Christchurch	1199
2ZU	Dannevirke	1100
4YA	Dunedin	650
4ZB	Dunedin	1079
4ZO	Dunedin	1078
4ZM	Dunedin	1078
4ZL	Dunedin	1219
2ZE	Eketahuna	1210
2ZJ	Gisborne	1150
3ZR	Greymouth	820
1ZH	Hamilton	630
2ZI	Hastings	1330
2ZL	Hastings	1330
4ZP	Invercargill	1160
4ZI	Invercargill	1160
1ZM	Manurewa	1210
2ZD	Masterton	1180
2ZH	Napier	1260
2YB	New Plymouth	1230
2ZF	Palmerston North	1049
2ZO	Palmerston North	1120
2ZP	Wairoa	820
2ZK	Wanganui	600
2ZG	Wanganui	600
2ZR	Wanganui	600
2YA	Wellington	719
2ZW	Wellington	1120

NORWAY

Call	Location	Kc.
LKA	Alesund	671
LKB	Bergen	824
LKD	Bodo	662
LKF	Fredriksstad	815
LKH	Hamar	527
LKK	Kristianssand	1274
LKN	Notodden	671
LKO	Oslo	280
LKP	Porsgrund	662
LKR	Rjuken	671
LKS	Stavanger	1247
LKM	Tromso	662
LKT	Trondelag	608

PERU

Call	Location	Kc.
OAX	Lima	790
OA4M	Lima	1428

PHILIPPINE ISLANDS

Call	Location	Kc.
KZRC	Cebu	937
KZRM	Manila	618

POLAND

Call	Location	Kc.
SP3	Krakow	530
SP4	Kattowitz	710
SP7	Lodz	1229
SP6	Lwow	779
SP2	Poznan	875
SP8	Warsaw	1402
SP1	Warsaw	270
SP5	Wilno	690

PORTUGAL

Call	Location	Kc.
CT1AA	Lisbon	942

ROUMANIA

Call	Location	Kc.
......	Bucharest	759

SALVADOR

Call	Location	Kc.
AQM	Salvador	785
RUS	Salvador	664

SAMOA

Call	Location	Kc.
5ZA	Apia	940

SIAM

Call	Location	Kc.
HSP1	Bangkok	857
HSP3	Bangkok	938

SPAIN

Call	Location	Kc.
EAJ18	Almeria	1195
EAJ13	Barcelona	1119
EAJ1	Barcelona	860
EAJ15	Cartagena	1219
EAJ7	Madrid	707.5
EAJ2	Madrid	750
EAJ19	Oviedo	1119
EAJ8	San Sebastian	662
EAJ5	Seville	815

SWEDEN

Call	Location	Kc.
SBE	Boden	250
SCA	Boras	1301
SCB	Eskilstuna	1220
SCC	Falum	932
SCD	Gavle	1471
SBB	Goteborg	932
SCE	Halmstad	1380
SCG	Halsingborg	1299
SBH	Horby	1167
SCF	Hudiksvall	1111
SCH	Jonkoping	1490
SCI	Kalmar	1220
SCJ	Karlskrona	1531
SCK	Karlstadt	1376
SCL	Kiruna	1220
SCM	Kristinehamm	1481
SCN	Malmberget	688
SBC	Malmo	1299
SBG	Motala	222
SCO	Norrkoping	1111
SCV	Orebro	1266
SCW	Ornskoldsvik	1376
SBF	Ostersund	389
SCP	Saffle	1220
SBA	Stockholm	688
SBD	Sundsvall	553
SCQ	Trollhattan	1112
SCR	Uddevalla	1058
SCS	Umea	1301
SCT	Uppsla	662
SCU	Varborg	1060

SWITZERLAND

Call	Location	Kc.
HB3	Basel	941
......	Basel	1229
......	Berne	744
......	Berne	1220
......	Beromunster	653
......	Geneva	395
......	Lausanne	441
......	Monte Ceneri	441
......	Sottens	743
HBZ	Zurich	653

TUNISIA

Call	Location	Kc.
TNU	Carthage	162
TUA	Tunis	235

TURKEY

Call	Location	Kc.
TAE	Angora	193
TAL	Istanbul	250
......	Osmanieh	250

UNION OF SOVIET SOCIALIST REPUBLICS

Call	Location	Kc.
RW19	Achkhabad	334
RW60	Alma-Alta	310
RW36	Arkhangelsk	770
RW35	Astrakhan	434.8
RW8	Bakou	238
RW8	Bakou	245
RW43	Bakou	238
RW30	Dnepropetrovsk	511
RW21	Erivan	404
RW49	Gomel	621
RW23	Groznyi	676
RW14	Irkoutsk	187
RW31	Ivanovo-Voznesensk	604
RW46	Karaganda	687
RW17	Kazan	551
RW17	Kazan	644
RW54	Khabarovsk	1052
RW54	Khabarovsk	320
RW4	Kharkov	320
RW20	Kharkov	704
RW9	Kiev	368
RW9	Kiev	290
RW33	Krasnodar	650
RW66	Krasnoiarsk	333
RW53	Leningrad	300
RW27	Makhatch Kala	796
RW10	Minsk	428.6
RW1	Moscow	203
RW2	Moscow	416.7
RW37	Moscow	793
RW39	Moscow	707
RW58	Moscow	273
RW58	Moscow	268
RW49	Moscow	230
RW51	Naltchik	748
RW42	Nijni-Novgorod	394
RW6	Novosibirsk	238
RW13	Odessa	666
RW44	Omsk	471
RW45	Orenbourg	461
RW22	Oufa	444
RW22	Oufa	617
RW67	Oukhta	354
RW56	Penza	640
RW29	Petrozavodsk	468
RW29	Petrozavodsk	779
RW24	Piatigorsk	468
RW55	Pokrovsk	730
RW12	Rostov-sur-le-Don	353
RW16	Samara	521
RW16	Samara	404
RW18	Samarkand	343
RW3	Saratov	340
RW52	Simferopol	630
RW52	Simferopol	725
RW24	Smolensk	531
RW47	Stalinabad	421
RW26	Stalino	811
RW32	Stavropol	608
RW38	Sverdlovsk	157
RW5	Sverdlovsk	364
RW41	Syktyvkaz	560
RW11	Tachkent	256
RW7	Tiflis	280
RW48	Tomsk	645
RW63	Verkhneudinsk	350
RW64	Vladikavkag	752
RW28	Vladivostok	636
RW28	Vladivostok	725
RW25	Voronej	385
RW25	Voronej	450

URUGUAY

Call	Location	Kc.
CX6	Montevideo	650
CX10	Montevideo	730
CX12	Montevideo	770
CX14	Montevideo	810
CX16	Montevideo	850
CX18	Montevideo	890
CX20	Montevideo	930
CX22	Montevideo	970
CX26	Montevideo	1050
CX30	Montevideo	1130
CX32	Montevideo	1170
CX34	Montevideo	1210
CX36	Montevideo	1250
CX38	Montevideo	1290
CX40	Montevideo	1330
CX44	Montevideo	1410
CX46	Montevideo	1450
CX48	Montevideo	1490
CW40	Paysandu	1340
CW44	Paysandu	1420
CW32	Salto	1180
CW34	Salto	1220
CW36	Salto	1260
CW38	Salto	1300
CW30	Tacuarembo	1140

UNION OF SOUTH AFRICA

Call	Location	Kc.
ZTC	Capetown	800
ZTD	Durban	738
ZTJ	Johannesburg	666

VENEZUELA

Call	Location	Kc.
AYRE	Caracas	800
1BC	Caracas	960

YUGOSLAVIA

Call	Location	Kc.
......	Belgrade	696
......	Ljubljano	527
......	Zagreb	977

FOREIGN SHORT WAVE PHONE STATIONS

ARGENTINA

Call	Location	Kc.
LSX	Buenos Aires	10,352
LSG	Buenos Aires	19,900
LSN	Buenos Aires	21,200

AUSTRALIA

Call	Location	Kc.
VK3ME	Melbourne	9,510
VK6AG	Perth	7,194
VK2ME	Sydney	10,526
VLK	Sydney	10,526

AUSTRIA

Call	Location	Kc.
....	Vienna	13,514
UOR2	Vienna	11,801
OUITH	Vienna	8,060
UOR2	Vienna	6,072
OHK2	Vienna	4,274

BELGIUM

BOLIVIA

BRAZIL

Call	Location	Kc.
PPU	Rio de Janeiro	6,122
PPU	Rio de Janeiro	19,270

BRITISH COLONIES

Call	Location	Kc.
VRY	Georgetown, Guiana	6,726
TJW	Hamilton, Bermuda	9,500
....	Mombras, Kenya	13,895
....	Mombras, Kenya	8,230
VQ7LO	Nairobi, Kenya	6,100
VS6WX	Singapore	7,190

CANAL ZONE

CANADA

Call	Location	Kc.
VE9GW	Bowmanville, Ont.	6,095
VE9GW	Bowmanville, Ont.	11,810
VE9GW	Bowmanville, Ont.	24,380
VE9CG	Calgary, Alta.	6,110
VE9CA	Calgary, Alta.	6,030
VE9CA	Calgary, Alta.	11,860
VE9DR	Drummondville, Que.	11,780
VE9CF	Halifax, N. S.	6,050
VE9CL	Middlechurch, Man.	6,150
VE9DN	Montreal, Que.	6,005
VE9DN	Montreal, Que.	9,580
VE9DN	Montreal, Que.	11,895
VE9BA	Montreal, Que.	6,130
VE9BA	Montreal, Que.	11,705
VE9BA	Montreal, Que.	15,190
VE9AK	Red Deer, Alta.	2,830
VE9BJ	St. John, N. B.	6,090
VE9CS	Vancouver, B. C.	6,070

CURACAO

Call	Location	Kc.
PJZ	Curacao	11,718

CZECHOSLOVAKIA

Call	Location	Kc.
....	Bratislava	5,000
OKIMPT	Prague	5,119
OKIMPT	Prague	4,412

CHILE

CHINA

Call	Location	Kc.
XCTE	Shanghai	5,000

COLOMBIA

Call	Location	Kc.
HKA	Barranquilla	5,837
HKD	Barranquilla	6,993
HKF	Bogota	7,194
HKF	Bogota	7,610
HKC	Bogota	6,250
HKX	Bogota	6,977
HKX	Bogota	7,143

COSTA RICA

Call	Location	Kc.
TIH	Heredia	9,734
TITR	San Jose	11,790

CUBA

Call	Location	Kc.
CM2LA	Havana	10,007
CM2MK	Havana	9,360
CM6XJ	Tuinucu	15,008

DANZIG

Call	Location	Kc.
EK4ZZZ	Danzig	7,500

DENMARK

Call	Location	Kc.
OXZ	Skamlaback	9,520

DOMINICAN REPUBLIC

Call	Location	Kc.
HIX	Santo Domingo	4,610

DUTCH EAST INDIES

Call	Location	Kc.
PMB	Bandoeng	20,620
PLE	Bandoeng	18,830
PLG	Bandoeng	15,957
PMY	Bandoeng, Java	5,172
PK2AF	Djocjacorta, Java	6,000
PK6KZ	Makassar	11,765
PK2AG	Semerang, Java	2,609
PK3AN	Surabaya, Java	6,036
....	Surabaya	2,143
PK1AA	Weltevreden, Java	4,000

ECUADOR

Call	Location	Kc.
....	Riobamba	7,540

EGYPT

ESTONIA

FIJI

Call	Location	Kc.
VPD	Suva	14,430

FINLAND

FRANCE

Call	Location	Kc.
....	Agen	9,760
FYR	Lyons	7,463
FYR	Lyons	5,172
....	Nancy	19,350
F8AV	Nogent	3,750
FLJ	Paris	9,230
F8LH	Paris	7,317
....	Paris	6,860
F8GC	Paris	4,918
....	Pontoise-Seine-et-Oise	11,720
....	Pontoise-Seine-et-Oise	11,905
....	Pontoise-Seine-et-Oise	15,243
F8BP	Rugles	5,455
FTD	St. Assise	19,840
FRO	St. Assise	19,417
FRE	St. Assise	19,417
FTM	St. Assise	19,355
FTO	St. Assise	18,248
FTE	St. Assise	18,248
FSE	St. Assise	13,441
FQO	St. Assise	12,161
FQE	St. Assise	12,161
FTN	St. Assise	12,265
FTL	St. Assise	9,950
FTF	St. Assise	7,770
FTB	St. Assise	7,490
....	Touraine	7,500
....	Toulouse	6,122

FRENCH COLONIES

Call	Location	Kc.
FM8KR	Constantine	7,009
FM8KR	Constantine	3,750

GERMANY

Call	Location	Kc.
....	Elberswalde	7,407
D4AFF	Kothen	7,042
DHA	Nauen	11,760
DHC	Nauen	15,200
....	Nauen	6,020
DGW	Nauen	17,760
....	Nauen	9,560

GREAT BRITAIN

Call	Location	Kc.
GBK	Bodmin	18,105
GBK	Bodmin	9,260
G5SW	Chelmsford	11,750
GBX	Rugby	16,164
GBS	Rugby	18,310
GBW	Rugby	18,138
GBW	Rugby	14,493
GBU	Rugby	12,290
GBX	Rugby	12,195
GBS	Rugby	12,195
GBS	Rugby	9,020
GBS	Rugby	6,993
G2MN	Sonning-on-Thames	14,320

HAITI

GUATEMALA

HOLLAND

Call	Location	Kc.
PBF5	Hague	6,438
PCJ	Hilversum	9,590
PCJ	Hilversum	15,220
PHI	Huizen	17,775
PCK	Kootwijk	18,400
PCV	Kootwijk	17,836

HONDURAS

Call	Location	Kc.
HRB	Tegucigalpa	6,170

HUNGARY

Call	Location	Kc.
HAT	Szekesfehervar	9,125

ICELAND

INDIA

Call	Location	Kc.
VUC	Calcutta	11,870

INDO-CHINA

Call	Location	Kc.
F31CD	Chi-hoa	6,122
FZR	Saigon	16,216
FZR	Saigon	12,043

IRISH FREE STATE

ITALY

Call	Location	Kc.
12RO	Rome	11,811
I2RO	Rome	3,750
IMA	Rome	6,897
I2RO	Rome	3,750
....	Turin	3,750
HVJ	Vatican City	5,968
HVJ	Vatican City	15,120

JAPAN

Call	Location	Kc.
J1AA	Kemikawa	17,391
J1AA	Kemikawa	8,000

JUGOSLAVIA

Call	Location	Kc.
....	Belgrade	10,000

LATVIA

LITHUANIA

MADAGASCAR

Call	Location	Kc.
....	Tananarive	6,000

MADEIRA

Call	Location	Kc.
CT3AG	Funchal	6,383

MEXICO

Call	Location	Kc.
XDA	Mexico City	14,634
XDA	Mexico City	9,380
XDA	Mexico City	6,818
XFD	Mexico City	6,667
XFD	Mexico City	9,091
XFD	Mexico City	11,111
XFA	Mexico City	6,977
XFA	Mexico City	7,143
XFA	Mexico City	21,249

MONACO

MOROCCO

Call	Location	Kc.
CN8MC	Casablanca	6,881
CN8MC	Casablanca	5,882
....	Rabat	12,610
....	Rabat	9,300
....	Rabat	12,605
....	Rabat	9,300

NEWFOUNDLAND

Call	Location	Kc.
VO8A	St. Johns	6,800

NEW ZEALAND

Call	Location	Kc.
ZL2XX	Wellington	9,550

NORWAY

PERU

PHILIPPINE ISLANDS

Call	Location	Kc.
KA1XR	Manila	12,245
KZRM	Manila	11,840
KZRM	Manila	9,570
KZRM	Manila	6,140

POLAND

Call	Location	Kc.
....	Poznan	11,001
....	Poznan	8,900

PORTUGAL

Call	Location	Kc.
PT1AA	Lisbon	7,143
....	Oporto	12,000

ROUMANIA

Call	Location	Kc.
YO1	Bucharest	13,950

SALVADOR

SHIP PHONE STATIONS

Call	Location	Kc.
GMJQ	SS. Belgenland	17,650
GMJQ	SS. Belgenland	13,040
GMJQ	SS. Belgenland	8,570
GMJQ	SS. Belgenland	4,762
DDDX	SS. Bremen	11,710
DDDX	SS. Bremen	7,560
IBDX	SS. Electra (Marconi's Yacht)	11,240
....	SS. Hamburg	13,040
GDLJ	SS. Homeric	12,380
GDLJ	SS. Homeric	4,754
WSBN	SS. Leviathan	8,830
WSBN	SS. Leviathan	6,637
WSBN	SS. Leviathan	4,392
WSBN	SS. Leviathan	3,429
GFWV	SS. Majestic	17,590
GFWV	SS. Majestic	13,228
GFWV	SS. Majestic	4,430
GFWV	SS. Majestic	4,180
GLSQ	SS. Olympic	12,387
GLSQ	SS. Olympic	16,456
GLSQ	SS. Olympic	8,840

SIAM

Call	Location	Kc.
HS2PJ	Bangkok	10,169
HSP2	Bangkok	9,500
HSP2	Bangkok	7,300

SPAIN

Call	Location	Kc.
EAJ1	Barcelona	15,789
EAR96	Barcelona	6,522
EAR25	Barcelona	6,000
EAR58	Las Palmas, Canary Islands	7,210
EAR110	Madrid	7,026
EAR125	Madrid	7,026
EAJ25	Malaga	3000
EAR113	Viscaya	6,522

SWEDEN

Call	Location	Kc.
....	Motala	6,070

SWITZERLAND

Call	Location	Kc.
HB9OC	Berne	9,130
HB9XD	Zurich	9,380
HB9XD	Zurich	7,229
HB9XD	Zurich	3,488

TURKEY

UNION OF SOVIET SOCIALIST REPUBLICS

Call	Location	Kc.
RW15	Khabarovsk	4,273
RW3KAA	Leningrad	8,333
....	Leningrad	11,111
....	Leningrad	10,526
RW62	Minsk	6,420
RW61	Moscow	51,724
RW38	Moscow	5,514
RW59	Moscow	6,000
......	Moscow	6,611
RW50	Moscow	11,924
RW65	Peredvijka	3,560
RW19	Tomsk	8,111

URUGUAY

UNION OF SOUTH AFRICA

Call	Location	Kc.
ZTJ	Johannesburg	9,380

VENEZUELA

Linear Amplifiers in Broadcasting

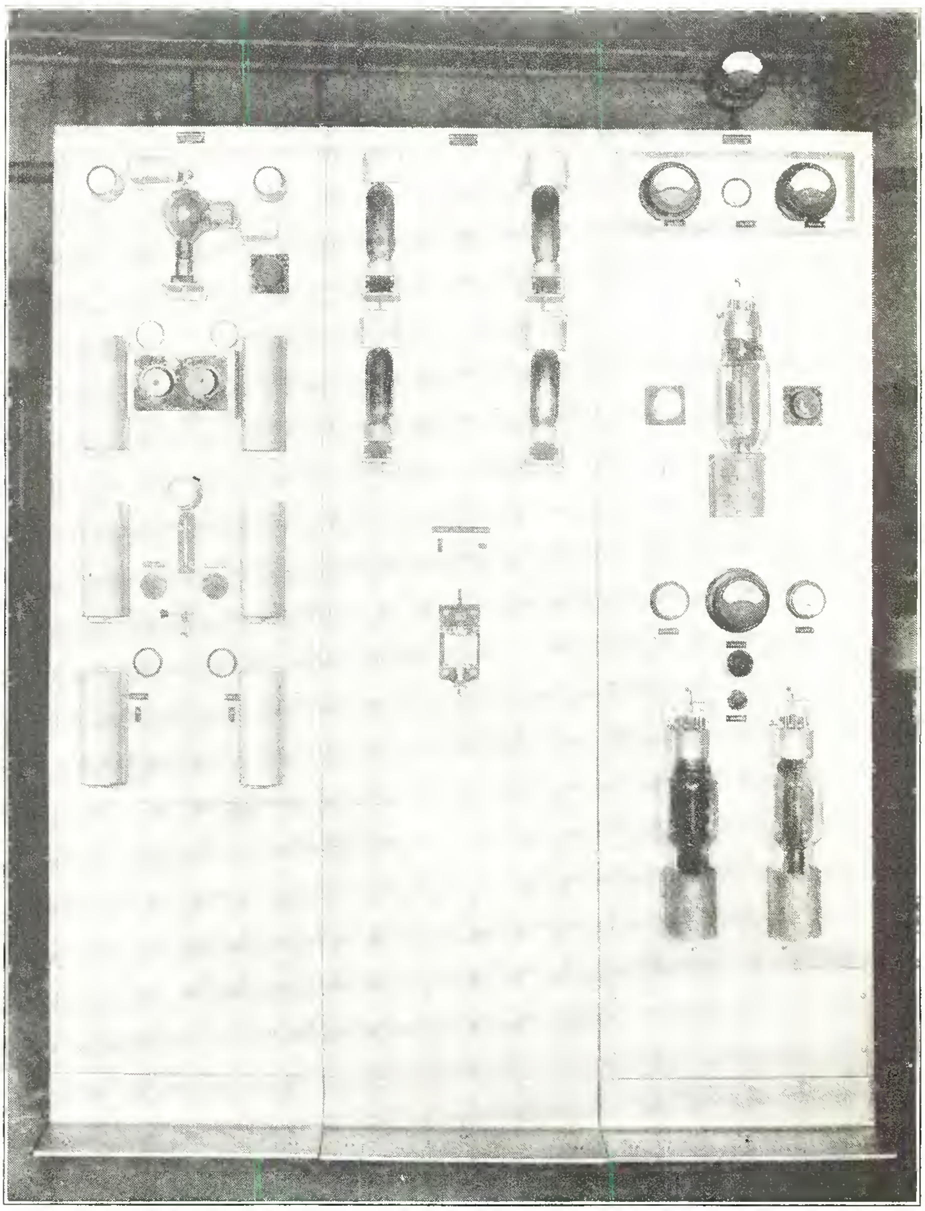
By H. M. SMITH*

WITH the advent of vacuum tubes and associated circuits in radio communication, the status of radiotelephony was changed from an interesting laboratory possibility to a point where its economic practicability was strongly indicated. Hitherto, investigations of radiotelephony had been confined to arc transmitters, high frequency alternators, etc., as sources of continuous waves, and the difficulties encountered in efficiently modulating the usually high power output of such devices made for low over-all transmitter efficiency and extremely doubtful economics.

By means of vacuum tubes in oscillatory and amplifying circuits the possibilities of voice transmission became increasingly evident. Many and varied schemes of modulation were evolved, ranging from absorption methods to frequency modulation. The Heising, or so-called "constant current" system of amplitude modulation has been adopted more generally in this country, due to its comparative simplicity and efficiency of operation. The general theory of modulation has been treated exhaustively in the technical literature. A practical application of some of the principles involved has apparently become somewhat obscured in the recent trend towards linear amplifiers.

Any system of amplitude modulation is essentially a method of varying the output power of a radio transmitter by an appreciable amount at the modulating frequency. Previous to the introduction of linear amplifiers, this was effected in the oscillator or power amplifier. An audio amplifier of suitable power (usually termed the modulator) is so connected in the power amplifier plate supply that the varying output voltage of the modulator raises and lowers the d.c. plate voltage on the modulated tube at an audio frequency rate. Within the approximate limits of plate saturation and cut-off the radio frequency voltage across the tank circuit of the modulated tube, and consequently the antenna current, are directly proportional to the instantaneous plate voltage applied to the modulated tube.

Until comparatively recently, radio frequency amplifiers having power outputs up to 50 kw and more were modulated in this manner without serious difficulty. As has been pointed out, the so-called modulator is essentially an audio amplifier, and, as such, is subject to the inherent limitations of any class A amplifier, i. e., very low efficiency if distortion is to be kept at a low value. In practice a bank of low impedance tubes is usually required to fulfill the conditions of high percentage modulation with low distortion, with the necessity for a choke of high inductance capable of carrying a large amount of direct current. In the case of high power transmitters using water cooled tubes, this represents a formidable investment, and due to the low efficiency of the modulator, the operating cost is quite high. To obtain 100 per cent modulation, some sort of voltage dropping device is generally used to lower the plate voltage applied to the modulated tubes. At the higher powers, such a device becomes rather bulky and expensive and the power dissipated in this device becomes appreciable.



Due to the large variety of power outputs and plate impedances of available air-cooled tubes, high level modulation is usually to be preferred in transmitters of power outputs up to about 500 watts. A 250 watt, high level, 100 per cent modulated transmitter of recent design is shown. It is of the crystal-controlled, power amplifier type and has a self-contained rectifier using mercury vapor tubes,

(Continued on next page)

* Engineer, Doolittle & Falknor, Inc.

Linear Amplifiers in Broadcasting

(*Continued from page* 15)

together with a suitable filter.

Above 500 watts output, the factors mentioned in the previous paragraph, plus a consideration of the ratio of fixed cost to annual charges, usually make the use of some form of linear amplifier desirable. Any amplification taking place after modulation has been effected must be of such a nature that the instantaneous voltages across the antenna coupling device will be directly proportional to the voltages across the tank circuit of the modulated amplifier. It might be supposed that such amplifiers would have to be operated class A to fulfill these conditions. This is not the case however, as the tube has an oscillatory circuit as its load. Such a circuit, if properly designed, has quite a flywheel effect, and its tube may be biased practically to cut-off (without excitation) and still provide an output of good wave form under certain conditions.

In a class B amplifier:

$$\text{Power input} = \frac{E_b I_p \text{ av}}{2} = \frac{E_b I_p \text{ max}^2}{2} \quad \ldots 1$$

$$\text{Power output} = \frac{.5\, E_p \text{ max } I_p \text{ max}}{2} \quad \ldots\ldots 2$$

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}} = \frac{E_p \text{ max}}{4\, E_b} \quad \ldots\ldots 3$$

where: E_b d.c. plate voltage

E_p max = maximum a.c. plate voltage

I_p av = average plate current

I_p max = maximum plate current

Equation 3 indicates that the maximum efficiency is obtained in a class B tube when the instantaneous peak plate voltage equals the d.c. supply voltage. Under such conditions the maximum efficiency would be 78.54 per cent. This value is purely theoretical and cannot be attained in practice. A maximum practical value of 66.67 per cent has been arbitrarily established and can usually be obtained on peaks without difficulty.

It may be shown that the input power to a class B tube varies directly with the grid voltage; the power output varies as the square of the grid voltage. It therefore follows that the efficiency, being a quotient, varies as the first power of the grid voltage. Also, 100 per cent modulation requires that the instantaneous grid and plate voltages be double the unmodulated value. Therefore the maximum unmodulated efficiency of a class B amplifier cannot be greater than 33.3 per cent or one-half of the 100 per cent modulated value. If it is greater, the transmitter output will not be capable of 100 per cent modulation; if less, the output power will be substantially reduced.

Equation 2 shows that the output power, on 100 per cent modulation peaks produced by doubling the instantaneous grid voltage, is four times the unmodulated value. For this reason it is necessary that the tube capacity in the amplifier be four times as large as would be required if the same carrier power were not modulated.

Conditions noted above for a single-sided circuit hold good where tubes are used in push-pull, if the tubes are individually biased so that without r.f. excitation no plate current flows. In this case the amplifier stage may be considered as a gas engine having two opposed cylinders. Such an arrangement will require less flywheel to supply a non-pulsating flow of power to a steady load than will a single cylinder. In application a higher L/C ratio may be used in the tank circuit of push-pull tubes than with a single tube, with a corresponding decrease in the ratio of circulating kva to kw output. Equations 1 and 2, for input and output power, are each multiplied by 2 where used for push-pull, class B tubes, but the efficiency as given in equation 3 is applicable to both single-sided and push-pull circuits.

To obtain maximum efficiency in a class B amplifier, the grid swing must be sufficiently great to carry the plate current almost to saturation. This usually means that the grids must be swung considerably positive with the result that the input impedance of the amplifier decreases. In operation, this impedance will become low enough to represent a substantial load on the exciting stage. If the load impedance on the driving stage varies, the voltage across this load, and consequently the voltage across the grid of the driven tube will vary, with the result that the amplifier is no longer linear, but rather will have a distorted output. To remedy this situation a constant load is provided for the driving tube, sufficiently great so that variations in input impedance of the driven tube will be so small in proportion as to be unable to vary the constant load to an appreciable extent. Such loading is usually effected by inserting a suitable resistance in the tank circuit of the driving tube or an equivalent shunt resistance from grid to ground in the driven tube. (In the latter case the resistor is for r.f. only and must have a series capacity to keep the rectified grid current out of this branch.) Regardless of its location it is usually necessary that 50 to 80 per cent of the output of the driven tube be dissipated in this load. This reduces the over-all efficiency of the driving stage and is undesirable to that extent. Consideration of the grid current characteristics of available tubes and the use of a proper L/C ratio in the tank circuit of the driven tube will tend to keep this dissipation towards the lower value given above.

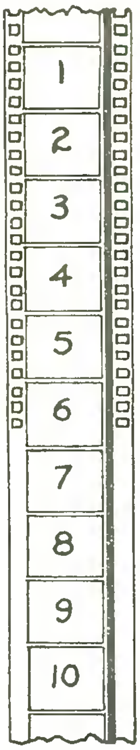
It happens occasionally that the function of such resistance loads which have just been discussed is to preclude the cutting of sidebands in the linear amplifier by broadening the resonance curve of the tank circuit. This is decidedly a secondary consideration for there is usually enough unavoidable resistance associated with tank circuits to satisfy the requirements for efficient transmission of the higher modulating frequencies.

Two recent examples in transmitter design are of interest. In one, using a push-pull amplifier (each tube operated class B) as the output stage, the secondary of an audio transformer is connected in series with the common bias supply. This scheme is in effect equivalent to a conventional linear amplifier, but due to the varying load placed on the speech input equipment, the linear amplifier grids cannot be swung very positive. For this reason the peak efficiency is about 45 per cent and the unmodulated efficiency must be held at about 22.5 per cent.

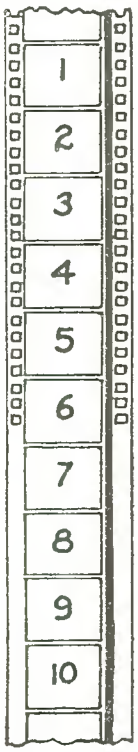
In the other, the designers have taken advantage of the fact that class B tubes used in push-pull result in a class A stage over-all, and apply this to the modulator system. A much greater amount of undistorted audio power can be obtained from such an arrangement than can be obtained from the same tubes used as conventional class A amplifiers. The modulator output is coupled to the modulated amplifier through a transformer of rather involved design. The gain in over-all efficiency is such as to make high level modulation economically practicable at considerably higher powers than heretofore.

Sound Films & Television Broadcast

THE film output of the moving picture studios of Hollywood, the East coast, Europe, features, news reels and shorts, have been made available for broadcasting by television. Though not in the home at the moment, the moving picture theatre is right at the front door, ready to take possession of the living room. The perfecting of apparatus enables television stations to make use of



FILM No1



FILM No2

standard commercial sight-sound films, such as are furnished moving picture houses. These are broadcast without distortion of the sound, the barrier which, until now, was apparently insurmountable.

One of the greatest difficulties encountered in the adaptation of the sight-sound film to television projection was caused by the difference in the rate of speed with which the pictures are taken on the movie lot, and that with which they are scanned in the television studio. The moving picture camera exposes 24 sections of the film each second, whereas television laboratories have experimented with scanning systems that project a maximum of 20 pictures per second.

The consequent slowing down of the film results in "slow-motion" of the characters in the picture. What is more important, the slower movement of the sound track past the photoelectric cell creates a sound distortion such as that occasioned by rotating the turntable of a phonograph at a speed slower than that at which the recording was made.

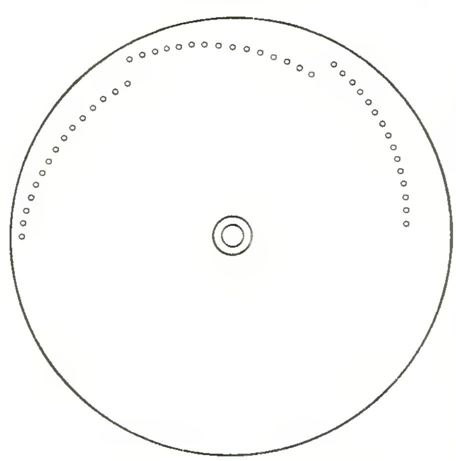
Armando Conto, research engineer for Western Television Corporation, of Chicago, sensing the difficulties, set about, 18 months ago, to perfect apparatus that would not only broadcast the pictures, so that the figures move with normal speed, but would also permit the sound to be taken from the film, undistorted.

The Western Television Corporation 3 spiral scanning system with which Conto worked divides any area to be broadcast into 45 horizontal parts at a speed of 15 times per second. This leaves a considerable gap between the 15 pictures per second as broadcast by the television station and the 24 pictures per second projected in the motion picture houses.

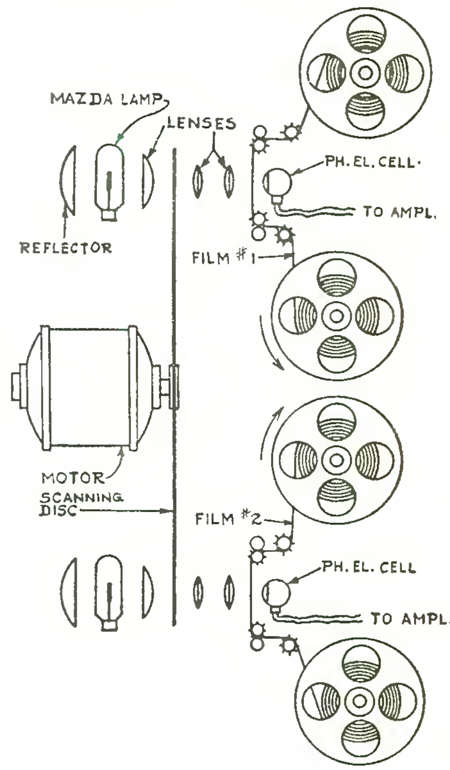
Conto looked with disfavor upon the method by which the film is kept in motion as a part of the scanning operation, a practice used in previous technique. He decided that better results could be obtained if the film remained stationary, as it does in the projection of moving pictures, moving forward at a predetermined time. Consequently, it was necessary to design a disc that would combine the effects produced by an ordinary scanning device and the shutter on a moving picture projector.

The resulting disc is so constructed that the apertures through which the light penetrates are placed on radii that are four degrees apart instead of eight degrees as in the ordinary 3 spiral 45 aperture disc. Thus, the 45 apertures occupy a 180-degree segment of the disc, leaving the other half blank to act as the shutter.

Conto uses two identical films. Film number 1 is located at the upper diam-



eter of the scanning disc and number 2 at the lower. The movement of both films is toward the center of the disc. The films are placed in the same position in each Geneva movement (the device which moves the films forward). The two Geneva movements and the scanning disc are interconnected mechanically in such a way that when the first aperture of the first spiral is in a position to scan picture No. 1 in film No. 1, film No. 1 remains motionless for the duration of the entire scanning operation.

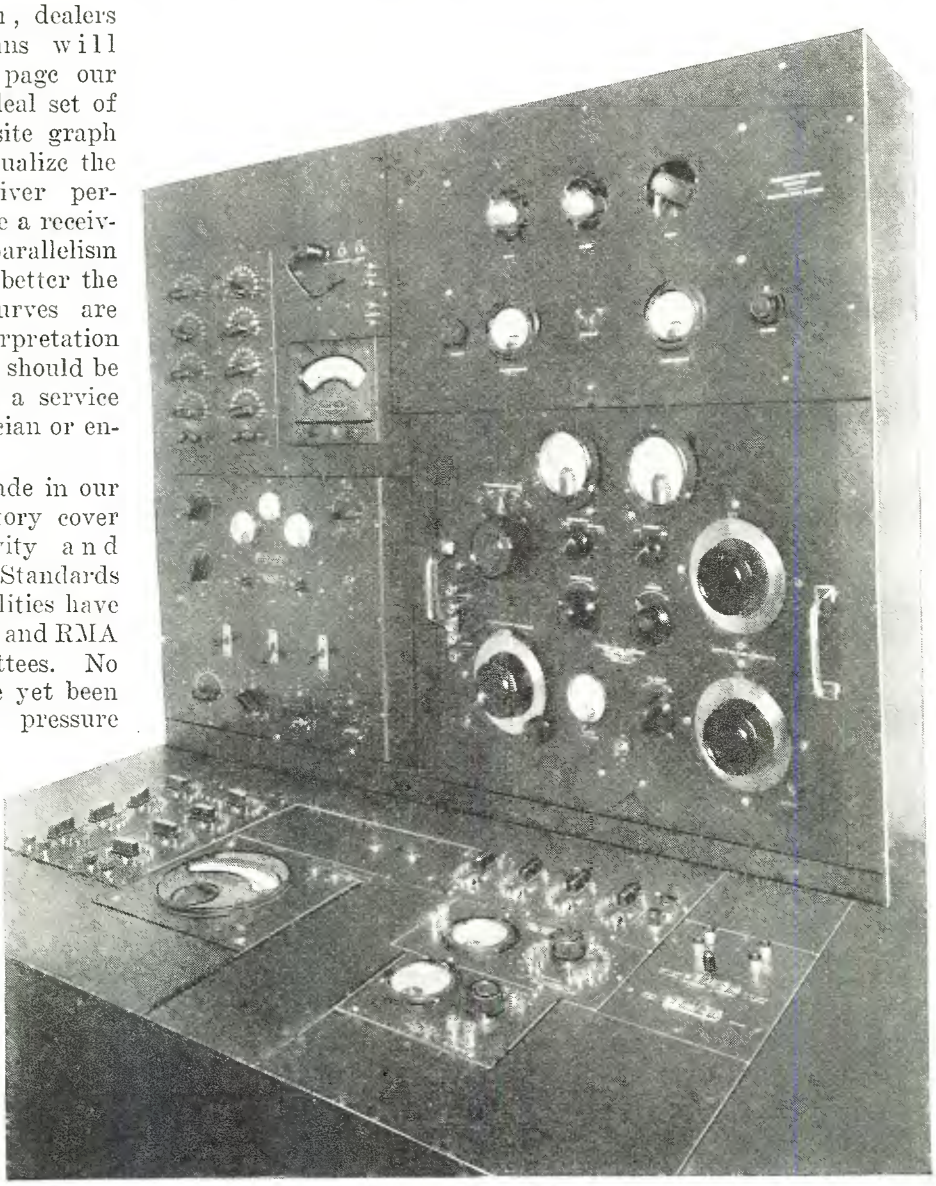


While picture No. 1 in film No. 1 is being scanned, the blank segment of the disc is passing before film No. 2, shutting off the light. This interval is used to move picture No. 2 in film No. 2 to a stand-still position so that it will be scanned immediately after picture No. 1 of film No. 1 is scanned. So, of the two identical films, the pictures of film No. 1 which will be scanned are Nos. 1-3-5-7-9, etc.; while pictures Nos. 2-4-6-8-10, etc., will be scanned in film No. 2.

Conto's real difficulty came in broadcasting standard sound films taken at a standard rate of 24 picture frames per second without sound distortion and without slowing down the movements of the actors. But he made provision for that, too. He held the opinion that the continuity of the picture would not be broken if part of the pictures in the film were eliminated, for it must be remembered that the movement registered on the two duplicate films is that which takes place in 1/24 of a second, a shorter

(*Continued on page 38*)

Receiver Performance Curve Section



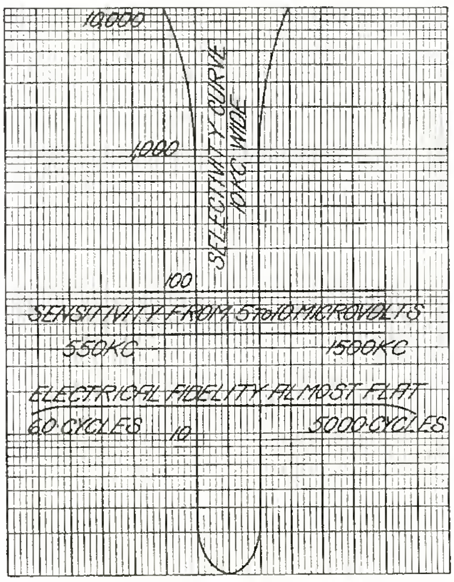
SERVICE men, dealers and technicians will find on this page our conception of an ideal set of curves. The composite graph may be used to visualize the best possible receiver performance. The more a receiver's curves near parallelism with the ideal, the better the receiver. These curves are not capable of interpretation by a layman. They should be translated only by a service man, dealer, technician or engineer.

Measurements made in our engineering laboratory cover sensitivity, selectivity and electrical fidelity. Standards for these three qualities have been set by the IRE and RMA engineering committees. No standards have yet been adopted for sound pressure measurements. Until a standard is selected, our laboratory will measure only electrical fidelity, which disregards speaker response curves. The fourth measurement appearing with the sensitivity, selectivity and electrical fidelity curves represents power overload curves, or automatic volume control curves, as the case may be.

Definitions of the three major characteristics of a receiver are:

Sensitivity is that characteristic of a receiver which determines *to how weak* a signal it is capable of responding. It is measured quantitatively in terms of the input voltage required to give standard output. The ideal sensitivity, according to the graph on this page, would fall between the two lines, ranging from 10 to 5 microvolts (absolute) or less. This is an arbitrary value.

Selectivity is the degree to which a receiver is capable of *differentiating between* the desired signal, and signals of other carrier frequencies. This characteristic is not expressible by a single numerical value, but requires one or more graphs for its expression. Best selectivity possible would be somewhat like a "chimney" whose sides would be 10 kilocycles apart nearly all the way up the graph sheet. Selectivity as measured by our laboratory only concerns itself with energy entering the receiver via the input circuit (disregarding shielding effectiveness), since no standard has as yet been adopted to simulate selectivity conditions in the field.



Ideal Composite Curve

Fidelity is the degree to which the receiver *accurately reproduces* at its output terminals, the modulated form of the received wave impressed upon it. Ideal electrical fidelity curve would be a horizontal line almost flat over the frequency range from 60 to 5000 cycles. This range is also of an arbitrary width.

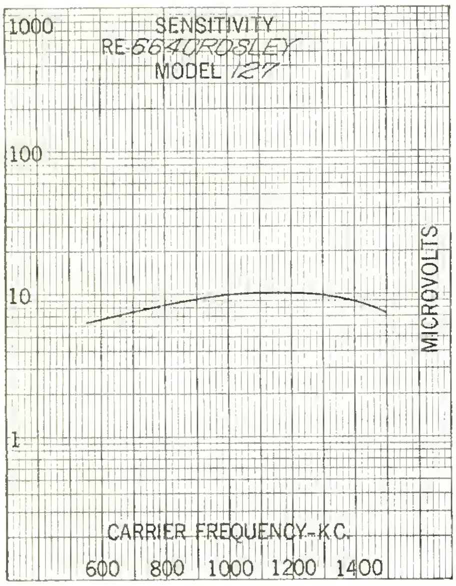
The photograph illustrates the equipment used in making the measurements. It conforms to the specifications of the IRE and RMA Standardization Committees. All test frequencies are determined by zero beat of a crystal-controlled dynatron oscillator. Voltmeters and microvoltmeters are periodically checked against calibrated standards for accuracy of adjustment. Individual conditions of measurement pertaining to each receiver will be found in the text accompanying each family of curves.

Since curves of all receivers are taken under the same conditions, it may be said that such curves constitute a yardstick by which receivers of the same general class may be compared, as long as this analysis is made by those technically competent to do so.

Crosley Model 127

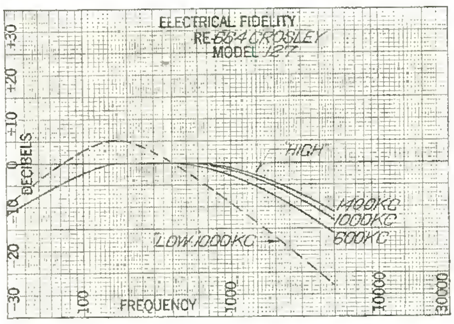
CROSLEY'S model 127 superheterodyne, when measured in our laboratory, gave the included overall response curves.

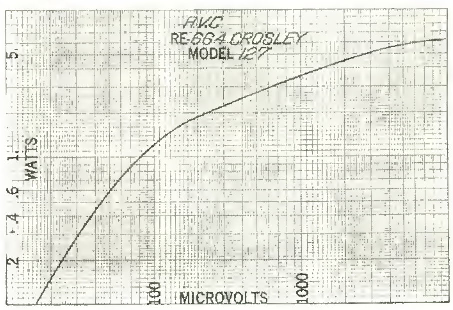
Input to the receiver was through the standard dummy antenna of 20 uh, 200 uuf, and 25 ohms, while the output, as measured by the vacuum tube voltmeter, was maintained at a standard level of .05 watts, except for the automatic volume control curve. A line current of 1.09 amperes was drawn by this receiver, with a line voltage of 116 volts. For all tests the volume control was turned for maximum receiver sensitivity, the tubes as furnished by the manufacturer with the receiver were employed, and factory adjustment of trimmers was left undisturbed.



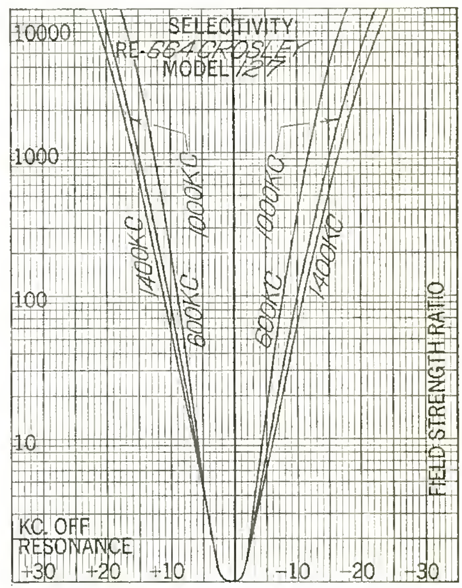
To match the optimum operating impedance of the push-pull 247 pentodes employed in the last audio stage, a non-inductive load resistance of 14,000 ohms was connected between the plates, and the voice coil circuit was opened to prevent any reflected impedance of the secondary to the primary circuit. The output plates were capacitatively coupled to the output indicating device.

An average sensitivity of 8.8 microvolts was taken from the sensitivity curve of column 1. This is equivalent to 2.2 microvolts per meter when a standard four-meter height antenna is used. A minimum noise level of 4.7 per cent was recorded at 1200 kc and a maximum of 22.1 at 1400 kc. At 1000 kc the measured image ratio was 66,800. In column 2, from the automatic volume control curve, a maximum of 6.2 watts power output is found at the maximum input, i. e., 10,000 microvolts. No consideration is made of the harmonic distortion present in the wave form across the primary of the speaker transformer. Under the selectivity curves of column 3 will be found the band widths taken from them.



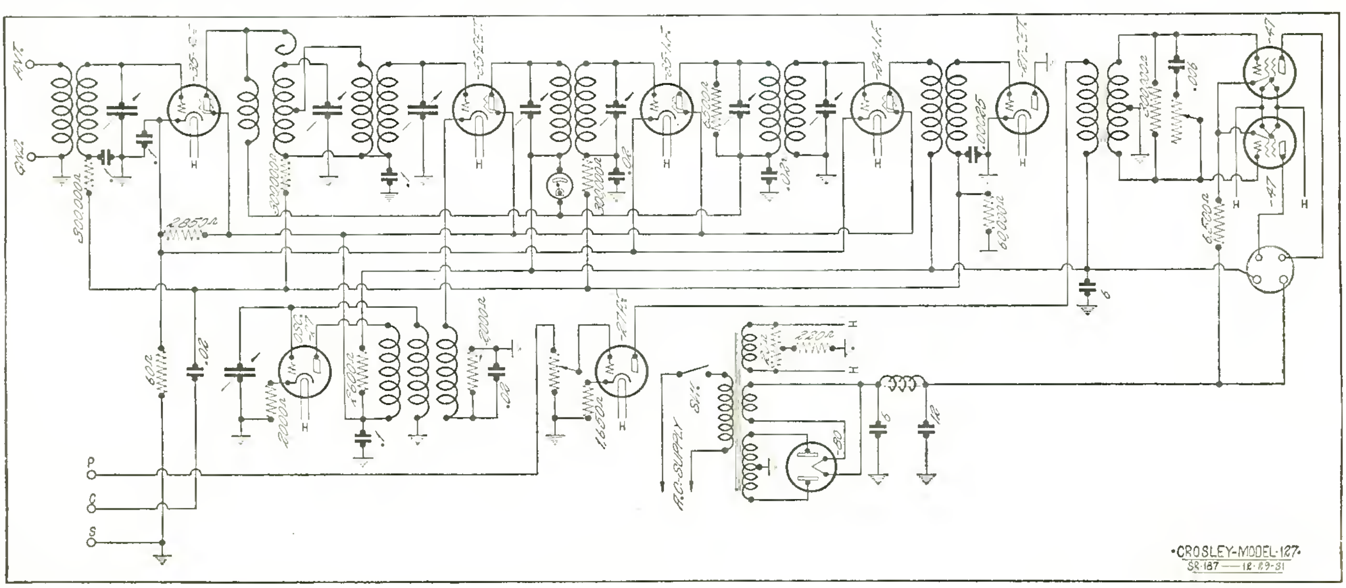


A schematic wiring diagram of the model 127 will be found at the bottom of the page. Required tubes are a 235 r-f, 235 first detector, 227 oscillator, 235 second i-f, 235 third i-f, 227 diode detector, 227 a-f, push-pull 247 pentodes, and a 280 rectifier.



Band Widths

Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	10	11.5	12.5
100	16.5	20.5	22
1000	24.5	30.5	32.5
10000	35.5	43	46



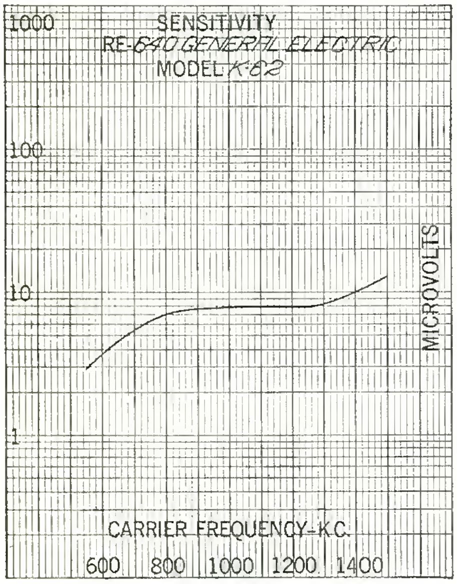
General Electric Model K-62

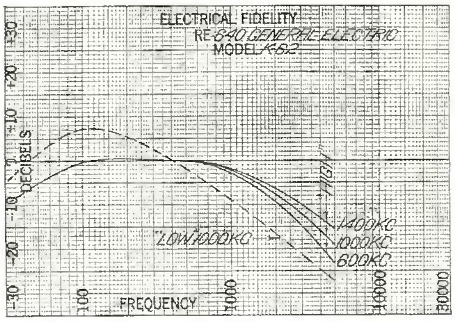
CURVES on the performance of the General Electric model K-62 superheterodyne receiver plotted from recent measurements in our laboratory are included on this page.

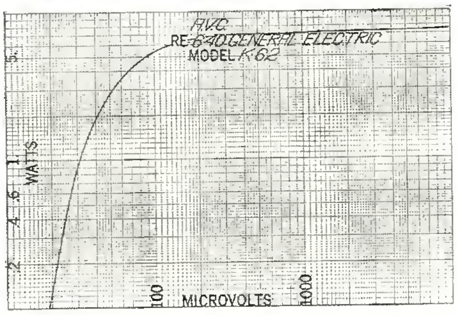
A dummy antenna standard of 20 uh, 200 uuf and 25 ohms was used to couple the output of the signal generator to the input circuit of the chassis. A resistance of 15,000 ohms was coupled across the push-pull pentode plates for optimum plate load, while the voice coil circuit was opened to eliminate the reflected impedance influence on the primary of the output transformer. Output plates were capacitatively coupled to the output tube volt meter, which indicated a standard level of .05 watts in all measurements but the automatic volume control test.

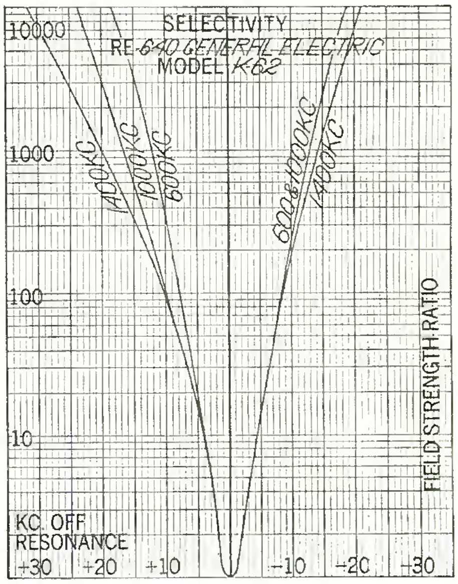
No changes were made in the alignment of the receiver from factory adjustment, the volume control was set for maximum receiver sensitivity, and the tubes employed in the chassis were furnished with it as standard equipment. With an a-c line voltage of 115 volts, the line drain was .95 amperes.

In column 1 is the sensitivity curve, which gives an average sensitivity value of 7.35 microvolts absolute, which is equivalent to 1.84 microvolts per meter, when the standard four-meter antenna is used. Measured noise levels were 14.4 per cent at 600 k-c and 1.8 per cent at 1400 k-c, the maximum and minimum values respectively. The image ratio measured with the receiver tuned to 1000 k-c was 1450 times against the undesired signal impressed at 1350 k-c. Power output reached a maximum of 7.52 watts at an input of 10,000 microvolts, as seen from the automatic volume control curve in column 2, but this figure does not take into account the distortion entered by the harmonics present in the output wave across the primary of the output transformer. From the selectivity curves of column 3 the band widths were taken and they will be found tabulated below the curves.





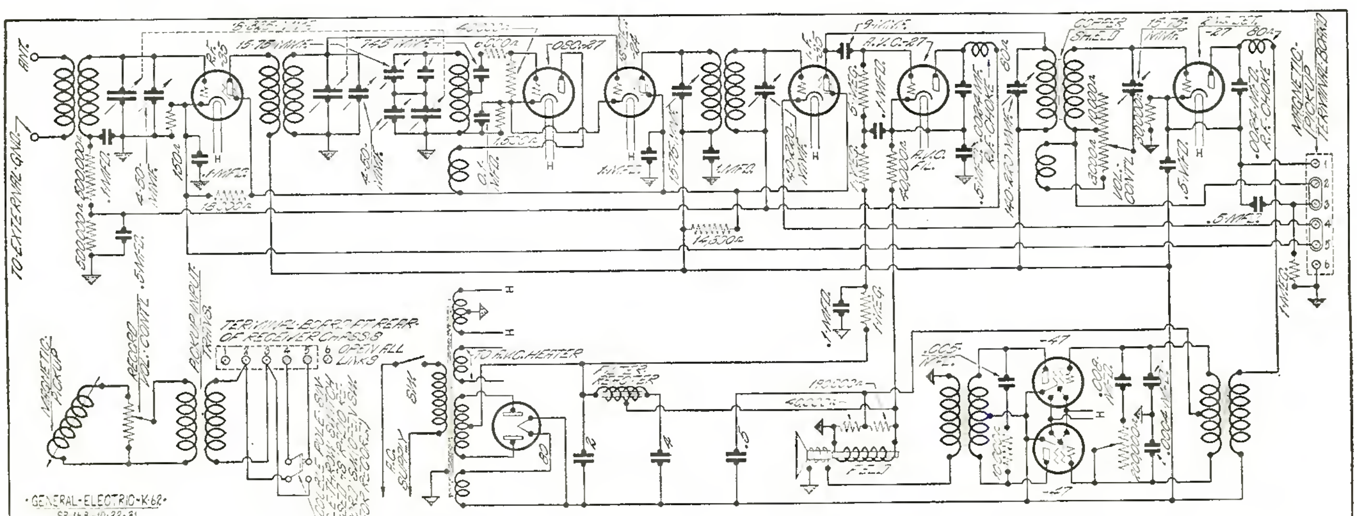




A schematic wiring diagram of the model K-62 superheterodyne will be found below. The tubes required are a 235 r-f, 227 oscillator, 224 first detector, 235 second i-f, 227 automatic volume control, 227 second detector, 247 push-pull pentodes, and a 280 rectifier. It will be noted that the filter is used on the negative side of the rectifier.

Band Widths

Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	9	9	9
100	16.5	18.5	19
1000	25.5	29.5	34.5
10000	37	42.5	52



Gulbransen Model 23

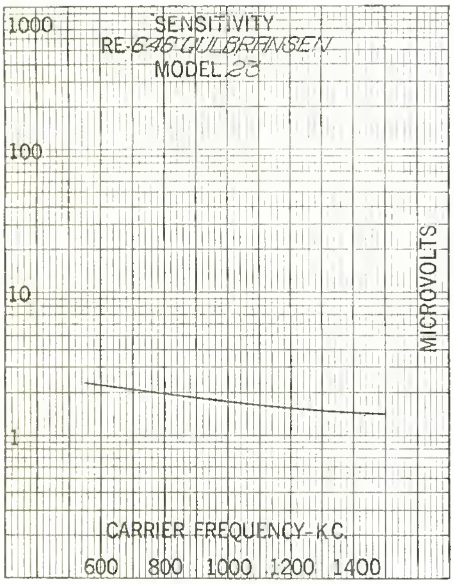
ON measurement in our laboratory recently the Gulbransen model 23 superheterodyne produced the included overall performance curves.

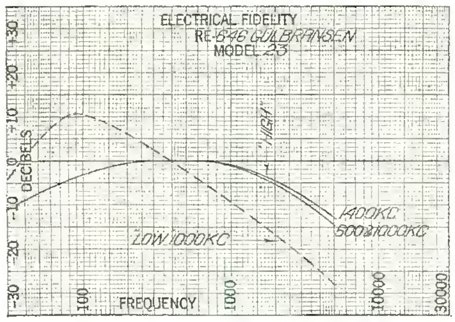
Signal generator output was coupled through the standard dummy antenna of 20 uh, 200 uuf and 25 ohms to the receiver antenna circuit. A standard output of .05 watts was maintained for all measurements but automatic volume control, and was indicated on the vacuum tube voltmeter coupled capacitatively to the output plates of the push-pull 247 tubes. A non-inductive load resistance of 14,000 ohms was used to match the operating impedance of these tubes. The voice coil circuit was opened to prevent a reflection of undesirable impedance to the primary circuit during measurements.

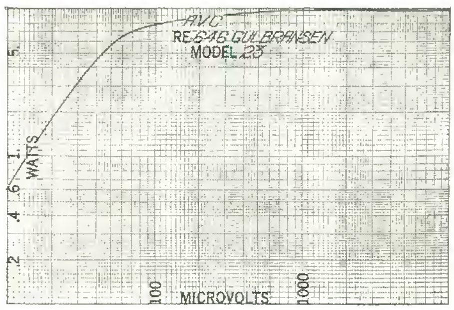
A line voltage of 112 volts gave the receiver a drain of 1.11 amperes. For all measurements the volume control was adjusted for maximum receiver sensitivity, the tubes as furnished by the manufacturer were employed in the chassis, and no changes were made in the alignment of tuned circuits from factory adjustment.

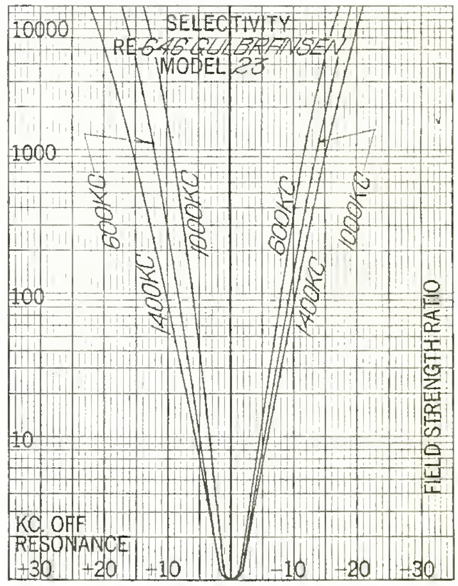
From the sensitivity curve of column 1, the average is found to be 1.9 microvolts absolute, which value corresponds to .475 microvolts, per meter, using a standard four-meter height antenna. Maximum noise level was measured at 1000 kc and had a value of 69 per cent, while the minimum value occurred at 1200 kc and 1400 kc, with a value of 57 per cent. An image ratio of 18,900 was measured on this receiver with the dial adjusted to 1000 kc. From the automatic volume control curve of column 2, the maximum audio output is found to be 10 watts for the highest input value taken, but no consideration was made of the harmonics present in the output voltage wave form across the primary of the speaker transformer. Under the selectivity curves of column 3 will be found the tabulated band widths from which they were taken.

Below is a schematic wiring diagram of the receiver. Required tubes for operation consist of a 235 r-f, 235 first detector, 235 second i-f, 235 third i-f, 227 diode second detector, 227 audio, push-pull 247 pentodes, 227 oscillator, and a 280 full wave rectifier. It will be noted from the diagram that a resonance indicating meter is used for convenience in tuning the receiver, since there is an apparent broadness in the automatic volume control feature.



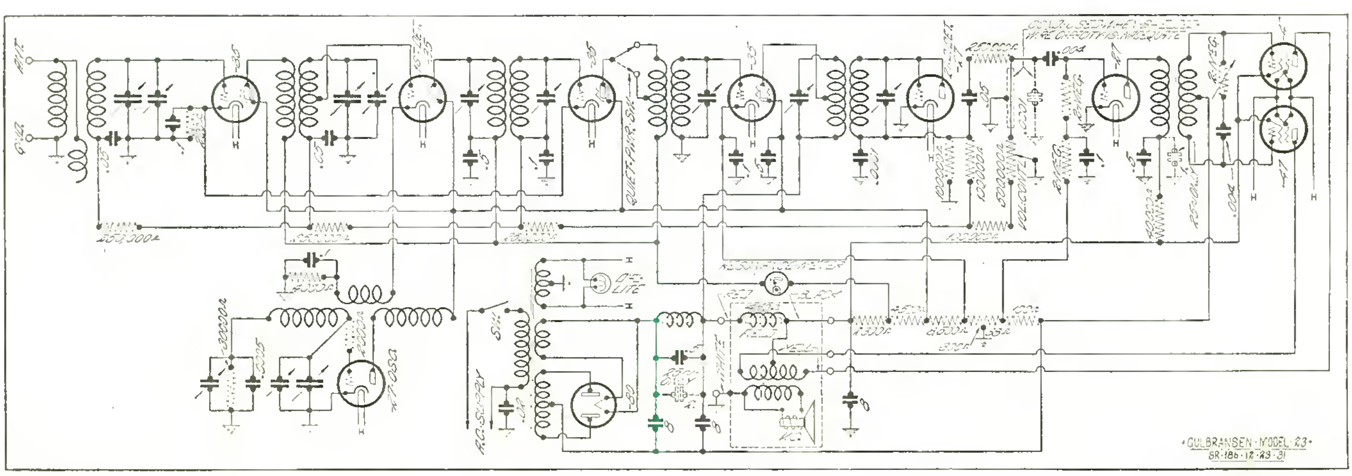






Band Widths

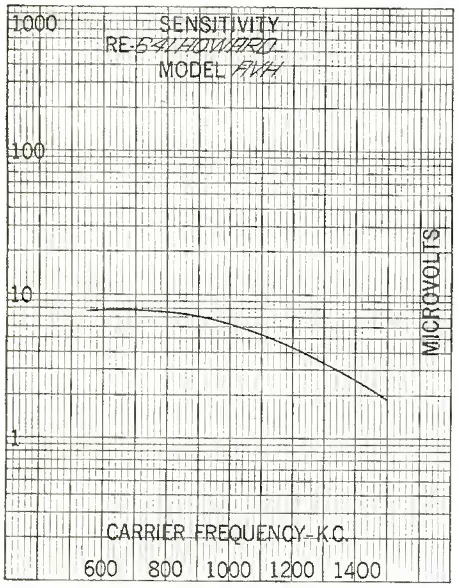
Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	9.5	9	11.5
100	16.5	15.5	21
1000	24	23	31
10000	34	33	43



Howard Model AVH

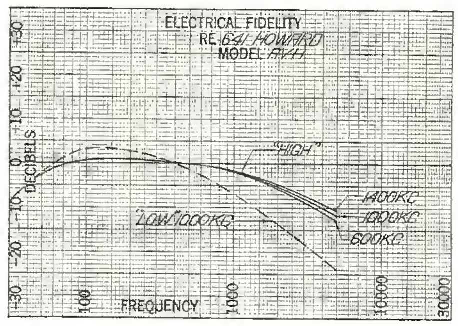
UPON measurement in our laboratory, the Howard model AVH produced the overall performance curves given on this page.

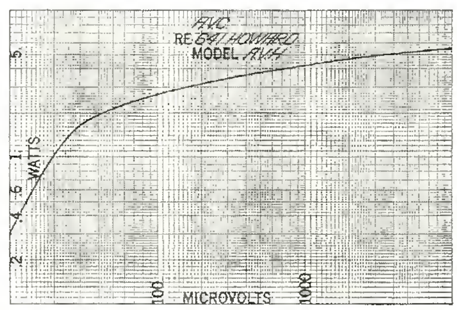
Signal generator output was coupled to the receiver input circuit



by means of the standard dummy antenna of 20 uh, 200 uuf and 25 ohms, while the output was maintained at a level of .05 watts. The operating impedance of the push-pull 247 tubes was matched with a 14,000 ohm non-inductive load resistance and the plates were capacitatively coupled to the output measuring tube voltmeter. To prevent any reflection of impedance on the primary circuit, the voice coil was opened during all measurements. For all tests the volume control was turned to maximum sensitivity, the alignment of tuned circuits was not varied from factory adjustment, and the tubes as furnished by the manufacturer were employed. The receiver line drain was 1.23 amperes, with a line voltage of 115 volts.

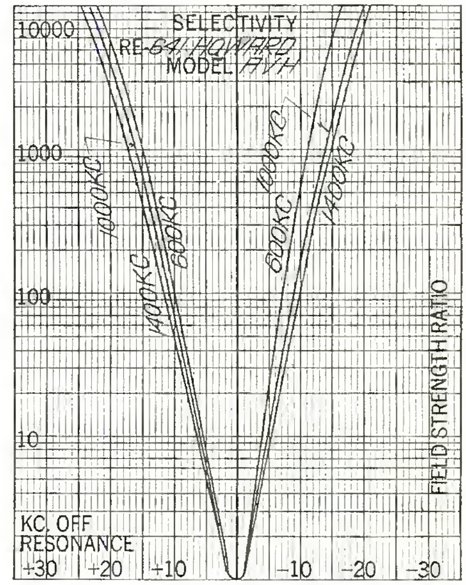
An average sensitivity of 5.60 microvolts absolute was measured, which is the equivalent of 1.40 micro-





volts per meter, using a four-meter antenna. Computed noise levels, maximum and minimum values, were 13.8 per cent at 1400 kc and 5.1 per cent at 600 kc respectively. At 1000 kc the image ratio was measured as 1110 times. At 10,000 microvolts input the maximum measured power output occurred as seen from the automatic volume control curve of column 2, and shows a value of 5.60 watts. This figure does not take into account the produced harmonics present in the output wave form. In column 3 under the selectivity curves are the tabulated band widths.

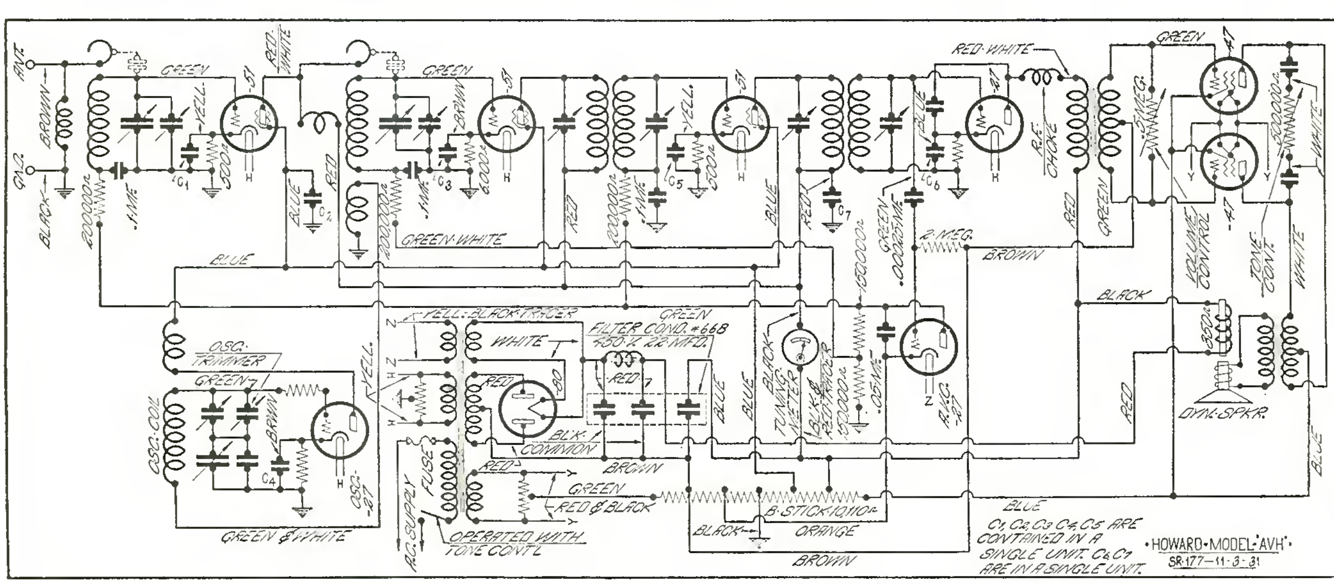
At the bottom of the page is the schematic wiring diagram of the model AVH. Tubes required are a 551 r-f, 227 oscillator, 551 first de-



tector, 551 second i-f, 227 automatic volume control tube, 227 second detector, 247 push-pull pentodes, and a 280 rectifier. Oscillator energy is coupled to the secondary coil of the second r-f transformer by means of a pick-up coil. It will be noted that a meter is used for correct resonance indication in timing.

Band Widths

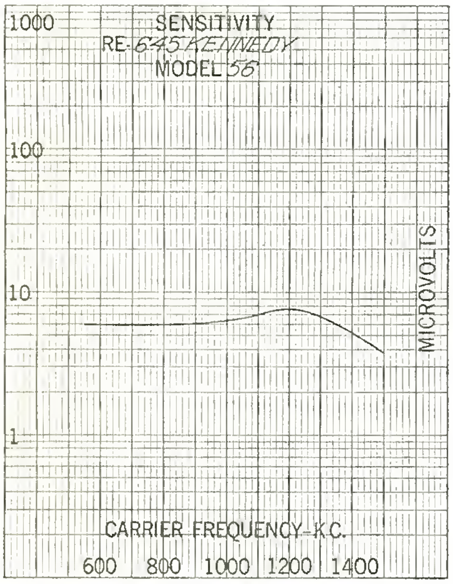
Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	9.5	10.5	11.5
100	17.5	20.5	21.5
1000	26	30	31.5
10000	38.5	42	45.5



Kennedy Model 56

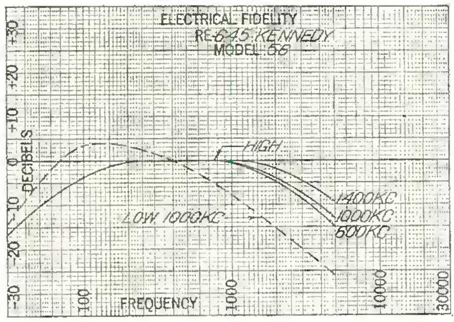
MEASUREMENTS of the Kennedy model 56 made recently in our laboratory gave the included overall performance curves.

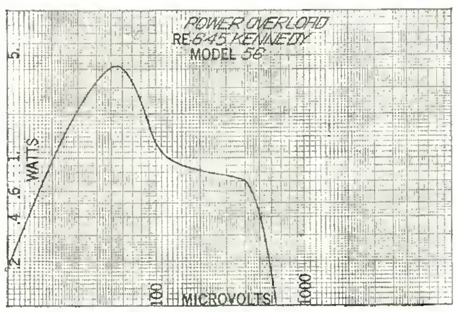
For signal input the standard generator was coupled to the receiver an-



tenna circuit by means of a dummy antenna of 20 uh, 200 uuf and 25 ohms. Output voltage equivalent to .05 watts of audio power was measured by the vacuum tube voltmeter, capacitatively coupled to the 247 pentodes. The plate load was adjusted to 14,000 ohms to match the optimum operating plate impedance. For all tests the voice coil circuit of the speaker was opened to eliminate any undesirable impedance reflection on the primary side. With a line voltage of 117 volts, the power transformer primary drain was .82 amperes. For all measurements, no changes were made in the factory alignment of the receiver, the tubes furnished with the receiver as standard equipment were used, and the volume control was turned on full.

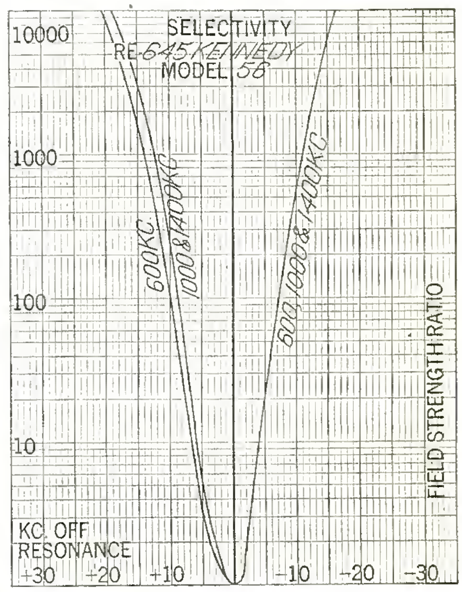
From the sensitivity curve of column 1, the average sensitivity is taken as 6.32 microvolts absolute,





which corresponds to 1.58 microvolts per meter, with a standard height antenna. Noise level values were 4 per cent at 600 kc, the minimum, and 53 per cent at 1400 kc, the maximum. An image ratio of 3760 was measured at 1000 kc. From the power overload curve of column 2 a maximum power output of 4.14 watts is found, but this figure disregards the harmonics produced in the wave form across the output transformer primary at this power level. Band widths are tabulated under the selectivity curves of column 3, from which they were taken.

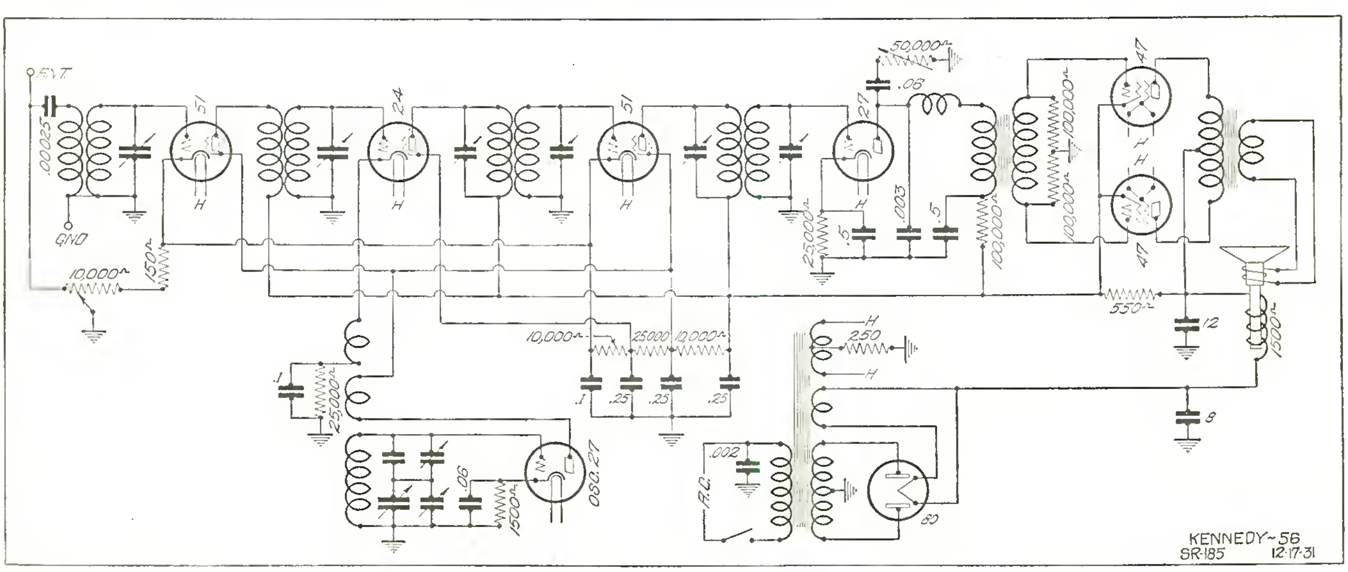
Below is a schematic wiring diagram of the model 56 Kennedy superheterodyne. Required tubes are a 551 r-f, 224 first detector, 227 oscillator, 551 second i-f, 227 second de-



tector, two 247s in push-pull output, and a 280 full wave rectifier for all B supply voltages. An 8 mfd and 12 mfd condenser are used on each side of the speaker field for hum filtration. Bias for the 247 pentodes is obtained by the drop across a 250 ohm resistor connected from the mid point of the filament winding to ground.

Band Widths

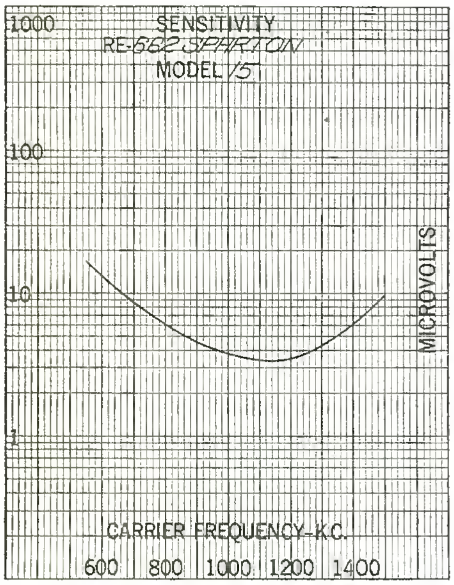
Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	10.5	10	10
100	17.5	16.5	16.5
1000	25	24	24
10000	36.5	35	35



Sparton Model 15

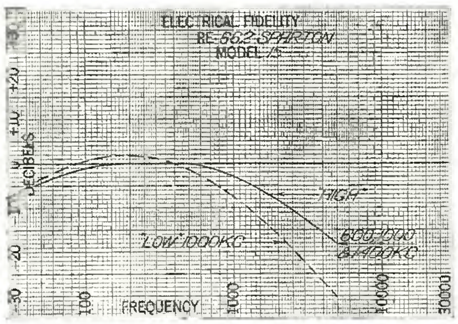
SPARTON'S model 15, when measured in our laboratory gave the included curves as indicative of its performance.

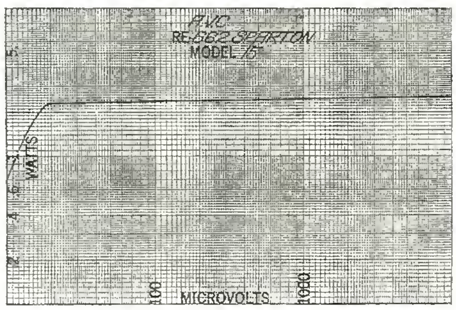
A dummy antenna standard of 20 uh, 200 uuf and 25 ohms coupled the output of the signal generator to the receiver input circuit. A load resistance of 7000 ohms matched the operating impedance of the 247 pentode, which had its plate capacitatively coupled to the output indicating device. The voice coil was opened during all measurements.



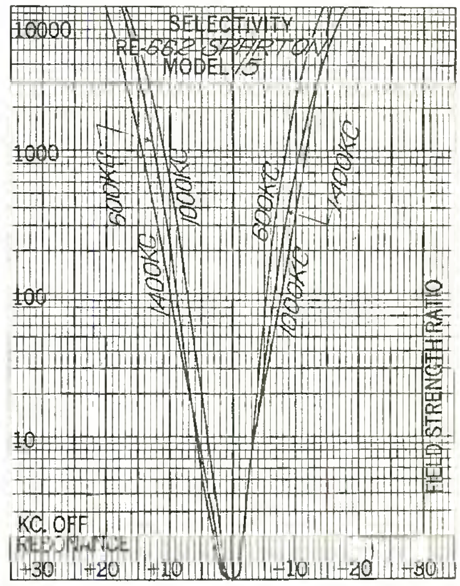
A line voltage of 116 volts resulted in a current drain of .71 amperes. For all tests, the tubes furnished with the chassis were used, the volume control was turned on full, and no adjustments were made in the alignment of tuned circuits.

An average of 6.72 microvolts absolute is found from the sensitivity curve of column 1. This value corresponds to 1.68 microvolts per meter. Maximum noise level occurred at 1000 kc, 1200 kc, and 1400 kc, with a value of 9 per cent, and the minimum of .7 per cent was found at 600 kc. The measured image ratio was 82,000 at a dial setting of 1000 kc. From the automatic volume control curve of column 2, maximum output is found to be 2.56 watts, which value does not take into consideration the harmonic content of the output. Band widths will be found tabulated under the selectivity curves of column 3.



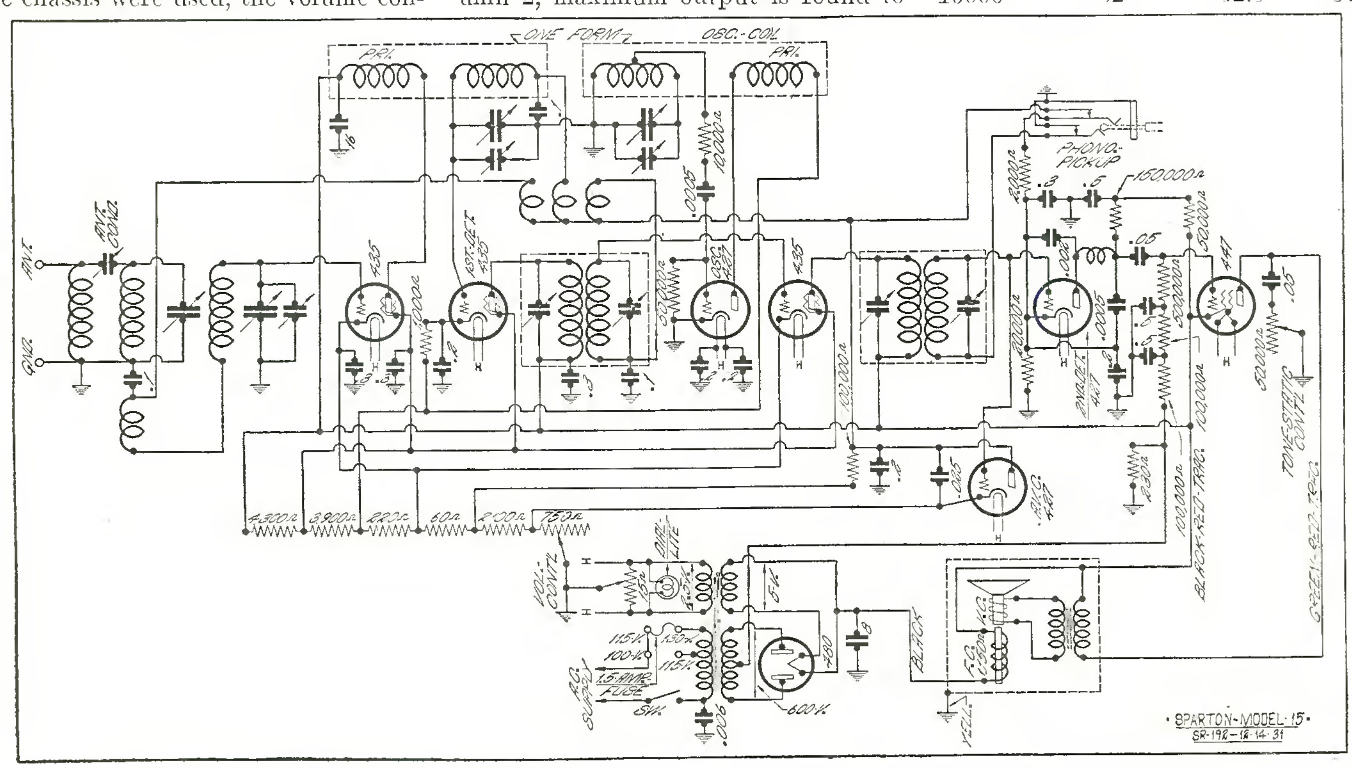


A schematic wiring diagram is shown below, and the required tubes are a 435 r-f, 435 first detector, 427 oscillator, 435 second i-f, 427 automatic volume control tube, 427 second detector, 447 pentode, and a 480 rectifier.



Band Widths

Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	9	7.5	9
100	14.5	13.5	16.5
1000	21	23	25
10000	32	32.5	37.5

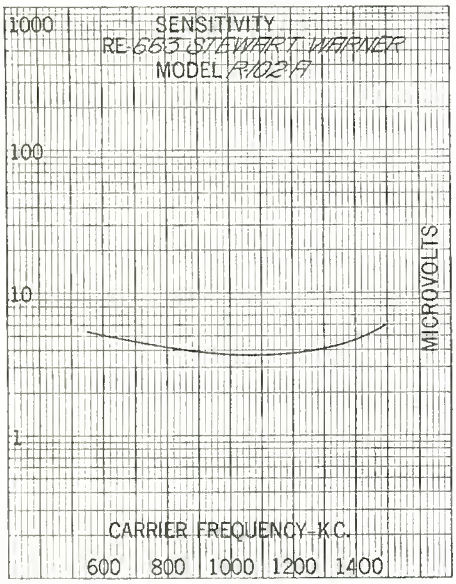


Stewart Warner Model R-102A

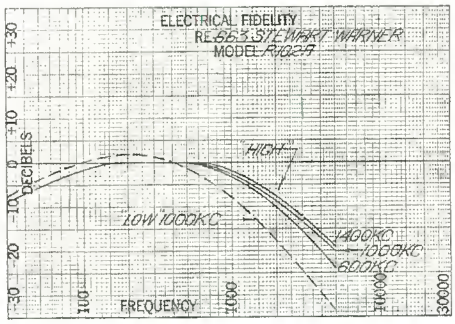
PERFORMANCE curves on the Stewart-Warner R-102A recently made in our laboratory are given on this page.

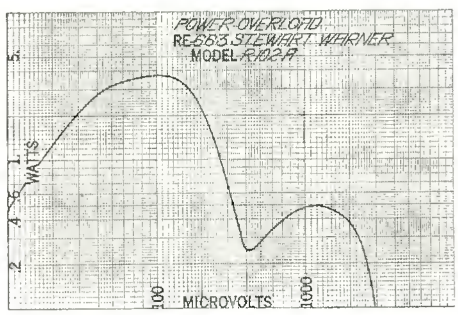
Receiver input from the standard signal generator was through the standard dummy antenna of 20 uh, 200 uuf, and 25 ohms. To match the operating output impedance of the single 247 pentode, a non-inductive load resistance of 7000 ohms was connected across the plate circuit, which in turn was capacitatively coupled to the output indicating voltmeter. A standard level of .05 watts was maintained for all measurements except that of power overload. The voice coil circuit was opened to prevent any impedance error caused by a reflection from the secondary to the primary circuit.

A line voltage of 117 volts gave the receiver a drain of .93 amperes. For all tests no alterations were made in the factory alignment of tuned circuits, the receiver was adjusted to its most sensitive position, and the tubes employed were those furnished with the chassis by the manufacturer as standard equipment.

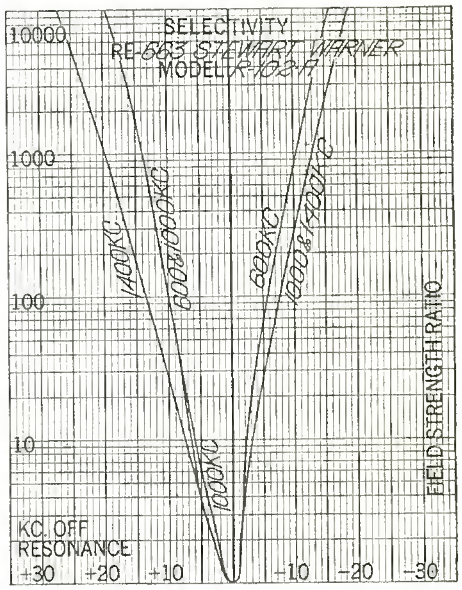


From the sensitivity curve of column 1 the average sensitivity is taken as 4.4 microvolts absolute, which corresponds to 1.1 microvolts per meter when a four-meter antenna is used. At 1000 kc, 1200 kc and 1400 kc the maximum noise level of 22 per cent was measured, and the minimum of 17.6 per cent was found at 600 kc. An image ratio of 3350 was measured with the receiver tuned to 1000 kc. In column 2 will be found the power overload curve, which gives a maximum audio output of 3.73 watts. However, this figure does not take into consideration the harmonics contained in the wave across the primary of the output transformer at this audio level. Tabulated band widths will be found under the selectivity curves, from which they were taken, in column 3.



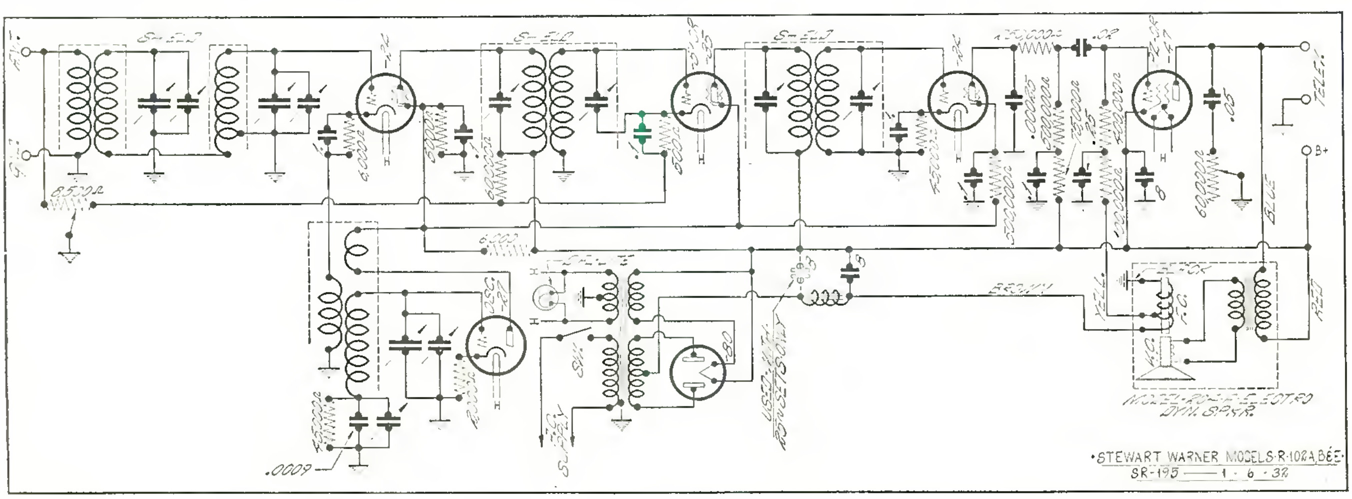


At the bottom of the page is a schematic wiring diagram, from which the required tubes are found to be a 224 first detector, 235 second i-f, 224 second detector, 227 oscillator, 247 power pentode, and a 280 full wave rectifier for complete receiver B supply. The speaker field is tapped to provide grid bias for the output pentode. Tone control consists of a .05 mfd fixed condenser from the plate of the pentode to ground through a variable resistance of 60,000 ohms. The change in the filter circuit from 60 cycle to 25 cycle operation is noted in dotted lines.



Band Widths

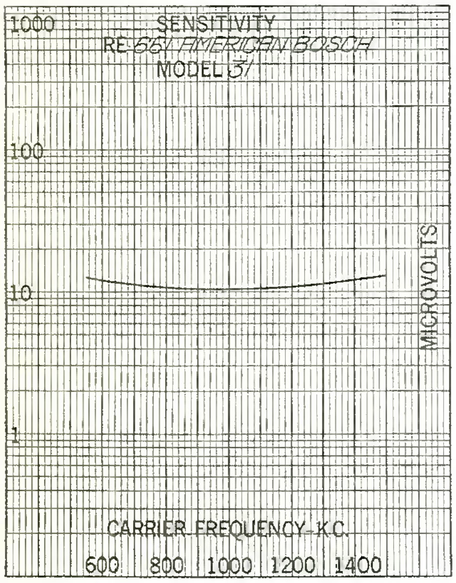
Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	8.5	9	11
100	15.5	18	21.5
1000	24.5	27	33
10000	35	38	45.5



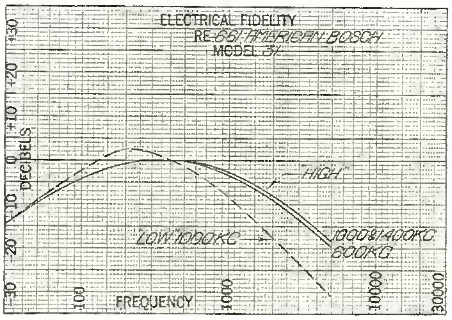
United American Bosch Model 31

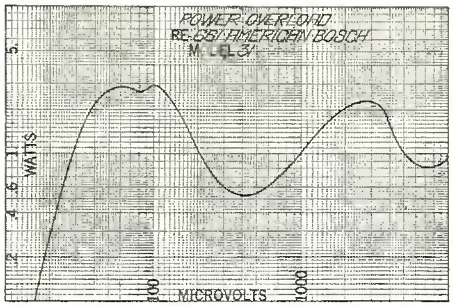
UNITED American Bosch models 31 and 32 gave the included performance curves after measurement in our laboratory recently.

A dummy antenna standard of 20 uh, 200 uuf, and 25 ohms coupled the output of the standard signal generator to the receiver input circuit. To match the operating impedance of the single 247 pentode employed in this superheterodyne, a non-inductive load resistance of 7000 ohms was connected across the plate circuit, which in turn was capacitatively coupled to the output measuring tube voltmeter used to indicate the standard audio output of .05 watts, except for the power overload curve. To eliminate any impedance reflection from the secondary to the primary circuit, the voice coil circuit was broken. In all measurements, no changes were made in factory alignment of tuned circuits, the volume control was turned to its maximum position, and the tubes furnished with the receiver as standard equipment were used. An a-c line drain of .64 amperes was recorded, with a line voltage of 117 volts.

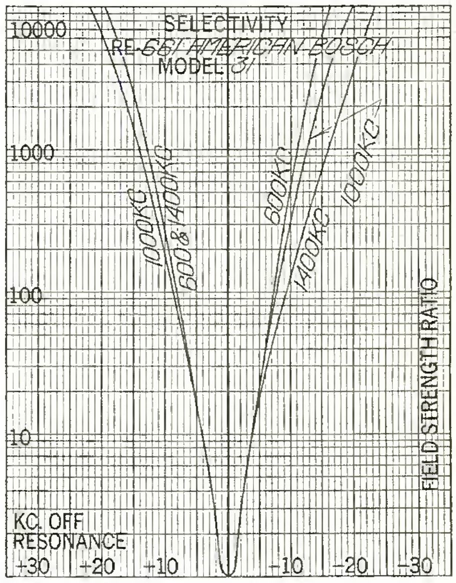


An average sensitivity of 12 microvolts absolute corresponding to 3 microvolts per meter with a standard height antenna is taken from the sensitivity curve of column 1. Maximum noise level of 19.4 per cent was measured at 1400 kc, while the minimum of 16 per cent occurred at 1200 kc. In column 2, the power overload curve gives a maximum output of 2.88 watts of audio power, but this figure does not take into consideration any produced harmonics. At 1000 kc the image ratio was measured as 2510. Below the selectivity curves of column 3 are the band widths taken from them.



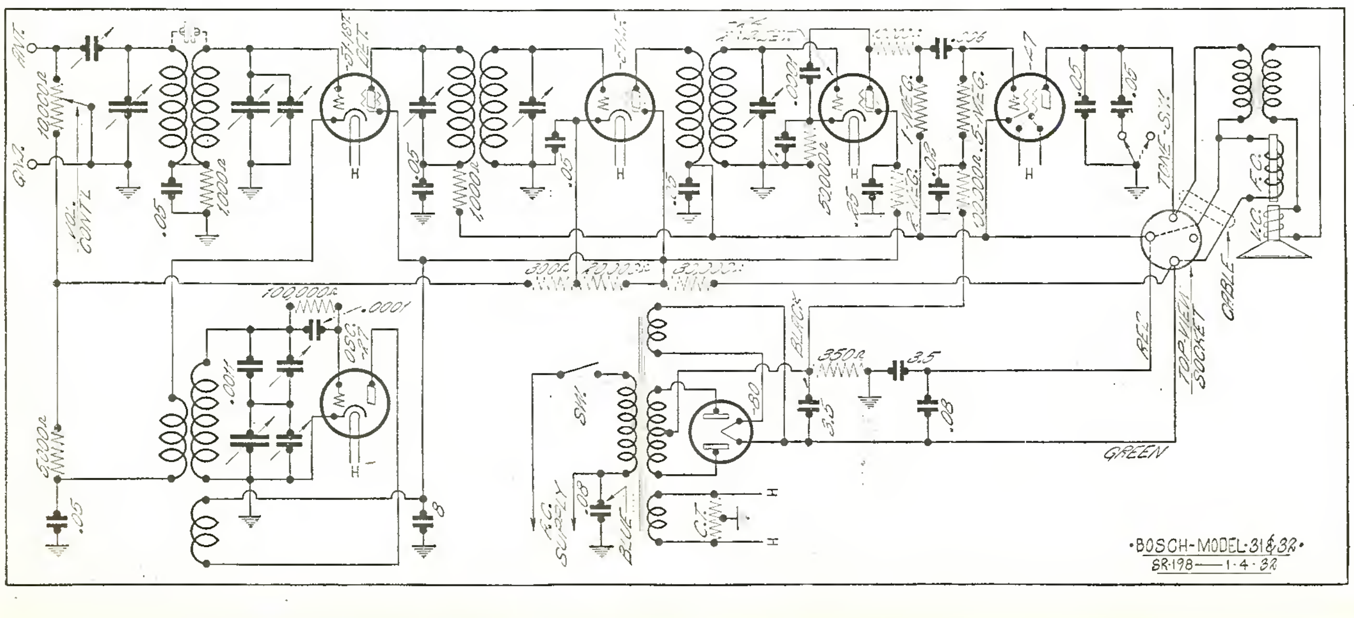


At the bottom of the page is a schematic wiring diagram of the model 31 superheterodyne. Required tubes for operation are a 551 first detector, 227 oscillator, 551 second i-f, 224 second detector, 247 pentode, and a 280 full wave rectifier.



Band Widths

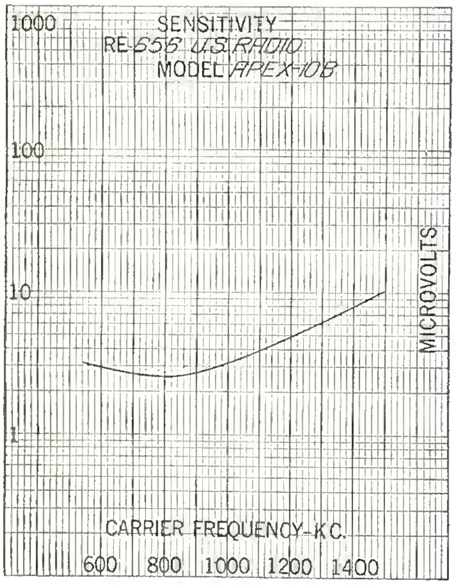
Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	8	8	8
100	15.5	16.5	17.5
1000	23.5	26.5	29
10000	35.5	41	42.5



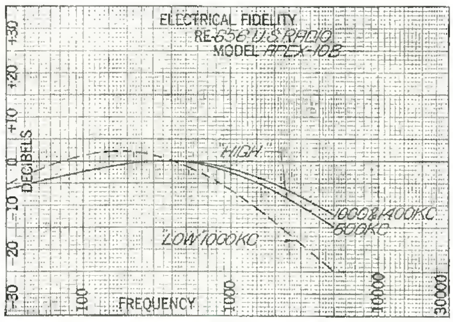
U. S. Radio, Apex Model 10B

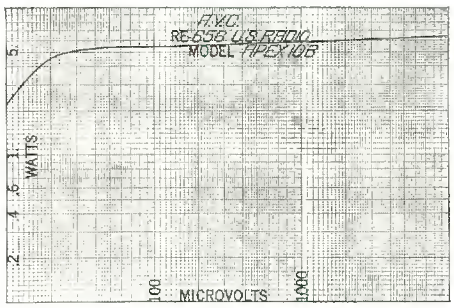
U. S. RADIO & TELEVISION CORPORATION'S Apex model 10-B gave the included overall performance curves when measured in our laboratory.

For signal input to the antenna circuit of this superheterodyne the standard signal generator was coupled through a dummy antenna standard of 20 uh, 200 uuf and 25 ohms. A non-inductive load resistance of 14,000 ohms was connected across the plates of the push-pull 247 pentodes to match their optimum operating impedance. The plates were capacitatively coupled to the vacuum tube voltmeter, which indicated the standard audio output level of .05 watts. To prevent any reflection of undesired impedance on the measured circuit, the voice coil was disconnected during all tests.



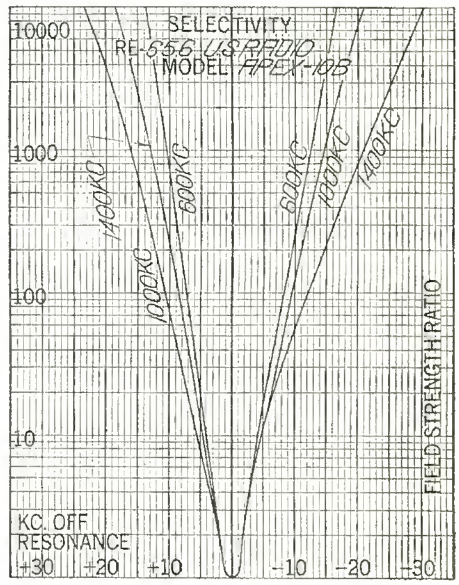
A line current of .95 amperes was drawn by the primary of the power transformer with an a-c voltage of 116. Tubes employed in the receiver were those furnished with it as standard equipment, the volume control was turned on full, and no adjustments were made on the tuned circuits during measurements. Average sensitivity is computed to be 4.4 microvolts absolute, from the sensitivity curve in column 1. This corresponds to a value of 1.1 microvolts per meter when a standard height antenna is employed. Noise levels, maximum and minimum values, are 37.2 per cent at 800 kc and 9.3 per cent at 1400 kc respectively. At 1000 kc the measured image ratio was greater than 50,000 times. Power output reached a maximum of 6.25 watts at the greatest input used, i. e., 10,000 microvolts.





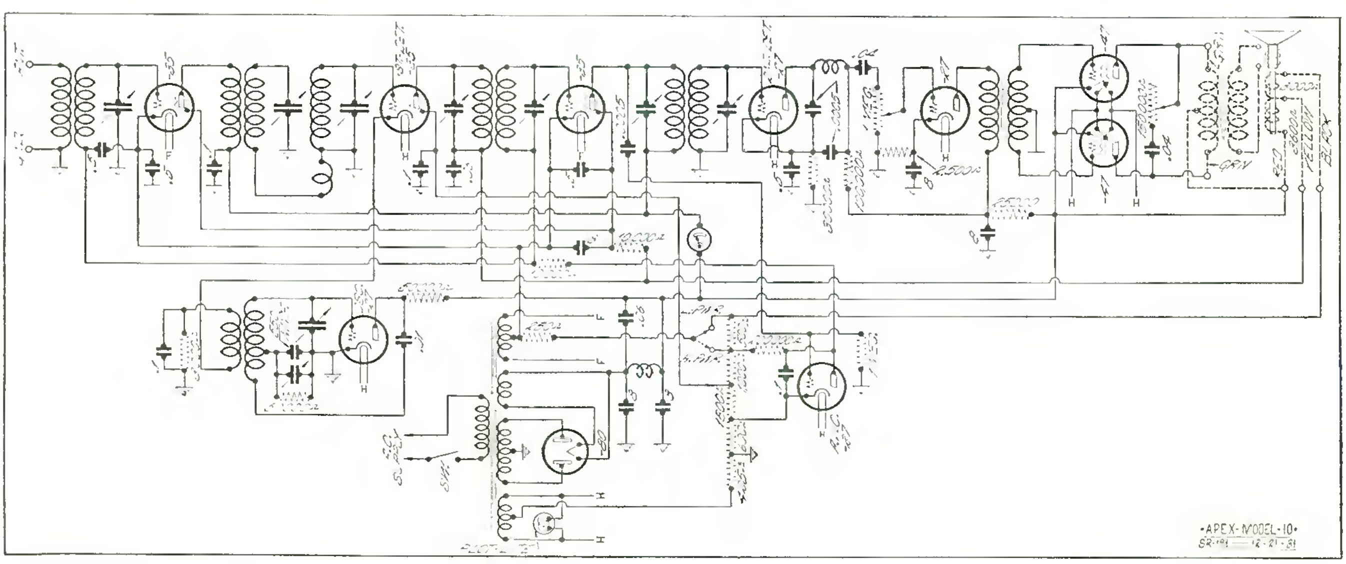
However, this figure does not take into consideration harmonic distortion introduced into the wave form at this high level. Below the selectivity curves in column 3 are the tabulated band widths taken from them.

At the bottom of the page is a schematic wiring diagram of the model 10-B. From it the tubes required are found to be a 235 r-f, 235 first detector, 235 second i-f, 227 second detector, 227 oscillator, 227 automatic volume control, 227 audio, push-pull 247 pentodes, and a 280 rectifier. In this receiver a meter is used for resonance indications.



Band Widths

Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	8	9.5	10
100	15.5	18.5	22.5
11000	23	26.5	37
10000	30	39	53



Zenith Models 91, 92

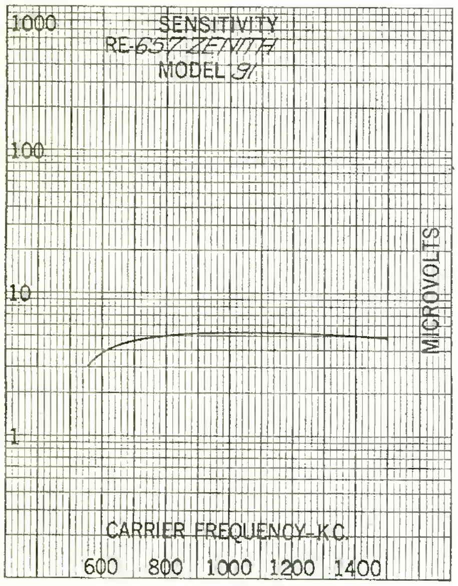
CURVES of the Zenith models 91 and 92 appearing on this page were made from our recent laboratory measurements.

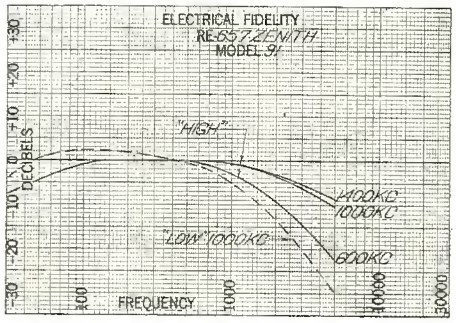
Input to the receiver antenna circuit from the standard signal generator was through the dummy antenna standard of 20 uh, 200 uuf and 25 ohms, while the output was maintained at .05 watts, except for the automatic volume control curve. The vacuum tube voltmeter in the output circuit was capacitatively coupled to the plates of the 245 push-pull output tubes, the impedance of which was matched by a non-inductive load resistance of 7800 ohms.

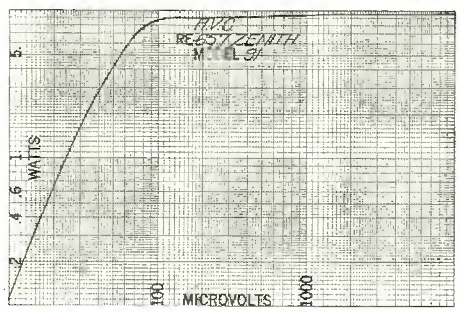
With a line voltage of 116 volts, the receiver current drain was 1.16 amperes. During all measurements the volume control was at maximum, the tubes as furnished by the manufacturer were employed in the receiver, and no adjustments were made on the alignment of the tuned circuits.

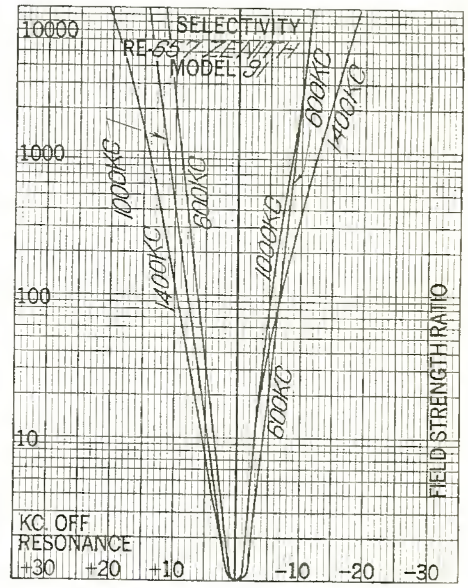
Average sensitivity as taken from the curve of column 1 is computed to be 4.8 microvolts absolute or 1.2 microvolts per meter, using the standard height antenna. Maximum noise level of 61 per cent occurred at 600 kc, while the minimum of 6.24 per cent was measured at 1400 kc. From the automatic volume control curve of column 2 the maximum power output is seen to be 9.46 watts at the point of greatest signal input taken. This figure does not take into consideration the harmonic content of the wave impressed across the primary of the output transformer. At 1000 kc dial setting the image ratio measured 11,900 times. In column 3 are the band widths given in tabular form under the selectivity curves, from which they were measured.

A schematic wiring diagram of the Zenith superheterodynes is given below. Tubes required for operation of the receivers are a 551 r-f, 551 first detector, 227 oscillator, 551 second if-, 227 second detector, 224 automatic volume control tube, 227 audio, push-pull 245 tubes, and a 280 full wave rectifier. From the diagram it is seen that the first section of the filter employs a tuned unit, while the speaker field makes up the second. Both choke units are in the B return lead and serve to give the proper voltage drop from ground to -B.



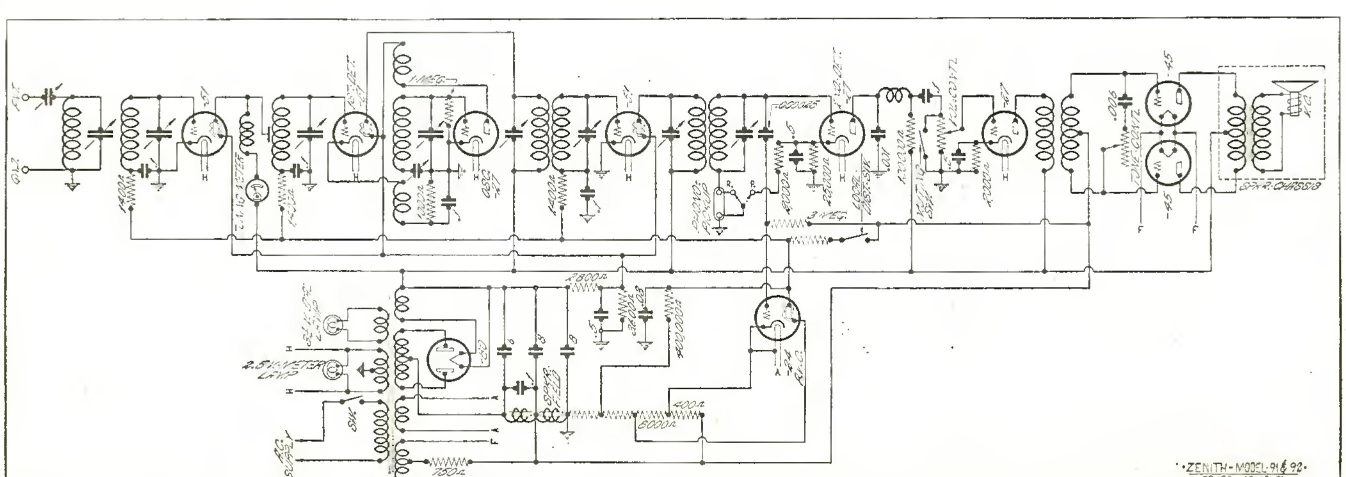




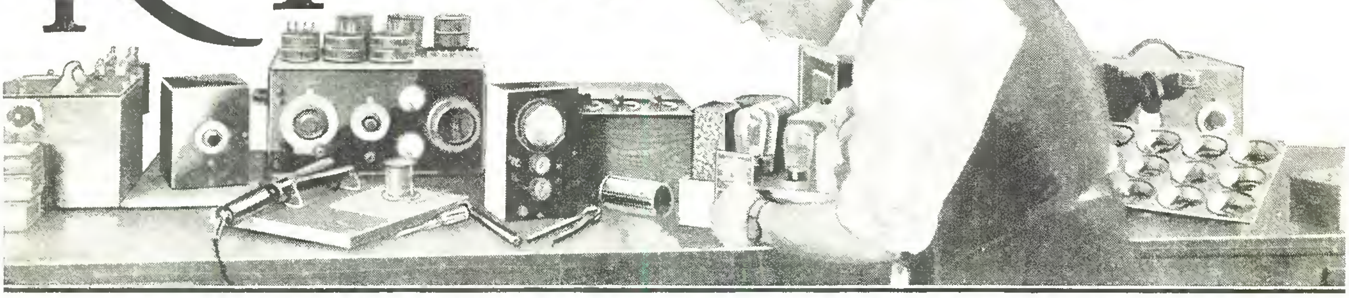


Band Widths

Times Field Strength	*Kilocycles width* 600 kc.	1000 kc.	1400 kc.
10	7.5	7.5	8
100	13	13	16.5
1000	18	20	27
10000	23	26	39.5



Service and Repair



SCHEMATICS PUBLISHED TO DATE

A. C. Dayton

Model	Published	Drawing No.
Navigator	November, 1929	SR24

Acme Mfg. Co.

Model	Published	Drawing No.
AC7	March, 1929	SR3
AC4	March, 1929	SR4

All-American Mohawk

Model	Published	Drawing No.
Lyric 90	November, 1930	SR74
Lyric 6	March, 1929	SR1
Lyric 8	March, 1929	SR2
Lyric J	October, 1931	SR128
Lyric B-7	December, 1931	SR165
Lyric S-8	January, 1932	SR170

Amrad

Model	Published	Drawing No.
70	November, 1929	SR22
81	March, 1930	SR44
84	January, 1931	SR106

Apex

Model	Published	Drawing No.
48	November, 1930	SR80
31 (U. S. Radio)	January, 1931	SR108

Atwater-Kent

Model	Published	Drawing No.
38	January, 1930	SR28
55, 55C (Cap.)	September, 1930	SR51
55, 55C (Ind.)	September, 1930	SR52
66	March, 1931	SR114
H-2	December, 1931	SR131

Audiola

Model	Published	Drawing No.
Series 31 (t.r.f.)	November, 1930	SR79
Super 31	March, 1931	SR111
Junior	March, 1931	SR112
13-S7	February, 1932	SR181

Balkeit

Model	Published	Drawing No.
A	September, 1929	SR12

Bosch

Model	Published	Drawing No.
48	November, 1930	SR73
58	January, 1931	SR109
60	March, 1931	SR117
28-29	November, 1929	SR21
Auto	November, 1930	SR94
7DC	November, 1931	SR160

Bremer-Tully

Model	Published	Drawing No.
7-70	September, 1929	SR10
81-82	November, 1930	SR75
S81-82	October, 1931	SR126

Brunswick

Model	Published	Drawing No.
3KRO	November, 1929	SR23
15, 22, 32 and 42	November, 1930	SR86
S14	November, 1930	SR71
11, 12, 16	October, 1931	SR148
17, 24	December, 1931	SR164
E	February, 1932	SR183

Colonial

Model	Published	Drawing No.
31AC	January, 1930	SR29
33 and 34 a-c	November, 1930	SR95
47-48	December, 1931	SR160

Crosley

Model	Published	Drawing No.
Roamio	September, 1930	SR67
40S, 41S, 42S, 82S	September, 1930	SR57
608 Gembox	March, 1930	SR41
705 Showbox	March, 1929	SR6
Jewelbox 704B	March, 1929	SR5
77	November, 1930	SR83
53, 54, 57	January, 1931	SR103
120	October, 1931	SR133
121-1	November, 1931	SR149
124	December, 1931	SR150
125	January, 1932	SR174

Dayfan

Model	Published	Drawing No.
5080	September, 1929	SR11

Delco

Model	Published	Drawing No.
Auto Radio	September, 1930	SR66

Edison

Model	Published	Drawing No.
R4, R5, C4	November, 1930	SR49
R6, R7	January, 1931	SR99

Erla

Model	Published	Drawing No.
Duo Concerto R-2	January, 1930	SR33

Eveready

Model	Published	Drawing No.
50	March, 1931	SR50

Fada

Model	Published	Drawing No.
7AC	September, 1929	SR13
35-35Z	November, 1930	SR70
KW28-29	December, 1931	SR158

Federal

Model	Published	Drawing No.
H	November, 1929	SR19

Freed-Eisemann

Model	Published	Drawing No.
NR80	November, 1929	SR20

Freshman

Model	Published	Drawing No.
2-N-12	September, 1929	SR14

General Electric

Model	Published	Drawing No.
H-32	January, 1932	SR166
S-22	January, 1932	SR137

General Motors

Model	Published	Drawing No.
A	November, 1930	SR68
120-A	November, 1931	SR116
S3A	November, 1931	SR154
S9A	January, 1932	SR173
S-10A	February, 1932	SR179

Gilfillan Bros.

Model	Published	Drawing No.
100	January, 1930	SR32

Graybar

Model	Published	Drawing No.
600	March, 1930	SR42

Grebe

Model	Published	Drawing No.
7AC	November, 1929	SR17
AH1	November, 1930	SR96

Gulbransen

Model	Published	Drawing No.
Nine-in-Line	March, 1930	SR40
161	March, 1931	SR110
10, 13	February, 1932	SR175

Howard

Model	Published	Drawing No.
S. G. A.	September, 1930	SR56
Green Diamond 8	September, 1929	SR16
H	October, 1931	SR145
SG-B	November, 1931	SR130
O	December, 1931	SR163

Jesse French, Jr.

Model	Published	Drawing No.
G	March, 1931	SR118

Kellogg

Model	Published	Drawing No.
523-528	November, 1930	SR77

Kennedy

Model	Published	Drawing No.
20	March, 1930	SR48
26	November, 1930	SR81
10	January, 1931	SR38
30-32	November, 1931	SR129
52	February, 1932	SR184

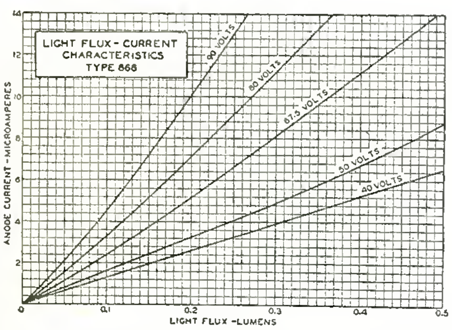
King

Model	Published	Drawing No.
J	January, 1930	SR31

Model	*Published*	*Drawing No.*
Kolster		
K20, K22, K25 and K27	September, 1929	SR8
K21, K23, K24 and K28	March, 1930	SR45
K-43	November, 1930	SR72
K80	November, 1931	SR159
90, 92	February, 1932	SR182
Kylectron		
70	November, 1930	SR65
Majestic		
70	September, 1929	SR7
90B	September, 1930	SR55
130-A	November, 1930	SR84
50	January, 1931	SR98
20	October, 1931	SR124
60	October, 1931	SR138
15	November, 1931	SR157
25	February, 1932	SR178
Philco		
86-82	November, 1929	SR26
95	September, 1930	SR60
90-90A	November, 1931	SR156
112	January, 1932	SR172
Pilot		
148	February, 1932	SR176
Radiette		
F14	January, 1931	SR104
Radiola		
60	January, 1930	SR30
66	September, 1930	SR64
44	January, 1931	SR102
18	October, 1931	SR127
RCA-Victor		
R-7	October, 1931	SR137
R50-55	December, 1931	SR166
R11	January, 1932	SR168
Sentinel		
11, 12, 15, 16	March, 1931	SR115
106B	March, 1931	SR113
108A	October, 1931	SR146
108	November, 1931	SR123
111	November, 1931	SR155
Silver		
36A	January, 1931	SR105
30B	September, 1930	SR53
30	January, 1930	SR35
35-A	November, 1930	SR82
782	October, 1931	SR120
726SW	October, 1931	SR144
D-E	November, 1931	SR152
F	December, 1931	SR140
G	January, 1932	SR153
A	February, 1932	SR169
Slagle (Continental)		
9	January, 1930	SR27
R-20	March, 1930	SR46
Sonora		
5R	November, 1929	SR25
Sparton		
AC89	September, 1929	SR9
589	September, 1930	SR63
600, 610, 620	March, 1931	SR91
25-26	December, 1931	SR161
10	February, 1932	SR180
Splitdorf		
E175	January, 1930	SR36
Steinite		
261	September, 1929	SR15
70, 80, 95	November, 1930	SR76
600, 605, 630, 635	November, 1931	SR132
Stewart-Warner		
950	September, 1930	SR62
Series 900	January, 1930	SR34
R100	January, 1931	SR85
102A	October, 1931	SR147
Stromberg-Carlson		
846	September, 1930	SR54
635-636	November, 1929	SR18
12-14	November, 1930	SR93
10-11	November, 1931	SR134
19-20	November, 1931	SR151
Transformer Corp.		
50	November, 1930	SR78
80-81	October, 1931	SR139
Temple		
8-60, 8-80, 8-90	March, 1930	SR37
SG 8-61, 8-81, 8-91	October, 1931	SR125
Transitone		
Auto Radio	November, 1930	SR69
Trav-Ler		
C	March, 1931	SR120
U. S. Radio		
37	March, 1930	SR39
26P	October, 1931	SR143
99A	January, 1932	SR171
Victor		
R32, RE45, R52	September, 1930	SR61
R35, R39, RE57	January, 1931	SR101
Westinghouse		
WR-5	November, 1930	SR92
WR-4	January, 1931	SR107
WR10-12	November, 1931	SR137
WR15	January, 1932	SR168
Zaney-Gill		
54	March, 1931	SR119
Zenith		
52, 53, 54, 522, 532 and 542	March, 1930	SR43
71, 72, 73 and 77	November, 1930	SR97
A, B, C, D	November, 1931	SR141

868 Type Phototube

RCA Radiotron Company, Inc., and E. T. Cunningham, Inc., have recently made available to experimenters a Phototube designated as Radiotron RCA-868 and Cunningham CX-868. This tube is of particular interest because of its use for sound movies in the home and because of its adaptability to many novel experimental uses with light.



This Phototube is an electronic device and consists of two electrodes enclosed in a glass bulb. One electrode, the cathrode, has a sensitized surface which emits electrons when the surface is exposed to light. The other electrode, the anode, acts as a collector for these electrons when a battery is connected across the cathode and anode terminals. The anode or collector, is, of course, connected to the positive terminal of the battery so as to assist the flow of electrons from the cathode to anode. This circuit is not unlike that of the usual vacuum tube except that the electrons are emitted from a light sensitive surface instead of from an incandescent cathode.

The current flowing in the Phototube circuit is dependent on the amount of light received by the sensitized surface. The Phototube, like a vacuum tube, has practically no time lag, so that variations in light intensity instantaneously affect the amount of current passing through the tube. The cathode of the 868 is a semi-

(*Continued on page* 40)

The rating and characteristics of RCA-868 and CX-868 are as follows:

Anode Supply Voltage	90 volts maximum
Anode Current	20 microamperes maximum
Static Sensitivity*	45 microamperes per lumen
Dynamic Sensitivity @ 1000 cycles*	40 microamperes per lumen
Dynamic Sensitivity @ 5000 cycles*	38 microamperes per lumen
Gas Amplification Factor**	Not over 7
Load Circuit Resistance	0.1 to 5 megohms
Maximum Overall Length	4⅛"
Maximum Diameter	1 3/16"
Window Area of Cathode	0.9 sq. inches
Bulb	T-8
Base	Small Four Prong

* Sensitivity values are given for conditions where a Mazda Projection Lamp operated at a filament color temperature of 2870° Kelvin is used as a light source. A one megohm load resistance is used in the test circuit.

** Gas amplification factor is given as the ratio of sensitivity at rated voltage to the sensitivity at a voltage sufficiently low (approx. 25 volts) to eliminate gas ionization effects.

Automobile Radio Receivers

Twenty-Seven Million Prospects

By L. FREDERICK SINCLAIR*

IN these days of small profits or perhaps losses, and "Old Man Overhead" unescapably with us, a line that will bring new business with a minimum of sales resistance, should receive a hearty "Welcome Stranger" from every dealer who has faith in himself and the future of our country. And when it is learned that the line has a real margin of profit, a real demand, public acceptance, and practically no "grief," the most aggressive dealers are getting themselves lined up with no lost time or lost motion.

There are a few auto-radio receivers which have actually developed to the point where they will give results equal to the best home reception. From every quarter comes the report that auto-radio is here to stay. It is, therefore, apparent that the leading distributors, dealers, and many industrial organizations have recognized the importance, necessity and future of this new marvel of the age. Just a few years ago the auto-radio was looked upon as an experiment, and little or no attention was given to it; but today most of the leading car manufacturers and allied fields realize the importance of this new business stimulant.

There is a vast field for the sale of auto-radios, the surface of which has barely been scratched. Over twenty four million passenger cars are in use in the country, less than 2% being radio equipped, and relatively few being equipped with the modern powerful, efficient, and satisfactory instruments now available. There are also close to three million trucks, busses, motor-boats, aeroplanes, and public motor conveyances to add to the above. Think of it! Twenty-seven million logical prospects! A conservative estimate is that one million auto-radio receivers will be sold in 1932. A year ago auto-radio was practically unknown, yet today there are over half a million sets in use, with the market steadily improving.

A number of manufacturers furnishing parts for radios, are concentrating day and night to produce special tubes, batteries and other equipment for auto receivers. Two of the largest spark plug organizations have perfected a radio spark plug which serves more efficiently than does the ordinary suppressor to eliminate motor noises. Sixteen or more prominent motor car builders are now including a built-in aerial or antenna in their cars as standard equipment. Several of these manufacturers instruct their distributors and dealers to recommend an auto-radio as optional equipment, and distributors are offering these receivers to their dealers as additional sales stimuli.

It is obvious that all this preparation cannot be the result of blind optimism; there are too many big organizations and leading authorities involved. The market and opportunity is so tremendous that many of the interested parties are just realizing tho significance of this new product that the motoring public eagerly awaits.

Twelve months ago only a few thousand motor car receivers were in use, but as the public and certain industrial organizations began to realize just what a good auto-radio can do to stimulate sales, a cry went up for better equipment. Today half a million auto-radio receivers are in use. It is true that in this particular industry, like any other new field, much inferior equipment was sold. Many complications had to be overcome and many radio engineering problems had to be solved, to develop a set that would operate under normal as well as adverse conditions, i. e., a receiver that will bring distance with excellent tone quality, plenty of volume, sharp selectivity, and free from extraneous noises. Because of the varying conditions that automobile sets are subjected to, the automatic volume control, available on a few of the finest instruments, is of great benefit in obtaining uniform reception.

Put yourself for a moment in the position of the average motorist, who is also one of the 95% of those who enjoy radio programs. Wouldn't you buy an auto-radio receiver if your dealer gave you a demonstration that proved conclusively that you could enjoy just as good reception on the road in your car, as in your own comfortable home, and (very important) if the price and terms were such that you could pay for it without difficulty? Twenty-five cents a day for a year would pay for an excellent set.

From the dealer's angle it is important to know that the installation of a motor car set is now so standardized and simplified that any mechanic or service man can install one properly in an hour.

For motor conveyances not factory equipped with an aerial, a type of antenna for suspending between the front and rear axles is furnished, out of sight and indestructible. The receiver needs but three holes for mounting and the super dynamic speaker, one hole. The remote control clamps on the steering column. The set may be mounted on either side of the bulk-head, in the engine compartment or inside the body behind the instrument panel, otherwise unused space. B batteries for the battery set or a B automatic eliminator for the all electric set are mounted under the car or any other convenient place. The A current is supplied from the regular car storage battery, and by stepping up the charging rate one or two amperes, an ample current supply is maintained.

The auto-radio line is ideal for the real merchandiser to handle because:

(1) There is a real demand for it
(2) The principal sales effort required is to make the demonstration
(3) There is a wide margin of profit
(4) The business is clean cut, easy to transact—no "trade-ins"
(5) It is logically related to your business
(6) Each sale brings in new prospects
(7) Small investment and quick turnover

There are many specific sales plans and methods and the dealer is justified in looking to the manufacturer for real merchandising co-operation. Here are some actual instances and suggestions as to the sales possibilities of auto-radio.

An unusual method was employed by a man in Denver, and his plan was disclosed to me after I had a short talk with him. He was in the battery and ignition business. One plan was to rent auto-radios to anyone making trips out of the city. Checking up his records showed that his average sales were 94%. In other words, when the person who rented this equipment returned from the trip and reported at his store, he was so thoroughly enthusiastic about his radio, that it was a simple matter to close the sale on the spot.

During the interim, the plan was to charge the car owners a small fee to cover cost of installation and removal,

* President, Motomaster Radio Corporation.

if not sold when the prospect returned. The charge of fifty cents per day for the use of the set was the only other fee. Wherever the individual had an established credit, no deposit was required on the set. Otherwise an amount representing one half of the sales price was required.

I observed another excellent market in Chicago and St. Louis. Several recognized firms who travel a great many salesmen, were called upon to learn of their interest in auto-radio for their men. In an instance such as this where a quantity purchase was in sight, the distributor was prepared to allow a substantial discount to the firm purchasing the sets, and the firm employing the salesmen installed the sets in any salesman's car employed by them if his sales showed an increase, if he made his quota for three consecutive months, or for any other good reason. In other words, auto-radios were used as a direct stimulant to the salesmen.

A used car dealer found that he had a large stock of cars on hand that were moving slowly. He installed auto-radios in most of the cars and merely added on the cost of the radio to his sales price; so that all in all, the total cost with the auto-radio, was far more attractive to the prospective purchaser than a second hand car alone, or a silent second hand car. He found that after fifteen weeks almost 81% of his cars were sold. This naturally prompted him to make plans for the more extensive use of motor car receivers. He purchased more second hand cars and before they were put on the lot, he had radios put in each one of them. In each instance he received his regular sales price plus the cost of the radio, the purchaser was equally well satisfied, and his profit on the transaction was considerably increased. He found that his sales increased over 300% and that the radio was a very convincing piece of merchandise.

In another instance, a new car dealer handling a well known make decided that he was going to install auto-radios in a few cars on the floor. He also arranged to install this auto-radio in his salesmen's cars and by merely adding the cost of the radio plus anywhere from 10% to 50% as he would any other "extras" he found that the radio acted as a very decided sales stimulant. Sales increased! The salesmen became very enthusiastic and a certain make radio was adopted as standard equipment by this progressive dealer and became optional on all purchases, the same as all other accessories.

In some of the other key cities, a unique plan was used which seemed meritorious if properly executed. It was termed by some as a "European sales plan," and by others as a "Self-payment plan." The purchaser of an auto-radio was able to acquire this unit and have it installed in his car on the time payment schedule. Usually his car is clear but used as security, and if it carried a first mortgage with enough equity in line with the blue-book requirements, then a second mortgage was taken. The time payments were usually on a ten months basis.

This same customer was permitted to go out demonstrating his radio to other prospects, and for every contract accepted by the dealer from whom he purchased his set, he was allowed a commission equal to one monthly payment. This enabled him to liquidate his obligation to the car dealer or finance company, whichever one held the paper without requiring cash payment. Thousands of auto-radios have been sold by this pyramiding method.

State police and a number of other similar organizations have quite an elaborate and efficient plan of operation in effect. They provide all city, county, and state officers with auto receivers. This enables the key personnel of the government to know at a moment's notice when crimes have been committed, when criminals are at large, or to be advised of any other matters of importance immediately. This opened a tremendous market to the officials and other persons who are interested in keeping in touch with activities and plans which will require the purchase of auto-radios.

Recently I learned that several leading motor transportation lines who used trucks in hauling products, both perishable and otherwise, have become interested in auto-radio.

One instance with an organization running one hundred and six trucks, brought out the importance of auto-radio from the safety angle. They were hauling cotton and other freight from the south to some of the northern key markets, when they had a severe accident with one of their truck units en route north. It was later learned that in order to make time the driver kept at the wheel continuously for over fifteen hours. This, of course, prompted the accident. The driver dosing off, ran into a telegraph pole and killed himself, wrecked the truck, and injured others on the road.

This particular transportation company is installing auto-radios in their trucks which will entertain the drivers during these long trips and keep them alert to all road conditions. It will be difficult for them to fall asleep and will enable them to carry on in the face of all travel hazards. Many of the leading passenger bus lines have recognized the importance of installing auto-radios. In the south the writer was entertained by one of these wonders of the age in a bus going in to Nashville.

Another tremendous field for auto-radios is taxicabs. Usually the taxi fleet owners or the independent owner of a cab, has the remote control of the set placed within an easy reach of the passengers. This adds considerable pleasure to the trip and also is an important factor in keeping the driver alert in dull periods or on long journeys.

One taxicab fleet which installed auto-radios in about 40% of its cars, learned after several months that the cabs so equipped had an income in excess of 35% over others without the same equipment, and also increased their business as a whole because of their reputation for being the most modern cab company in town since putting in the new equipment. Needless to say, they are planning to equip their fleet 100%.

It is obvious that any live distributor or dealer should place auto-radio demonstrators in public garages, battery stations, auto accessory stores, and certain types of gas stations which will automatically create and stimulate a big outlet. Some dealers have raffled off sets in leading theatres in their towns and have secured a great deal of low cost publicity plus thousands of prospective purchasers, many of which have become sales. There are other methods of stimulating sales by giving out a ticket for every purchase or arranging to give special discounts to those who purchase auto-radios from a certain dealer.

The leading "Rent-a-car" systems throughout the nation have recognized the advantages of auto-radio and it has been observed in many of the leading cities that these organizations have capitalized on this business stimulant by installing it in nearly every car made available to the public. The auto-radio in this instance as well as in the case of the taxicab and bus, serves a dual purpose by attracting the attention of the public as well as entertaining it. The auto-radio can also be installed in aeroplanes and motor-boats, or any type of public carrier. This is a new industry which is growing very rapidly and is being quickly recognized by many distributors and dealers as the livest field for quick profits.

The foregoing possibilities are but a few and many of the new outlets will be found and created as time goes on. In these times when selling has become scientific merchandising, isn't it worth while to investigate this new "hot" item and get in on it while the going is good? In other words, doesn't this really appeal to you as a "tonic for your business"?

Notes on Distortion

THE two principal sources of distortion in audio frequency amplifiers and reproducers are non-linear response with frequency and the addition of frequencies not originally present.

The first has been fairly well taken care of in modern equipment. The overall response of any audio amplifier can be made flat enough so that no apparent non-uniformity will exist between the amplification of different frequencies. This is not quite the case with loud speakers. The response curve of a good audio amplifier taken with its speaker by means of a calibrated microphone will have a good many peaks and hollows although the average level from 50 to 5000 cycles or higher can be maintained practically constant.

It is interesting to note that the attenuation at different frequencies in any room or auditorium is different for each position in that room. Thus, if one should sit in one seat, there would be certain frequencies which would be much more attenuated than others, and the overall transmission of sound from the source might have even more peaks and hollows than the output curve of the amplifier and speaker. Viewed from this standpoint, the non-uniformity of output of a speaker is not decidedly serious.

It is also a fact that large variations in sound pressure do not cause a correspondingly large difference in the sense of sound. However, it is this ability of the ear which often causes a small amount of discordant distortion to take on more significance than the ratio of its energy to that of the fundamental frequency would signify. Thus, the second cause of distortion, the addition of frequencies not originally present, becomes more serious by virtue of the same trait of the human ear which makes non-uniform response with frequency less objectionable.

To the average radio engineer, the term distortion immediately brings to mind the ratio of the added harmonic voltage to that of a fundamental monotone. As a matter of fact, this is not as important as the attention given it might indicate. True harmonics of any frequency or group of frequencies are, as the term indicates, harmonious with the fundamentals and are fairly well masked by them. It is seldom that anything less than twenty to twenty-five per cent of these can even be detected, to say nothing of causing the annoying discords that often come from the loud speaker even before the actual overload level is reached.

However, this harmonic content ratio is in direct proportion to another type of distortion which does produce discords and which has been given less thought than its importance would merit. When two frequencies are applied to an amplifying vacuum tube, non-linearity of its characteristic not only causes the amplifier to produce harmonics in the ratio of whole multiples of the fundamental, but it also causes the addition of sum and difference frequencies, which are often actual discords. It is present-day practice to use but one audio stage following the detector in radio receiver design. For this reason, the r.f. voltages applied to the detector grid must of necessity be large and the detector tube does not depend upon the squared function of its characteristic for its detector action. Thus the average detector tube worked at a sufficient input level so that the negative swing is well below cutoff is not a serious offender when it comes to adding either harmonics or sum and difference frequencies. This is particularly so if the impedance in its plate circuit is well above the plate impedance of the tube, as is the case with a type '27 tube working into a well designed audio transformer. However, the several power tubes and particularly the type '47 pentode will produce sum and difference frequencies which can be detected well before the grid excitation is raised to the overload point. An analysis of the frequencies introduced by the squared and cubed functions of the characteristics of these tubes will indicate the magnitude of this distortion.

Assume that some voltage $A \cos \theta$ is to be amplified by a '45 power tube. The squared function of the characteristic of this tube would produce a second harmonic of the frequency $\frac{\theta}{2\pi}$ as follows:

$$A^2 \cos^2 \theta = \frac{A^2}{2} \cos 2\theta + \frac{A^2}{2}$$

In the case of the '45, the limit of this second harmonic distortion is taken as 5 per cent. From the above equation we can see that when the coefficient $\frac{A^2}{2}$ is equal to 5 per cent of the peak value of current that there will also be an increase in the d-c. current equal to $\frac{A^2}{2}$. Since the peak current which can pass thru the speaker is equal to the d-c. plate current, the increase in plate current can be taken as a direct measure of the second harmonic distortion. This, of course, assumes that all of the distortion is due to the squared function of the characteristic only.

If we take this same tube and apply two equal voltages of the same amplitude but of different frequencies, we will have in the plate circuit all of the frequencies caused by the squared function as follows:

$$(A \cos \theta + A \cos \phi)^2$$

This becomes

$$A^2 \cos^2 \theta + 2A^2 \cos \theta \cos \phi + A^2 \cos^2 \phi$$

Upon being still further expanded, this becomes

$$\frac{A^2}{2} \cos 2\theta + \frac{A^2}{2} A^2 \cos (\theta + \phi) + A^2 \cos (\theta - \phi) + \frac{A^2}{2} \cos 2\theta + \frac{A^2}{2}$$

The first and fifth terms are the second harmonics of the frequencies $\frac{\theta}{2\pi}$ and $\frac{\phi}{2\pi}$. The third and fourth terms are the sum and difference frequencies, and the second and sixth terms are increases in the d-c. current. From this expression, it is evident that the magnitudes of the sum and difference frequencies are equal to twice the second harmonic voltages which are produced. Assume that the coefficient $\frac{A^2}{2}$ is equal to 5 per cent of the peak value of the fundamental currents at the frequencies $\frac{\theta}{2\pi}$ and $\frac{\phi}{2\pi}$, then from the coefficients of the sum and difference frequencies we can see that these have an amplitude equal to 10 per cent of the fundamental frequencies.

As stated above, harmonics up to the amount of 20 per cent are not extremely objectionable, but these sum and difference frequencies will produce actual discords. For example let the frequencies $\frac{\theta}{2\pi}$ and $\frac{\phi}{2\pi}$ be middle C and E, the first two notes of a Major Triad, which correspond to 264 and 330 cycles per second. The second harmonic frequencies of 528 and 660 are still harmonious with each other and with the fundamentals. The sum and difference frequencies of 66 and 594 correspond to C two octaves below middle C and to upper D. This latter frequency is a decided discord with the two fundamentals and it is even more objectionable because it delivers twice the voltage or four times the power of the second harmonic frequencies to the speaker.

In the case of the pentode, we have to deal with a large cubed function in the tube's characteristic. Taking these same two frequencies of equal magnitude and cubing them, we have

$$\frac{A^3}{4}\cos 3\ominus + \frac{A^3}{4}\cos 3\emptyset + \frac{9A^3}{4}\cos\ominus + \frac{3A^3}{4}\cos\emptyset + \frac{3A^3}{4}\cos(2\emptyset+\ominus)\ \frac{3A^3}{4}\cos(2\emptyset-\ominus) + \frac{3A^3}{4}\cos(2\ominus+\emptyset) + \frac{3A^3}{4}\cos(2\ominus-\emptyset)$$

The first and second terms are the third harmonic frequencies. The third and fourth terms are additions to the fundamental frequencies, and the last four terms are sum and difference frequencies. Here it will be noticed that the sum and difference frequencies fall on both sides of the second harmonics. In other words, they all include the exponent 2 before either one or the other of the angular velocities of these frequencies. Thus in the case of the fundamentals of 264 and 330, we have additional frequencies of 198, 396, 858 and 924. These correspond to low G, G, upper G sharp and upper A sharp. The first two frequencies are harmonious, and serve to complete the Major Triad, but the last two frequencies cause distinct discords with the fundamentals and their harmonics.

From the expression it is also seen that the coefficients of the sum and difference terms are all $\frac{3A^3}{4}$ whereas the coefficients of the third harmonic terms are $\frac{A^3}{4}$, or only one third as much. Here again the third harmonic frequencies are not objectionable unless they exceed 20 per cent, but the sum and difference frequencies, which are three times as strong, are at once noticeable because of the discordant results when some of them are combined with the fundamentals and the harmonics. It is for this reason that the '47 pentode must be operated under exactly the proper conditions to keep the cubed function of its characteristic as small as possible.

Photo Electric Cells

THESE photo electric tubes are the culmination of years of experimental research work conducted both in this country and abroad. They represent an attainment that in the past has been but a vision in the minds of physicists.

They have two zones of maximum sensitivity. The first extends into the near ultra-violet, peaking at approximately 3500 Angstroms but falling off rapidly below this point due to glass absorption. The second zone has a much broader peak extending into the red and infra red region and peaking from 7500 to 8500 Angstroms. The great sensitivity at this point taken in conjunction with the fact that radiation from an incandescent lamp source is largely in this region gives great overall sensitivity. The sensitivity of Speed Foto-lectric tubes to radiation from light sources ordinarily employed for talking pictures is of an extremely high order.

Because of the uniformly high sensitivity brought about by a special cathode treatment, it has been found practical to supply Speed Foto-lectric tubes with a somewhat higher ionizing voltage than that generally obtainable. This allows increased latitude in pickup adjustment, in addition to minimizing tube damage from accidental ionization during adjustment, while still retaining gain equivalent to that obtainable from other photo electric tubes at similar operating voltages. Standard Speed Foto-lectric tubes have an ionization voltage of 108 + 8 volts and are designed for operating at 90 volts. However, tubes having other operating voltages are regularly stocked and may be obtained without delay.

No photo electric tube should be operated at voltages above ionization for more than a few seconds, although these tubes will safely handle hundreds of microamperes for short periods without serious damage.

It is recommended that these tubes be protected against intense illumination or excessive heat, to avoid shortening of life. Under light of moderate intensity they will retain their sensitivity for long periods of time.

While the gas-filled photo-lectric tube is supplied as standard equipment, vacuum photo-lectric tubes may be obtained to special order in any of the illustrated types. Their sensitivity, however, is only a fraction of that obtained from gas-filled tubes and thus their use is restricted to applications where extreme constancy is of prime importance, such as quantitative measuring, etc. Particular attention has been given in the design of Speed Foto-lectric tubes to a sturdy anchored construction, insuring noiseless non-microphonic operation, free from transient disturbances.

Type B

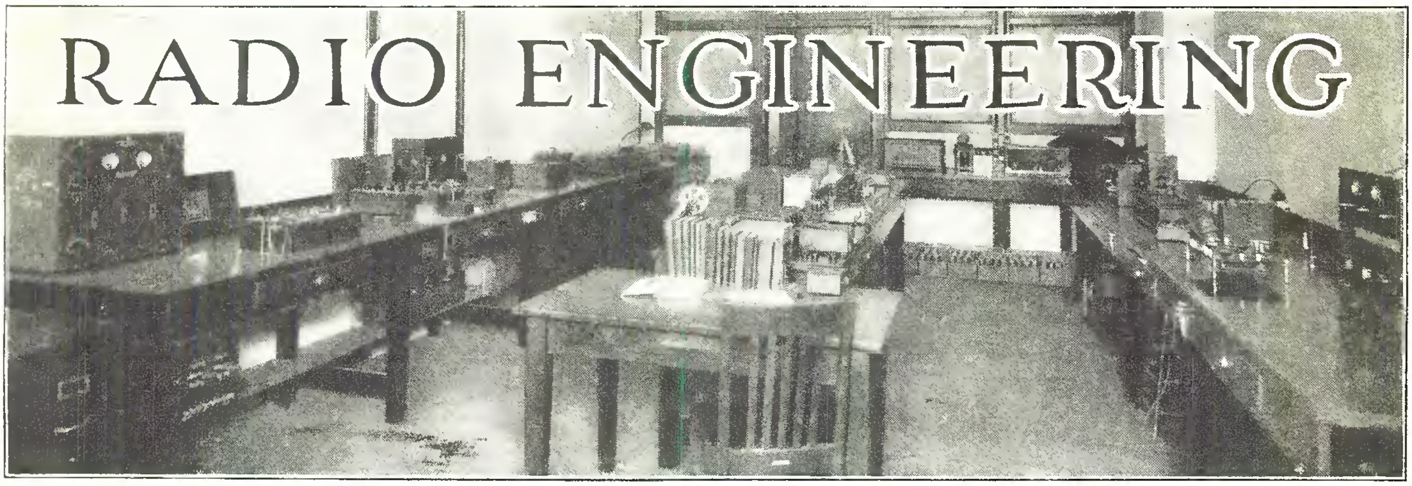
These tubes, without appreciable loss of sensitivity, have an expected life in excess of one year, provided they are not subjected to abuse. They are guaranteed against defects in workmanship or material for a period of six months from date of purchase.

Type A: small tubular 16 mm bulb supplied with flexible braided leads. (No base.) For use with DeForest Phonofilm, Biophone, Tobis-Klangfilm, Kinoplay. This tube should be mounted in the special cartridge supplied by equipment manufacturer.

Type B: tubular T8 bulb. Supplied with flexible braided leads. (No base.) For use with Weber Synchrofilm, Platter Phototone (old equipment), Duofone (old equipment), Sonofilm, Brel, Eastern Electric. This tube should be mounted in the special cartridge supplied by the equipment manufacturer.

Type D

Type D: tubular T12 bulb supplied with standard large 4 prong base. Base designation, 2 (D2) for use with Pacent, Powers Cinephone, Motiograph, Tone-o-Graph, Royal Amplitone, Universal, Gries (G. R. C.), Photophone Talkafilm (new equipment), Pulverman Royal, Saf-ray, Bell Portable, Douglas, Lincrophone, National.



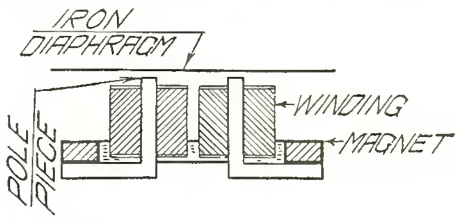
Sound Reproducers

SOUND waves may be defined as being more or less regular vibrations in material media. Such waves do not travel through a vacuum but will travel through solids and fluids, the most common of the latter being air, which is practically the universal carrier. In air, sound has a velocity of approximately 1100 feet per second. In other words, it travels a mile in a little less than five seconds. There are many factors which influence the velocity of travel, such as air density, pressure, humidity, etc. An interesting fact for comparing the velocity of sound with light is brought out in the following example. Suppose a symphony orchestra is being broadcast from a hall before an audience and a person 3000 miles away is listening to the program. Let us say that a person is sitting in the audience 100 feet from the orchestra and the former is sitting before his radio receiver, which is 3000 miles away, ten feet from the loudspeaker. Which hears the program first and how much sooner than the other?

First let us take the individual in the audience. As sound travels 1100 feet per second and he is 100 feet from the orchestra, it will take $\frac{100}{1100} = \frac{1}{11} =$ or .091 seconds for the sound to reach his ears, almost .1 of a second. Now let us consider the man who is listening to a radio receiver. Radio waves travel with the speed of light, i. e., 186,000 miles per second. It would then require $\frac{3000}{186000} = \frac{3}{186}$ $= .01613$ seconds to travel to the radio receiver. The path between the radio listener's ear and the loudspeaker would require a time interval of $\frac{10}{1100} = \frac{1}{110} =$ .0091 seconds in addition to the .01613 seconds or a total of .02523 seconds. Thus it would almost take four times the time for the person sitting before the orchestra to hear the program as it would the radio listener 3000 miles away from the orchestra by virtue of the difference in velocities of sound and electrical waves.

Sounds have three distinct qualities which make them different from each other. These are known as intensity, pitch and timbre. Intensity may be defined as the loudness of sounds which may distinguish one from another; pitch denotes the rate of vibration in cycles per second and hence a low or bass note has fewer vibrations per second than a high or treble note; timbre is probably the most interesting of the three characteristics and determines the quality of the note. It depends upon the harmonic content of the sound wave produced. The so-called overtones are all whole multiples of the fundamental or lowest rate of vibration. Thus a 500 cycle note may have overtones of 1000 cycles, 1500 cycles, 2000 cycles, etc. These overtones of various amplitudes determine the distinction between the note of an organ pipe and that of a violin when the fundamentals are all the same pitch and may have the same intensity. The variation in quality is also caused by the omission of certain of the harmonics, which determines the particular characteristic sound of the instrument.

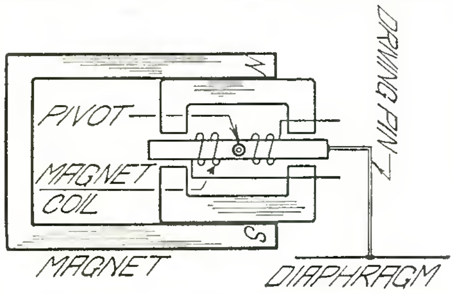
After demodulation and proper amplification of the audio signal in a radio receiver, some means must be employed to convert the electrical energy into sound energy. Present types require the intermediate stage of a conversion into mechanical energy, which is in turn converted into sound impulses. Very few are the engineers and technicians who did not clamp a pair of head phones over their ears and more or less satisfactorily catch fleeting phrases from the pioneer station KDKA "way back when." Even before this time head phones were used for continuous wave, interrupted continuous wave, and spark transmissions. In construction and operation the head phone is much like the ordinary telephone receiver. A permanent magnet presents its two poles to a



thin magnetic diaphragm. About the poles are many turns of enameled copper wire, finer than the average human hair. The reaction of variable or pulsating audio currents, first adding and then cancelling the constant flux of the permanent magnet, deflects the diaphragm, which sets up air waves known as sound. Such head phones are limited inherently by the magnet, the diaphragm, etc., which make good quality reproduction impossible as well as limiting the power handling ability. Think of the inconvenience of listening to a program with a constant pressure against the ears and also consider the expense of furnishing enough pairs of phones for a party!

A modification of the phone idea appeared in the horn type speaker, which was more convenient, of course, but which could handle no volume and give no quality. In both of these types the motion is limited by the pole pieces. Reaction of the flux is against the spring tension of the diaphragm, itself, and in these types low frequencies are invariably totally lost in the resulting reproduction. An increase in size of the unit combined with a properly designed exponential horn will make the speaker more satisfactory from the quality standpoint, but the old limitations still hold true for it.

Another variation may be found in the armature type speaker, of which there are at least two distinct styles. In this case a larger permanent magnet is used, and in place of an iron diaphragm, an armature is substituted, which is situated between the poles. Around this armature are found the coils which carry the audio currents, causing the reaction against the field set up by the permanent magnet. The armature is connected

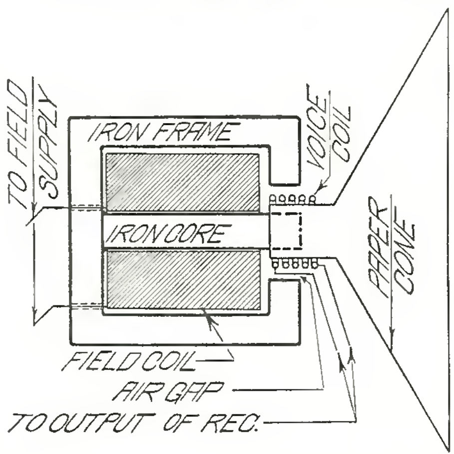


by a rigid member to a non-magnetic diaphragm, which in turn causes motion of the air column. An exponential horn is commonly employed and the quality of reproduction is improved over that of the iron diaphragm type speaker. It is also common practice, in fact, the most common practice in the magnetic speaker, to connect the armature through a lever system to the apex of a fairly heavy, stiff paper cone and thus transmit the magnetic movement to the cone, which in turn would set the air in motion as sound impulses. Better quality results but the output is limited by the motion of the armature which strikes the pole pieces when a definite amplitude is reached.

It might be well to consider the efficiencies of the types of reproducers so far considered. In speaking of efficiency, no account of the energy required to excite the magnetic circuit will be given and only the ratio of audio input to the sound output will be considered. All of the above types fall within the limits of about one-half of one per cent to two per cent, with only exceptional designs showing slight improvement over the latter figure. This immediately explains why power tubes are used in the output stage of radio receivers. Their need is apparent when it is seen that even with present-day speakers only one-twentieth of the audio power is finally transferred to sound energy.

The advent of the dynamic type speaker marked its immediate universal adoption, particularly on receivers operated from house lighting systems. Until very recently a portion of direct current was necessary to excite the field used on all of these reproducers. Instead of an armature or an iron diaphragm to transform the electrical energy to mechanical energy, this type employs a light weight single layer cylindrical coil, which is placed in a gap in the magnetic circuit, which is set up by a coil of many turns, having a direct current excitation. Such a system for any sensitivity at all must have a very small gap, which means only enough clearance between the coil and the metal to prevent actual rubbing contact. The so-called voice coil, which carries the audio current, reacts against the flux in the gap and transmits its motion to a paper or composition cone. This cone may be corrugated for stiffness and attached to the frame by means of a flexible strip around the periphery, though on some models it is attached rigidly.

The voice coils range from a single turn to perhaps as high as 200. It is evident, therefore, that some means must be used to make an impedance adjustment with regard to the tube or tubes used in the last audio amplifier. For this purpose a transformer known as the output transformer is commonly employed, having the proper step-down ratio. Ordinarily the types of speakers discussed before give an impedance to the load circuit of the output tube or tubes which is chiefly reactive and, therefore, give very noticeable peaks at various frequencies. Also the actual resonant frequency of the diaphragm or cone itself falls well within the



audible range. A dynamic speaker voice coil has only a small reactive component in its impedance, which makes the load practically a resistance, thus affording a nearly flat response for all audio frequencies and a close approach to the ideal. The voice coil's impedance ranges from 5 to 15 ohms for the various common types of dynamic speakers. In a given speaker the change in impedance is usually not more than 2 to 1, from 100 to 5000 cycles, whereas other type speakers would vary from 1000 to 50,000 ohms for the same audio frequencies picked.

As to efficiency, the very latest types of dynamics have been improved at least 100% during the past year or two, and now a good speaker may run as high as 5%. At resonance, which is usually made to fall above the hum frequency, the efficiency will run as high as 50% or 60%. Thus we now have a reproducer which gives excellent bass note response as well as highs, and we have one of greater sensitivity than was available heretofore. To make use of the low note response, a baffle is essential to the installation of all dynamic speakers to prevent sound waves from cancelling each other from the front of the cone to the back. Without a baffle there is no response below 300 or 400 cycles. The size of the baffle determines the lowest note which may be effectively reproduced, assuming the speaker itself is capable of transmitting this frequency by its inherent design. By the shortest mechanical path a baffle should be at least one-quarter of the wavelength to be reproduced. In other words, if a speaker is installed in a console which has no bottom, the path which governs the low note response is from the front of the speaker to the back via the bottom of the front panel of the console. It is also possible to install more than one speaker in a large baffle, such as for talkie theatre reproducers. Care must be taken that all cones move in the same direction, at the same time, for one being out of phase would prevent good response due to cancellation.

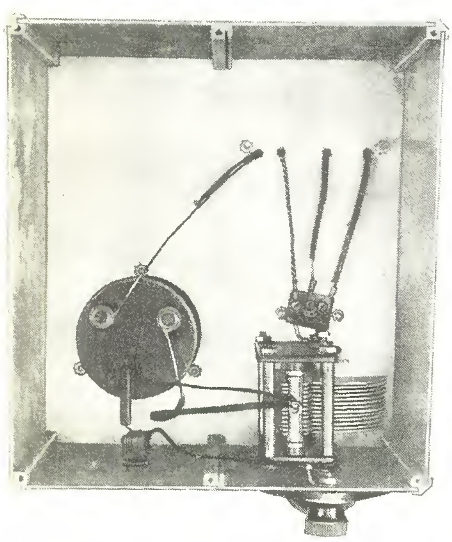
Newest developments in dynamics consist of the addition of a "bucking coil," which is made up of the required number of turns in series with the voice coil and placed in the field winding to "buck" or cancel any hum component introduced into the voice coil by a ripple present in the field coil. This addition in no way affects the response of the speaker itself. The very newest development on the market is a dynamic speaker which has a permanent magnet for the constant flux applied to the gap. This new speaker is in no way a magnetic speaker according to the old terminology, since the response is the same as that for a dynamic. It is entirely possible to duplicate the sensitivity of the separately excited dynamic, but the cost of the magnetic steel required to do this is prohibitive. Hence a metal having good magnetization powers is used so that the reduced response is only two decibels below that of the ordinary good dynamic type. Statements are made that not more than a two decibel loss will occur in five years.

A Service Wavemeter

WE present here a wavemeter which has proved almost indispensable to the author in all types of receiver alignment work. The range of this instrument is from approximately 130 kc to about 2000 kc, so that all intermediate frequencies and the broadcast band are covered, including the so-called long wave bands from 130 kc to 550 kc with only one coil and a single variable tuning condenser.

Cheap to Build

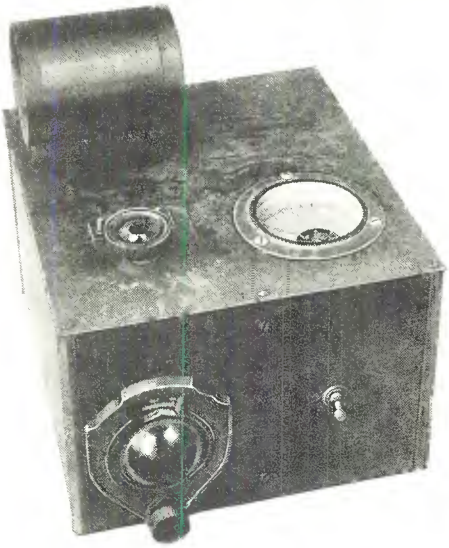
This instrument is very cheap and simple to build and for that reason does not represent the foremost possible design, but the service it renders is well worth the expenditure necessary in building it. The only real item of cost is the Weston model 425 thermogalvanometer used for resonant indications. To cover the frequency bands required, it was found necessary to tap the single inductance in two intermediate points, in addition to the entire coil. Some losses are naturally encountered, therefore, but sufficient indications can be procured under ordinary conditions so this does not merit serious consideration. A coil of No. 24 b. s. enameled wire about 3 inches long, wound on a tube of 2¾ inch diameter was used for the inductance. Taps are spaced about 1 inch apart, though the builder may



alter the spacing to give the overlap he desires on the frequency bands.

Ranges Covered

For intermediate frequencies a mica fixed condenser of the necessary capacity is shunted, by means of the switch shown at the right of the front panel, across the .0005 tuning condenser. Only two or three calibration points need be taken for this longest wave range (using the entire tuning inductance), since the dial setting-frequency curve is so nearly a straight line when using an SLF or modified SLF variable air condenser. The next range consists of the variable con-



denser only, in series with the whole inductance. This range will probably extend to about 700 kc or 800 kc. Next there is two-thirds of the coil with the variable condenser, and finally one-third of the coil with the variable condenser. As the inductance decreases and the frequency increases, more points must be taken to have an accurate calibration curve. A tap switch mounted on bakelite is used for selecting the proper inductance. In order to maintain a calibration which will hold for any length of time, it is imperative that all leads be of at least No. 16 copper wire and preferably No. 14 tinned copper, since the least movement or vibration will destroy the accuracy of the readings taken.

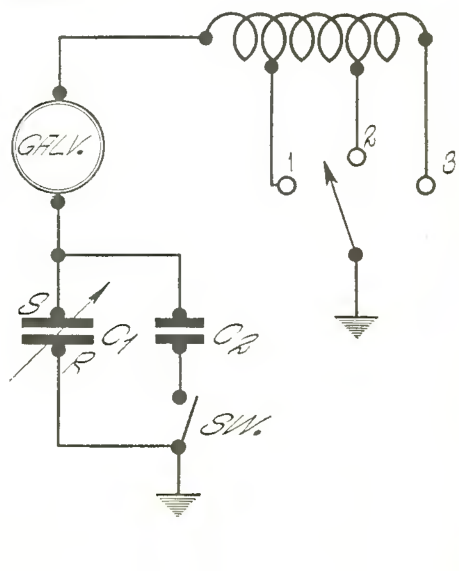
It is also highly advisable to use a good grade of collodion to fasten the turns of the coil and prevent them from becoming loose, in which case the calibration would be absolutely worthless. A coupling coil may be used to couple the signal to the wavemeter coil, but care must be taken to use only a very small indication to prevent the detuning effects occurring with tight coupling.

An inexpensive aluminum box shield was used as a housing for this wavemeter. Also, any vernier type dial may be used and any good SPST switch. A schematic diagram at the bottom of column 3 shows the simplicity of the circuit layout. The shield is used as the common ground for the switch, tuning condenser, and padding condenser.

Calibration

Probably the best method of calibrating this wavemeter is to use an oscillator which covers the band of intermediate frequencies, in conjunction with a broadcast receiver. For example, the 175 kc calibration point may be quite accurately determined by adjusting the oscillator near the point known to be in the neighborhood of 175 kc and obtain zero beat with a broadcast signal of dependable frequency. The author used WLW on 700 kc, obtaining a beat of the fourth harmonic of 175 kc.

As the frequency becomes higher, the task is simplified. In the broadcast band no trouble will be had in using a broadcast oscillator and zero beating if the fundamental frequencies of the stations employ crystal frequency control. In all cases the coupling to the local oscillator should be very loose. It is recommended in all work, including calibration, that the indication on the 425 galvanometer does not exceed two or three whole scale divisions to prevent any drag effects.



Sound Films and Television Broadcast

(*Continued from page* 17)

period of time than that required to create an impression on the human visual system. To maintain such unbroken continuity, the inventor controls the operation of the two Geneva movements by means of a cam which automatically selects certain frames out of each unit of 48 consecutive pictures so that the film runs at its normal speed of 24 frames per second.

For example, with "A" designating film No. 1 and "B" designating film No. 2, the following pictures out of a cycle of 48 are scanned successively in this order: 1A - 2B - 5A - 6B - 8A - 9B - 11A - 12B - 14A - 15B - 17A - 18B - 20A - 21B - 23A - 25B - 26A - 29B - 30A - 32B - 33A - 35B - 36A - 38B - 39A - 41B - 42A - 44B - 45A - 47B. Because the film moves forward at the regular rate of speed, 24 frames per second, the sound recorded on the film is reproduced without distortion by using the ordinary photo-cell system.

The perfection of the Western Television apparatus by Conto marks an important step in the development of Television. It is to be looked upon as a means to enable television station operators to present programs that are both interesting and entertaining. At the same time it removes that bugbear of having to develop special moving picture apparatus to produce pictures in the moving picture studios to correspond to the scanning methods employed in the Television stations.

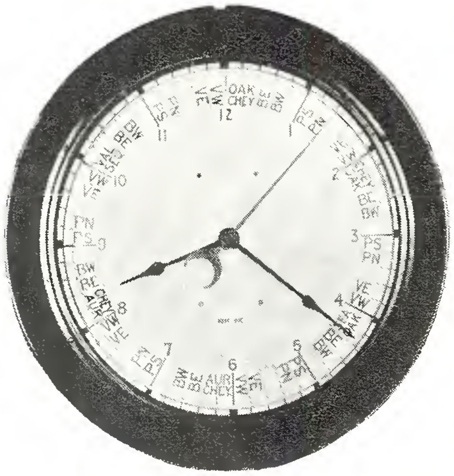
Television Note

TO determine definitely the pulse of the public regarding television, a rather unique idea was carried into effect by A. Pollak, President of the Television Manufacturing Company of America. A temporary store was rented in the Hollywood Theatre Building, 52nd Street and Broadway, New York City for a period of six weeks. Under very capable management free demonstrations of the "SEE-ALL" Television products were conducted daily, day and night, and it is estimated that a half million people obtained their first actual view of television. So vast was the attendance that at times traffic was blocked and it was necessary to lock the doors to keep in check the ever increasing numbers eager to learn about television. Although this store was located in one of the most highly electrically charged zones of New York due to the mass of electrical advertising signs which make up the district, the pictures obtained were exceptionally clear and pleasing.

Two types of "SEE-ALL" models were demonstrated—one a complete cabinet showing a picture on a screen about 6x9 inches and also a "SEE-ALL" Television assembled from one of the inexpensive kits now being marketed to experimenters by this company. Considerable time was spent by Mr. Pollak personally at this demonstration and much valuable information gathered which will be reflected in the 1932 line of "SEE-ALL" Television Cabinets. The wide range of models and prices of this line to be announced very shortly will place television within the means of everybody.

Radio Control and Aeroplanes

SIMPLIFIED radio controlled airplane movements have been developed to the point that the busiest airway radio station in the world,



WUCG, maintained at Chicago Municipal Airport by United Air Lines, can serve twenty-four mail and passenger planes of United Air Lines arriving and departing daily at the Chicago Airport, as well as exchange messages between the other thirty-four stations on United Air Lines' system extending from the Atlantic to the Pacific, from the Great Lakes to the Southwest, from the Rocky Mountain region to the Pacific Northwest and the length of the Pacific Coast. This marks a new step in controlling airplane movements, says a bulletin.

All passengers and mail planes of United Air Lines are equipped with two-way radio telephone, which permits the pilot to talk from his plane to ground stations or to pilots of other planes in flight. However, as United Air Lines never has less than twelve and often as many as eighteen planes in simultaneous flight, some method had to be developed for assigning each pilot a moment when he could 'phone into the ground station and receive instructions and weather from the dispatcher.

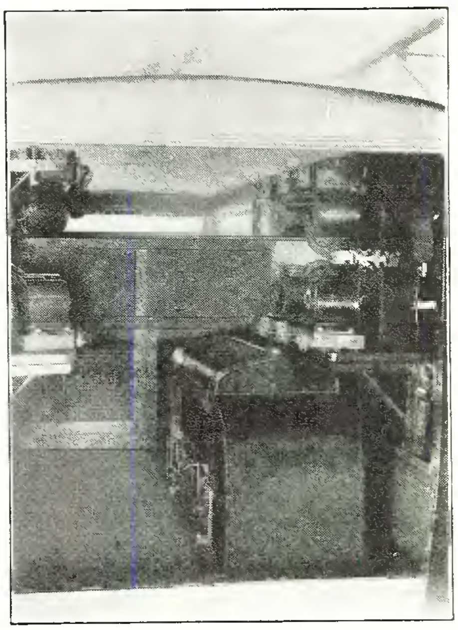
So a synchronized clock face was developed. It measures about eighteen inches in diameter; around the rim the minute segments are lettered at one or two-minute intervals with the abbreviation of a division of the airline. The minute hand successively designates the portion of the line over which radio communication is to be permitted, thus eliminating the possibility of garbling messages because of two or three conversations being attempted at the same time.

Thus, in any one hour there are four times when conversation may be held with planes on each section of the entire division, once every fifteen minutes. In addition there is one blank minute in every five-minute period for emergency communication or calls of a non-routine nature, and there is a two-minute period in each ten minutes during which direct station-to-station communication is permitted. Since each airline is assigned but a single frequency upon which to broadcast, it is apparent that, with the great range of the present sending and receiving sets, some such system is essential to successful communication.

One of these stations exchanges direct radio communication with pilots of twenty-four planes arriving and departing from one airport, as well as exchanging messages between the other thirty-four ground stations on United Air Lines' system.

Sound on Trucks

IN conjunction with the article in the January issue under the same title, on page 37, the illustration shows



another typical speaker and power plant installation for a portable power amplifier system by the RCA-Victor Company.

Long Line Frequency Control

WHAT constitutes the first practical employment of ultra-short radio waves, which for many years have remained one of the curiosities of radiotelegraph experimental work, has been accomplished with the establishment of the new, inter-island radio telephone system of Hawaii.

The development is regarded as an important milestone of radio, as it taps an altogether new reservoir of wave lengths for commercial utilization. Such an ultra-short wave communications system lends itself to duplication in other archipelago, and particularly in those of the tropical regions. For this and similar short distance communication purposes the ultra-short waves provide definite advantages in reliable, continuous communication, although the efficiency of frequencies now employed for long range communication remains unchallenged.

Attempts to establish inter-island telephone service for Hawaii were begun by the Mutual Telephone Company in 1912, when a survey disclosed that the channels between the islands were too deep to make the use of cables for voice communication practicable. The successful system eventually was established through the cooperation of RCA engineers with the Mutual Company, which called upon R. C. A. Communications, Inc., for assistance following extensive research and experimental work by RCA in the ultra-short wave field.

At the time RCA engineers were brought into consultation, in 1928, experiments had been conducted in Hawaii over a period of years on various frequency bands open for use by the telephone company. However, the spectrum of intermediate and the so-called "normal band" of short waves had been abandoned because of the selective fading and strong atmospherics experienced. It was quickly found that transmission on the ultra-short waves would convey telephone conversation with reliability over the required distances but many problems remained for solution before a practical system could be developed.

Ultra-short waves have many of the properties of light waves, which do not tend to follow the curvature of the earth. In the Hawaiian system they are transmitted from point to point on the same plane, without intervening mountains or other intervening obstacles. This condition was met by locating the Hawaiian stations on top of the mountains and in a direct air line with stations on the mountain peaks of other islands. Mathematically exact surveys were conducted so as to permit a perfect alignment of sending and receiving antennae at the different stations.

Although ultra-short waves provided, in this instance, the solution to transmission through the ether without static or interference, the apparatus which generated the waves was extremely critical of adjustment. A transmitter on so short a wave length is subject to "frequency drift" or shifting of wavelength, from very slight causes. Even so small a factor as a change in atmospherie temperature would throw it off the appointed wave. This had to be overcome, else the constant attention of trained engineers would be required to keep the stations "in tune" and even then interruptions to the service would be inevitable.

The usual engineering method of maintaining a transmitter on its assigned wave is by means of electric crystal control. But this necessitates much associated apparatus and, in the case of ultra-short waves, so much additional equipment as to place the cost of operation beyond all reasonable limits. RCA engineers solved this difficulty with a new development known as the Long Line Frequency Control. This is an electrical circuit, with no tubes and no moving parts, connected to the five meter transmitting circuit. The action of the Long Line Frequency Control is to correct automatically and entirely by electrical means any tendency of the transmitter to stray from its proper wave length. Through its employment, the apparatus is lifted out of the category of critical, laboratory equipment and made practical for commercial use. The Long Line Frequency Control makes possible installations which need only periodic attention and otherwise maintain telephone communication between islands as dependably as though they were connected by wires. Equipment for the new system was supplied by RCA Victor Company.

The possibilities of ultra-short waves have for some years been a subject of speculation and investigation among radio engineers. Pioneering research in this field has been done by Marconi, both in his independent efforts and in cooperation with the Italian Government. RCA began experiments several years ago. The ultra-short wave band is generally listed in present day parlance as that part of the radio spectrum which extends from five meters downward. There appears to be little or no difference in the essential properties of these frequencies except that they present more problems in control as the wave length shortens. Research among other frequencies in the realm of ultra-short waves has been and is being conducted at the R. C. A. Communications laboratories at Riverhead and Rocky Point, Long Island. It is believed that the principles of the Long Line Frequency Control will prove of great value in the taming of even the shorter of the ultra-short waves. The Long Line Frequency Control is so named because the electrical circuit which constitutes this device comprises lines having a length many times the length of the wave on which the transmitter operates.

The Hawaiian radiotelephone system is a tribute to the efforts and persistence of J. A. Balch, President of the Mutual Telephone Company, who pushed forward continuous experimental work on the islands. Of its operation, Mr. Balch reported that on the day the new system was opened for commercial traffic a total of 213 calls were handled without a single instance of a call having to be cancelled on account of unsuccessful transmission. During the first week of commercial service the islands were visited by a severe static storm, described by Mr. Balch as one of the worst in his experience, with lightning flashing almost continually for the better part of two days and nights. "No difficulty was experienced, however, in the operation of our ultra-frequency telephone circuits," said Mr. Balch, "and it was a weird experience to be watching the lightning flashing and at the same time talking to Hilo without difficulty, or without any particular annoyance being experienced from the very faint indications of static on the circuit."

The system links the islands of Hawaii, Kauai, Oahu and Maui. A radiotelephone service in which the Mutual Telephone Company is interested between Hawaii and the North American mainland will be opened probably before Christmas this year. For the mainland service, transmitting and receiving stations in Hawaii will be owned and operated by the R. C. A. Communications, Inc., and the transmitting and receiving stations in California will be owned and operated by the American Telephone and Telegraph Company. Connection to the Hawaiian land telephone network as well as to the new, inter-island radiotelephone service will be made through the Mutual Telephone Company.

Television on a Beam of Light

SCHENECTADY, Dec.—Television, transmitted experimentally on a beam of light, utilizing a wave length of but a billionth of a meter, has been successfully demonstrated here in the radio consulting laboratory of the General Electric Company it was announced today by Dr. E. F. W. Alexanderson. This use of the ultra-short waves, Dr. Alexanderson believes, opens the way to a new and valuable era in the art and promises to result in more distinct television pictures.

In the laboratory tests, the pickup device was of the conventional type such as used by Dr. Alexanderson in his previous television experiments. Instead of the electrical impulses being fed into a radio transmitter as heretofore, they were modulated into extremely high frequencies on a light beam from a high intensity arc. This beam was projected the length of the laboratory into a single photoelectric tube, which transposed the modulated light waves back into electrical waves. The electrical impulses reproduced the image by means of an ordinary television receiver.

"The work thus far is highly experimental, yet some day we may see television broadcast from a powerful arc light, mounted atop a single tower high above the city," Dr. Alexanderson said. "These modulated light waves will be picked up in the homes by individual photoelectric tubes or electric eye, instead of the present type wire antennae.

"Light broadcasting may have the same relation to radio broadcasting as the local newspaper has to the national newspapers. These light waves can be received at relative short distances only, perhaps ten miles. Each community could then have its light broadcasting system."

The greatest difficulty in television today, Dr. Alexanderson believes, is in the method of transmission. Radio waves usually follow several paths in travelling from the transmitter to the receiving station. Each ray following a different path produces a different image so that a composite image is apt to be blurred. For this reason television has been tending toward shorter waves.

"The logical progress of this development," said Dr. Alexanderson, "is that in the future we shall explore still shorter waves, until we finally arrive at the light waves which we know travel in straight lines and which can be accurately controlled by such optical means as mirrors and lenses.

"When it was decided to take up experimentation on this subject Dr. Irving Langmuir of the research laboratory was consulted about the probabilities of being able to modulate to a source of light at the required high frequencies of from 100,000 to a million cycles. Dr. Langmuir, who has done much research work with arcs, believed that this could be accomplished by using a high intensity arc. It was concluded that a most desirable light would be a high-intensity arc of the type where the light comes from the arc rather than from the crater. In the 10-ampere arc lamp used for the first test, most of the light comes from the crater, and comparatively little light is in the arc. The lamp was used in such a way that the light from the crater was eliminated, and the arc used was therefore quite a weak source of light. The current from our standard television pick-up was superimposed upon this arc, and the light from the arc intercepted by a photoelectric tube at a distance of 130 feet. The photoelectric tube was then used to control our regular television projector. The television image transmitted in this way had the same sharpness of detail as the one ordinarily obtained without the interposition of the light beam.

In 1927 a picture three inches square on the screen was achieved by Dr. Alexanderson; in 1928 the first radio-television drama was broadcast from Schenectady; in the fall of 1929 a picture 14 inches square, not simply black and white like a silhouette but with all the gray shades for depth and detail, was produced; in 1930 Dr. Alexanderson sent television signals to Australia and back, and after traveling 20,000 miles, a rectangle still had four corners; and in the same year television first appeared as part of a regular performance at a theater in Schenectady with an image on a screen seven feet square.

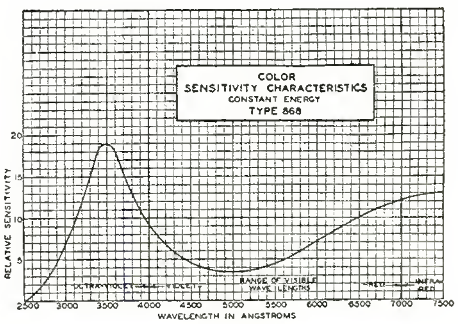
Modulated light has also been used in many previous experiments by the General Electric Company. For instance, there is the talking beam of light that has been used at meetings and convention demonstrations, and the ship-to-shore communication of last summer with a talking light beam.

Similarly, various other radio and pure research findings of other General Electric scientists are reflected in the new experiments with light-transmitted television. For instance, there is the work of Dr. Langmuir and W. F. Westendorp with a fog-penetrating light for aviation, wherein it has been demonstrated that a photoelectric tube is sensitive to modulated light even if the atmosphere is so foggy or hazy that the light source cannot be seen. This had led to the belief, that in event of local broadcasting with modulated light, haze and fog will not seriously interfere with signal reception.

868 Type Phototube

(*Continued from page* 30)

cylindrical sheet of metal and is coated with a thin film of caesium. The anode or collector consists of a small wire placed in the axis of the cathode surface. A small amount of gas is used in this tube to produce high sensitivity. The 868 is sensitive to light over the entire visible spectrum and



also to radiation in the near infra red zone. The large response in the red and infra red region makes this tube very well adapted to sound reproduction and television work where incandescent lamps are used for light sources.

Ordinarily, the output of an 868 requires further amplification. This may be accomplished by a suitable tube amplifier resistance coupled to the Phototube circuit.

Plans of the RMA to coordinate its annual convention and trade show next May with the national political campaign have proven successful. In anticipation of the presidential campaign and its probable great stimulus to radio sales, the arrangements for the RMA annual industry gathering and trade show, May 23-26, 1932, in Chicago, now will insure three weeks' time for the radio industry to take advantage of politics to make sales. The Republican national convention will be held June 13th at Chicago, just three weeks after the RMA trade show, and the Democratic national convention is scheduled July 1st.

Receiver Voltage Analyses

Zenith 91, 92

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
51	1st R. F.	2.25	175	.2	0	7.0	100
51	1st Det.	2.25	175	3.5	.4	3.5	90
27	Osc.	2.2	70	0	0	8.5	0
51	I. F.	2.2	200	4.0	0	2.5	115
27	2nd Det.	2.2	115	0	9.	.5	0
27	1st Aud.	2.2	145	0	13.	6.5	0
45	P. P.	2.2	275	54	0	30.	0
45	P. P.	2.2	275	54	0	30.	0
24	A. V. C.	2.2	35	.4	0	0	54
80	Rect.	4.8	355	0	0	76.	0

General Electric K-62

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
35	R. F.	2.2	205	.1	2	5	75
27	Osc.	2.2	60	0	8	5	
24	1st Det.	2.2	200	7	7	.5	70
35	I. F.	2.2	205	.1	2	5	75
27	A. V. C.	2.2	25	0	0	0	
27	2nd Det.	2.2	180	8	20	.5	
47	P. P.	2.2	205	10		25	210
47	P. P.	2.2	205	10		25	210

Crosley 125

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
24	Osc.-Det.	2.45	175	10			80
35	I. F.	2.45	220	2.3			80
24	2nd Det.	2.45	80	4.5			25
47	Output	2.55	215	16			
80	Rect.	4.95					

Silver-Marshall J

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
51	R. F.		220		3		76
24	1st Det.		220		15		76
27	Osc.		76		15		
51	I. F.		220		3		76
51	I. F.		220		3		76
27	2nd Det.		0				
27	Audio		190		18		
47	P. P.		225	16.5			
47	P. P.		225	16.5			
80	Rect.		320				

Westinghouse WR15

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
35	R. F.	2.2	205	.1	2	5	75
27	Osc.	2.2	60	0	8	5	
24	1st Det.	2.2	200	7	7	.5	70
35	I. F.	2.2	205	.1	2	5	75
27	A. V. C.	2.2	25	0	0	0	
27	2nd Det.	2.2	180	8	20	.5	
47	P. P.	2.2	205	10		25	210
47	P. P.	2.2	205	10		25	210

Stewart-Warner R-102 A, B, E

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
24	1st Det.	2.45	250	6.5			95
27	Osc.	2.45	95	9			
51	I. F.	2.40	250	3			95
24	2nd Det.	2.45	70	7			30
47	Output	2.45	230	15			250
80	Rect.	4.8	170				

Receiver Voltage Analyses

Crosley 127

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
35	R. F.	2.4	185	3			85
35	1st Det.	2.4	185	8			85
27	Osc.	2.4	185	10			
35	I. F.	2.4	185	3			85
24	I. F.	2.4	185	3			85
27	2nd Det.	2.4	0	0			
27	Aud.	2.4	185	10			
47	P. P.	2.4	285	16			
47	P. P.	2.4	285	16			
80	Rect.	4.8					

Sparton 15

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
35	R. F.	2.5	185	3		6	100
35	1st Det.	2.5	180	11		3	100
35	I. F.	2.5	185	3		6	100
27	Osc.	2.5	95				
27	2nd Det.	2.5	135	14		.7	
27	A. V. C.	2.5	40	24			
47	Output	2.5	260	18		36	270
80	Rect.	5·	370			55	

T.C.A.-Clarion 80, 81

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
51	R. F.	2.2	233	3	3	5	66
51	1st Det.	2.2	233	7	7	2.3	73
27	Osc.	2.2	80	0	0	4	
51	I. F.	2.2	233	3	3	5	77
24	2nd Det.	2.2	162	6.2	7.2	.5	73
47	Output	2.2	228	15	0	27	233
80	Rect.	4.8				50	

Stromberg-Carlson 19, 20

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
35	R. F.	2.4	150	3.3	3.3	3.3	80
35	1st Det.	2.4	140	12	12	1.1	66
27	Osc.	2.4	75		7	1.1	
35	I. F.	2.3	140	3.6	4	7.4	71
35	I. F.	2.3	140	3.6	4	7.4	74
27	2nd Det.	2.3	185		26	1.0	
45	P. P.	2.4	245	46		30	
45	P. P.	2.4	245	46		30	
80	Rect.	4.6				58	

Gulbransen 23

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
35	R. F.		181				90
35	1st Det.		179				84
27	Osc.		92				
35	I. F.		181				90
35	I. F.		303				86
27	1st A. F.		115				
47	Output		240	17			252
80	Rect.		356			118	

Kennedy 56

Tube	Position	Fil. Volts	Plate Volts	Grid Volts	Cath. Volts	Plate Ma.	S. G. Volts
51	R. F.	2.35	208	3–30			98
24	1st Det.	2.35	208	5			30
27	Osc.	2.35	90	10			
51	I. F.	2.35	208	3–30			98
27	2nd Det.	2.35	120	16			
47	P. P.	2.35	220	14			208
47	P. P.	2.35	220	14			
80	Rect.	4.9					

Set Manufacturers and Brand Names

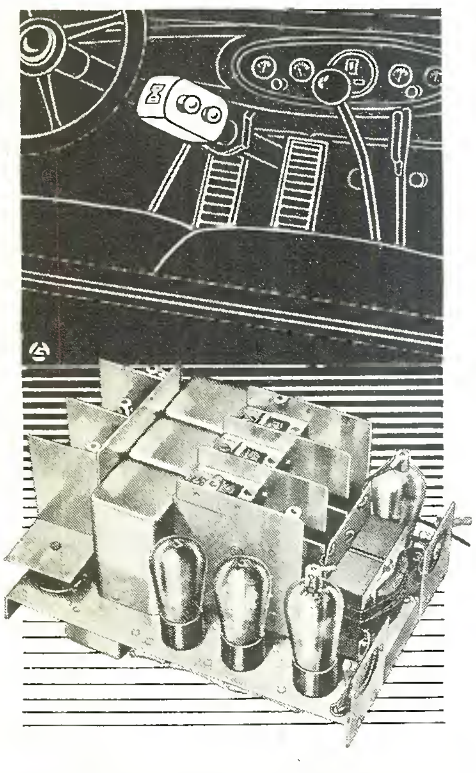
Manufacturer	Address	Brand
All-American Mohawk Corp.	North Tonawanda, N. Y.	Lyric
Andrea, F. A. D., Inc.	Long Island City, N. Y.	Fada
Atwater-Kent Mfg. Co.	4700 Wissahickon Ave., Philadelphia	Atwater-Kent
Audiola Radio Co.	430 S. Green St., Chicago	Audiola
Automatic Radio Mfg. Co.	112 Canal St., Boston, Mass.	Tom-Thumb
Aztec Radio Co.	Atchinson, Kans.	Aztec
Balder Radio Corp.	80—4th Ave., New York City	Balder, Knickerbocker
Balkeit Radio Co.	North Chicago, Ill.	Balkeit
Belmont Radio Co.	39th & Ashland Pl., Chicago	Belmont
Brown & Manhart Co.	6219 S. Hoover St., Los Angeles, Calif.	Roamer
Browning-Drake Corp.	West Townsend, Mass.	Browning-Drake
Brunswick Radio Corp.	120 W. 42nd St., New York City	Brunswick
Capehart Corp.	Fort Wayne, Ind.	Capehart
Carteret Radio Laboratories, Inc.	254 W. 18th St., New York City	Carteret, Moto-Radio
Century Radio Products Co.	3007 N. Austin, Chicago	Century
Clago Radio Corp.	2909 Indiana Ave., Chicago	Mayflower
Colonial Radio Corp.	254 Rano St., Buffalo, N. Y.	Colonial
Columbia Phonograph Co.	55—5th Ave., New York City	Columbia
Commonwealth Radio Mfg. Co.	847 W. Harrison, Chicago	Ajax, Commonwealth
Crescent Radio Mfg. Co.	1026—2nd Ave., Minneapolis, Minn.	Crescent
Crosley Radio Corp.	Cincinnati, Ohio	Crosley
Davison-Haynes Mfg. Co.	717 Mateo St., Los Angeles	Angelus
Delco Radio Corp.	Dayton, Ohio	Delco
Dubilier Clock Corp.	40 W. 17th St., New York City	Dubilier
Echophone Radio Mfg. Co.	104 Lake View Ave., Waukegan, Ill.	Echophone
Electrical Research Lab.	1731 W. 22nd St., Chicago	Erla
Elgin Radio & Tel. Corp.	41 W. 14th St., New York City	Elgin
Federal Radio Corp.	717 Mateo St., Los Angeles, Calif.	Federal Orthosonic
Fink Industries	706 Sheridan St., Lansing, Mich.	Imperial
Freed Television & Radio Corp.	Long Island City, N. Y.	Freed, Freed-Eiseman
French, Jesse, & Sons Co.	New Castle, Ind.	Jesse French
Frost-Minton Corp.	12 E. 41st St., New York City	Frost-Minton
Galvin Mfg. Co.	857 Harrison St., Chicago	Motorola
General Electric Co.	Bridgeport, Conn.	General Electric
General Motors Radio Corp.	Dayton, Ohio	General Motors
Gilfillan Bros., Inc.	1815 Venice Blvd., Los Angeles, Calif.	Gilfillan
Grand Rapids Radio Mfg. Co.	Grand Rapids, Mich.	Gypsy
Graybar Elec. Co., Inc.	Graybar Bldg., New York City	Graybar
Grebe, A. H., & Co., Inc.	70 Van Wyck Blvd., Richmond Hill, N. Y.	Grebe
Grigsby-Grunow Co.	5801 Dickens Ave., Chicago	Majestic
Gulbransen Co.	816 N. Kedzie Ave., Chicago	Gulbransen
Halson Radio Mfg. Corp.	49 Lispenard St., New York City	Halson
Herbert H. Horn	1629 S. Hill St., Los Angeles, Calif.	Tiffany-Tone
Howard Radio Co.	South Haven, Mich.	Howard
Insuline Corp. of America	27 Park Pl., New York City	Envoy
International All-Wave Corp.	510—6th Ave., New York City	Duo
Jackson-Bell Co.	5600 McKinley Ave., Los Angeles, Calif.	Jackson-Bell
Jackson Research Lab.	Malden, Mass.	Jackson
Kaemper-Barrett Corp.	871 Folsom St., San Francisco, Calif.	Radiette Troubadour
Keller-Fuller Mfg. Co. Ltd.	1573 W. Jefferson, Los Angeles, Calif.	Radiette
Kennedy, Colin B., Corp.	South Bend, Ind.	Kennedy
Kolster Radio Corp.	67 Broad St., New York City	Kolster
Leutz, C. R., Inc.	2700 Industrial Ave., Altoona, Pa.	Leutz
Lincoln Radio Corp.	329 S. Wood St., Chicago	Lincoln
Los Angeles Radio Mfg. Co.	3683 S. San Pedro St., Los Angeles, Calif.	Los Angeles
Midwest Radio Corp.	909 Broadway, Cincinnati, Ohio	Midwest
Minerva Radio Co.	10 N. Clark St., Chicago	Minerva
Mission Bell Radio Co.	1125 Wall St., Los Angeles, Calif.	Mission Bell
National Co., Inc.	Malden, Mass.	National
Ozarka, Inc.	1257 Fullerton Ave., Chicago	Ozarka, Viking
Patent Dev. Co.	South Bend, Ind.	Wren
Patterson Radio Co.	239 S. Los Angeles St., Los Angeles	Patterson
Perry Products, Inc.	150 W. 22nd St., New York City	Perry
Philadelphia Storage Battery Co.	Ontario & C Sts., Philadelphia, Pa.	Philco
Pierce-Airo, Inc.	510—6th Ave., New York City	Dewald
Pilot Radio & Tube Corp.	Lawrence, Mass.	Pilot
Premier Elec. Co.	Grace & Ravenswood Ave., Chicago	Premier
Radio Mfgrs. Corp.	3900 N. Claremont Ave., Chicago	
RCA Victor Co., Inc.	570 Lexington Ave., New York City	Radiola
Remler Co., Ltd.	2101 Bryant St., San Francisco, Calif.	Remler
Revere Mfg. Co.	Mansfield, O.	Revere
Royal Radio Mfg. Co.	2482 University Ave., St. Paul, Minn.	Royal
Savil Mfg. Co.	73 Grand St., New York City	Savil
Scott, E. H., Radio Lab.	4150 Ravenswood Ave., Chicago	Scott
Service Elec. Co., Ltd.	Indianapolis, Ind.	Service
Silver-Marshall, Inc.	6401 W. 65th St., Chicago	Silver-Marshall
Simplex Radio Co.	Monroe & King Sts., Sandusky, Ohio	Simplex
Sparks-Withington Co.	Jackson, Mich.	Sparton
Steinite Mfg. Co.	Ft. Wayne, Ind.	Steinite
Sterling Mfg. Co.	2831 Prospect Ave., Cleveland, Ohio	Sterling Concertone
Stewart-Warner Corp.	1824 Diversey Pkwy., Chicago	Stewart-Warner
Story & Clark Radio Corp.	173 N. Michigan Ave., Chicago	Story & Clark
Stromberg-Carlson Tel. Mfg. Co.	Rochester, N. Y.	Stromberg-Carlson
Transformer Corp. of America	Keeler & Ogden Ave., Chicago	Clarion
Trav-Ler Mfg. Co.	1818 Washington Blvd., St. Louis	Trav-Ler
Trojan Factories, Ltd.	5862 S. Hoover St., Los Angeles, Calif.	Trojan
United Air Cleaner Corp.	9705 Cottage Grove Ave., Chicago	Sentinel
United American Bosch Corp.	Springfield, Mass.	Bosch
Universal Auto-Radio Corp.	1223 S. Michigan Ave., Chicago	Universal
U. S. Radio & Television Co.	Marion, Ind.	Apex, Gloritone
Waltham Radio Corp., Ltd.	4228 S. Vermont Ave., Los Angeles	Waltham Utility
Ware Mfg. Co.	480 Lexington Ave., New York City	Ware
Westinghouse Elec. & Mfg.	150 Broadway, New York City	Westinghouse
Zenith Radio Corp.	3620 Iron St., Chicago	Zenette, Zenith

NEW PRODUCTS FOR THE TRADE

Motomaster Superheterodyne

Motomaster announces its 1932 seven tube superheterodyne autoradio, which it states has the efficiency of a nine tube set, built on a shock-proof Eraydo chassis, using a special alloy container to completely protect and shield its parts, eliminating motor interference and insuring continuous perfect performance.

The Motomaster superheterodyne has three multi-mu 235s, two screen grid 224s, one 227, and one 247 pentode. They state for the first time a



superheterodyne has been developed to perform satisfactorily in automobiles, giving coast to coast reception, with an ample reserve of power, and ten kilocycle selectivity and tone quality to surpass the average home set in performance, including a newly perfected automatic volume control to eliminate surging, fading and broadcasting inequalities.

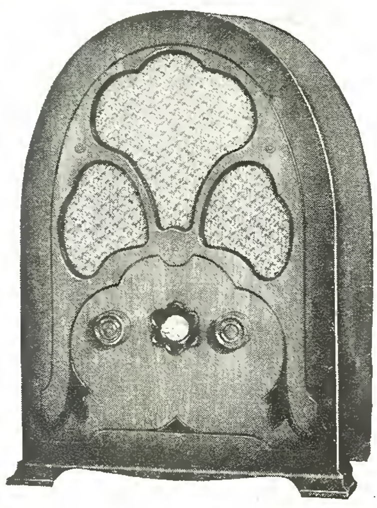
The electro-dynamic speaker, designed for the Motomaster superheterodyne, synchronizes perfectly with the output of the receiver. The mounting is simplicity itself, requiring one hole for center mounting or three holes for side mounting.

The remote control with lock-switch and key is mounted on the steering column to give maximum accessibility. The station selector is electrically illuminated and, with the manual volume control, is encased in a silvery, chromium-plated housing. This affords finger tip control of station selection and volume.

General Motors Little Corporal

A six-tube superheterodyne receiver, priced at $39.50, has been announced by the General Motors Radio Corp., Dayton, Ohio. The new receiver is known as the Little Corporal.

Both the new variable mu and the pentode tubes are used in this new set.



A 224 tube is used as the first detector with a 227 as an oscillator and a 235, or variable mu tube, in the radio frequency circuit. The second detector is a 224 tube with a 247, or pentode tube, in the audio circuit, greatly increasing the performance through its ability to perform the work of practically three tubes. A full wave 280 rectifying tube completes the tube complement.

The manufacturer states ease in tuning is obtained through use of a vernier drive on the tuning dial, which is of the arc type, while complete volume control is obtained through a combination volume control which controls the amplification of the receiver as well as the input to the antenna circuit. By this method, overloading is prevented if the set is used near a powerful station. The off-and-on switch is operated by the volume control knob, a slight turn to the right switching on the current and placing the volume control in position ready for operation. The 6-inch speaker is of the dynamic type and is matched to the receiver and cabinet to give the maximum range of reproduction.

The "Little Corporal" is housed in a walnut-finished cabinet, outlined with an ebonized pattern. The dial is in the center, flanked on either side by the tuning and volume control knobs, and set off with a rosette pattern. With a height of only 15 inches, a width of 11 inches and a depth of 8 inches, the Little Corporal may be moved easily from place to place.

Motor Radio Suppressor Kits

Electrical noises generated by the electrical system of the automobile and interfering with the enjoyment of the automobile radio set may now be eliminated by the installation of a kit of I. R. C. units for installation in the spark plug leads and in the main distributor lead, together with comprehensive and complete directions on the use of filter condensers and the proper adjustment of the electrical compo-

(*Continued on next page*)

nents for complete noise elimination. The directions are complete in folder form for the service man. The kits are available for four, six, and eight cylinder automobiles, with resistors packed in a carton. Individual suppressors are available if desired.

In meeting the requirements of motor radio suppressors, the engineers of the International Resistance Co., Philadelphia, Pa., have developed units to fit most makes of cars. These units are moisture-proof because of impregnation with a special compound. They are shock-proof, with terminals designed to withstand severe vibration. The resistor is imbedded in a high-grade ceramic tubing which is unaffected by heat and non-combustible. The units have an exceptionally low capacity, less than ½ mmf, permitting the choking out of ultra short waves and eliminating all spark plug noise. They make positive contact and have a long service life.

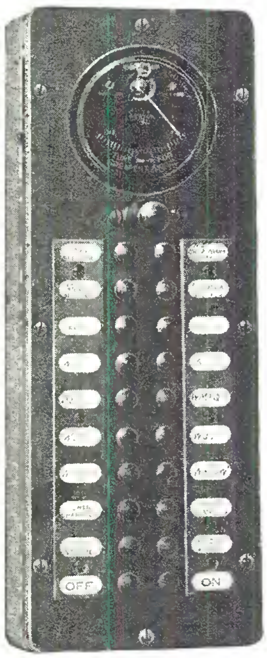
Dubilier Dry Type Electrolytic Filter Condensers

A line of Dubilier dry type electrolytic filter condensers is announced by the Dubilier Condenser Corp., New York City. These condensers, in paraffined cardboard containers, are available in the standard capacities, 4, 6, 8, 10 and 12 mfd. and for peak voltages up to 430, according to the conservative Dubilier rating. They will withstand 500 volts without appreciable deterioration. When supplied with wire leads, the red wire is the anode or positive while the black wire is the cathode or negative.

The new Dubilier electrolytic condensers aim at providing high capacity values with ample working voltage for the usual filter function in an a-c radio set. They may be substituted for the usual aluminum can type electrolytic condenser, effecting a saving in cost while at the same time permitting compact condenser blocks to be assembled with a number of these cardboard container units.

Stromberg-Carlson New Telektor System

The Stromberg-Carlson Tel. Mfg. Co., backed by 37 years in the manufacture of telephone transmitting and receiving apparatus, has presented a new Telektor System (residence type electrical remote control system), which gives complete remote control of both radio and records.



By push buttons in a small control box, one may, from any part of the house, start or stop a radio receiver, start or stop a multi-record phonograph at the same time switching from radio to phonograph, or vice versa, tune silently and automatically to any eight stations, tune silently and visually to other stations, adjust volume, adjust phonograph volume, switch four loud speakers on or off, switch off radio, loud speakers and phonograph by one button.

The new system is composed of radio, phonograph units in separate console cabinets, or in combination cabinets; or one or both may be concealed from view. With the provision of complete remote control of an entire system, the radio receiver loses its claim to a place in the living room and may be relegated to any dry place in the attic, basement, garage or a convenient closet or cupboard.

The Telektor control boxes are equipped with ten foot or thirty foot flexible cords. The portable type is 10 inches by 3¾ inches by 2½ inches in size, made of walnut, with walnut finished formica top, and weighs about a pound. Control boxes for mounting flush in walls can also be had.

A Stromberg-Carlson Telektor installed on Stromberg-Carlson receivers Nos. 12, 22, 27 and the No. 14 multi-record radio, if the No. 14 is equipped with phonograph relay, will operate simultaneously four dynamic speakers, or sixty magnetic (cone) speakers, or two dynamic in combination with 20 magnetic speakers. A power amplifier may be provided when more speakers are required. The system may readily be installed in old houses as well as those under construction, and requires a minimum of conduit wiring. All Telektor circuits operate at approximately 25 volts a-c, which is classed in the same category as door-bell wiring.

New Condenser Microphone

Shure Bros. Co., 337 W. Madison St., Chicago, Ill., announce their model 44 condenser microphone.

The manufacturers state that this instrument is designed to meet the most exacting requirements for high

(Continued on next page)

NEW PRODUCTS ITEMS

Manufacturers who have items that come within the scope of this department will find it of advantage to keep our name on their mailing list for announcements of new products. Halftones or electros should not exceed 2¼ inches in width. Address—New Products Editor, care this magazine.

quality radio broadcasting, sound recording, and sound measurement tests, and its outstanding characteristic is its relatively uniform response to all frequencies from 40 to 10,000 cycles. In the special design of its amplifier are combined the advantages of high output level with extreme wealth of richness in tone quality. Its reproduction is so realistic as to make it difficult for even the trained ear to discern the use of the instrument between the original source of sound and the listening ear.

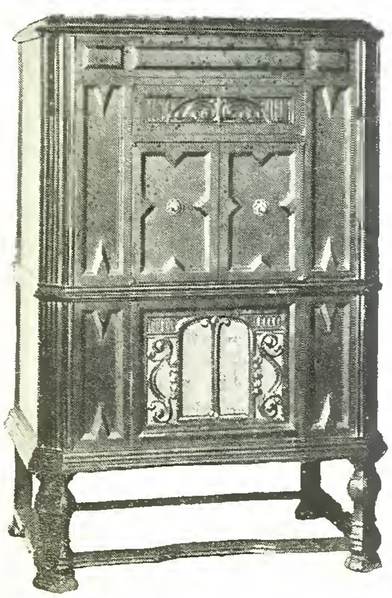
Balkeit Model L-7

The Balkeit Radio Co., North Chicago, Ill., announce their model L-7, being licensed by RCA and Hazeltine.

The cabinet is made of walnut with full vision illuminated dial. Height 18 inches, width 15½ inches, depth 10½ inches. This model uses two variable Mu type 235, two 224, one 227, one 247, and one 280 tubes.

The manufacturers state that this receiver uses a full size dynamic speaker, equipped with special hum bucking coil to reduce hum to a minimum. Shipping weight 34 pounds.

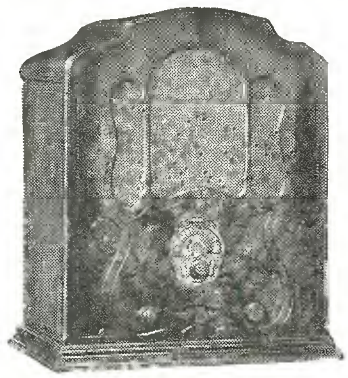
RCA-Victor Ten Tube Super



RCA Victor Corp., Inc., announces their model RAE-59, which is a ten tube superheterodyne with radio-phonograph combination. Equipped with totally shielded chassis, automatic volume control, micro tone control, low impedance pickup and inertia-type tone arm. Provided with the device for playing long-playing records, home recording with studio microphone, and automatic record changing. Chassis rubber-floated in beautiful walnut cabinet. Dimensions: height 46 inches; width 29⅜ inches; depth 19$^{13}/_{16}$ inches. Uses 2 RCA-247, 1 UX-280, 1 UY-224, 3 UY-227, 3 RCA-235 Radiotrons.

Sentinel Perfects 5 Tube Super

A unique detector-oscillator system which operates equally well over the entire broadcast range, which is trouble-proof and non-critical, and which does not require specially selected tubes, is incorporated in the Sentinel 116 five-tube superheterodyne radio receiving set recently developed and placed on the market by the United Air Cleaner Corp., 9705 Cottage Grove Ave., Chicago, Ill. This detector-oscillator system, together with the fact that there is a total of seven tuned circuits, gives a standard of performance which surpasses that of the ordinary seven tube superheterodyne receiver.



The new Sentinel 116 five-tube superheterodyne is housed in an attractive table model cabinet made of selected walnut with simple design and pleasing lines. The cabinet measures 15¾ inches high, 13¼ inches wide, and 8 inches deep.

Buss Radio Fuses

The Bussmann Mfg. Co. of St. Louis, makers of Buss fuses and Buss lights, announce a new radio fuse assortment, copying a similar step taken by the Bussmann Co. in the automobile fuse field in 1926, when fuses were packed in a metal box on which educational fuse information was printed.

"For years fuses were sold to automobile owners by dealers just to oblige them," an official of the company stated in announcing the new line, until the Bussmann company presented this item in a way to make it a staple in any garage, hardware or service store. We furnished the dealer and service man with an attractive stand in which to store his stock and packed fuses five in a metal box for the convenience of the car owner. Since that time, spare automobile fuses have become almost as important in the tool kit as the jack and tire tools. The purpose of the radio fuse assortment is to supply the radio dealer and the independent service man with an assortment of fuses which will service various makes of radios as well as to provide a counter display which will increase the sale of fuses to the home mechanic who likes to service his own set."

The announcement sets forth that the radio service man who carries the assortment will always have the correct fuse in his tool kit, and that the individual user may prevent the loss of an evening's entertainment by having a spare box of fuses on hand at his home.

New Jewell Oscillator

A new radio service oscillator, the pattern 563, has just been announced by the Jewell Electrical Instrument Co., 1650 Walnut St., Chicago, Ill.

This instrument employs one '30 type tube operated from self-contained batteries, in a self-modulated circuit. The output is continuously variable over three frequency ranges: 550 to 1500 kc, 125 to 185 kc, and 175 to 450 kc. These ranges provide for the adjustment of radio frequency circuits in all modern radio frequency and superheterodyne receivers.

BRIEF ITEMS OF INTEREST TO MANY

ERRATA—We are sorry that an error occurred in our January, 1932, issue, page 20, on the General Motors S-9A. The sensitivity as given is 50.3 microvolts absolute corresponding to 12.56 microvolts and should read 30.2 absolute, which is equivalent to 7.55 microvolts per meter.

Fred Haddock, Texon, Tex.: Find enclosed check for your magazine and Radio Service Schematics. I am a dealer here in Texon and I like your magazine the best of all the radio publications, as you have the radio tests and schematics which I believe are very instructive for radio men.

Victor McBeth, Spalding, Nebr.: Which is the best form of short wave set: super converter, a-c short wave t-r-f, a-c short wave superheterodyne or d-c? Would like to have a good one. I tried one but did not get very good results. Ans. We believe the best results are obtained in short wave reception, which is exclusively short wave, by the new combination short wave broadcast superheterodyne now on the market and entirely satisfactory. Otherwise we suggest a converter in preference to an adapter. Probably there will be a little less noise and local disturbance if a d-c job is used, but there always remains the inconvenience of batteries.

D. V. Fuller, Butte, Nebr.: I am interested in purchasing some new radio testing equipment and I notice in the last issue of Popular Mechanics a diagram for a vacuum tube voltmeter using a 0-200 microammeter. I wish to buy a Jewell oscillator, and in fact have ordered it without an output meter, pending my decision as to whether I decide on the output meter or a vacuum tube voltmeter. What I wish to know is whether the vacuum tube voltmeter would be as easy to use for the same purposes as the output meter? I would also like to know if it is practical to add automatic volume control to sets that do not have it. Ans. For accuracy we would recommend the vacuum tube voltmeter, but such an instrument is delicate, fragile and requires at least one battery for operation. It is primarily a laboratory instrument and is too sensitive for making a service alignment of a receiver. If you wish to have an instrument which is rugged, reasonably accurate and very good for alignment purposes, there is no question but what the rectifier type voltmeter, which is of very good sensitivity, is the proper instrument to use. You will find in our Brief Items columns of a previous issue that we do not recommend anyone attempting to add automatic volume control to a receiver which is not so equipped, because of the many difficulties which will be experienced and the redesigning necessary.

S. M. Lockwood, Chicago, Ill.: I wish to compliment you on your new monthly, which is just what the service man needs to help him along. The articles on Multi Range Meters certainly came along in good time. I was running around in circles and getting nowhere until you were kind enough to light the way. At the present I am badly in need of a tube tester that will give fairly reliable service every day, but owing to the present prices I have hesitated in buying. Can you supply me with constructional data for a tube tester that will not cost me too much? Any help will be appreciated. Ans. We wish to thank you for your kind words and hope that we may continue to serve our readers with valuable information and service

(Continued on next page)

Brief Items Continued

data. You will find what you desire, we believe, on page 30 of the January issue, where ways and means are given for measuring all of the essential characteristics of vacuum tubes.

H. W. Shannon, Soledad, Calif.: In reading over your new monthly addition I notice in Brief Items different comments from interested subscribers. It has long been my contention that four issues of your magazine per year was not enough, more so now in view of the fact that new models and new ideas are being produced on short notice. I have always felt that your Review is the best for these reasons: clear and explicit hook-ups and schematics, accurate and importance values and data are always shown in your testing, your experimental schematics and manufacturers' schematics. We all know these agencies furnish necessary data to their own service men and we find your publication of help to the independents. Your receiver performance and curve section is the most important in your magazine and it should be used by all service men after working over sets before delivering to the customer. You left out one necessary page in your call section and that is stations listed by cities and states. Please put this back. There is also one more important section which should be included in your Review, and that is all available data and schematics pertaining to elimination of interference in antenna and a-c lines. Your schematics, if kept by subscribers, will eliminate the necessity of going to the expense of purchasing large and cumbersome books. If the Call Book magazines are filed properly and an index is kept by the subscriber showing the contents of each of your issues in one separate note-book, by writing down contents of each issue, I find that one automatically seems to remember just where to look up information when he wants it. Your New Products section will become more important now that it is issued monthly. Also because of the fact that you print statements regarding these articles, can be relied upon. This also applies to your paid advertisers, as we have come to look upon your magazine as our reliable purchasing agent. By cutting out unimportant reading you have given us a quicker reference guide with which no other publication can compete. One thing before I close, and that is I wish you would show the correct voltage at the sockets in chart form. Remember that the experimenter comes first, as I stated in the first part of my letter regarding commercial data. Ans. We wish to thank you for your kind words and thoughtful suggestions in your letter. We appreciate a boost now and then from our subscribers. You will find in this issue the inauguration of the receiver voltage charts published in each issue whenever we can get them. Also we shall publish the charts for receivers which are appearing in all of our monthly issues.

V. H. Herndon, Odon, Ind.: You know once in a while you are forced to boil over whether you want to or not, and after reading your Brief Items of Interest to Many in the January issue, I could not stay put any longer. These apple knockers get my goat, so here I go to quote on. "After having reexamined the December issue I find that it does consist of the following: 16 pages of advertising, 9 pages of station calls, 13 pages of performance and 1 page of contents, also 9 pages of reading matter and worth every cent I gave for it, and not even you could improve it if you tried. I know what I am talking about because I received the first number of the General Radio Experimenter in 1924 and still have it, as I do the last number they put out. I also have all the Call Books from Vol. 6, No. 1, to the present, every issue of Radio Craft, 60 issues of Radio, 74 issues of QST, 90 issues of Radio

(Continued on next page)

Brief Items Continued

News, Radio World every week for ten years and the following until they signed off: Radio in the Home, Radio Mechanics, Radio Digest while a weekly, Radio Review, and Radio Listeners' Guide and Call Book, and other manuals. I want to say that I have received a lot of good reading in the Call Book, and also that it has always gone forward and never back and still remains in a class by itself, and in view of the fact that I have taken, read and still possess the above publications, I will leave it to you as to whether or not I have the right to be judge. So just go ahead as you are, for your curves are great and I sold the first super sold in this town through your curves and my explanation."

Roger D. Spencer, Middlefield, Conn.: I have been reading one of the criticisms you received, but we all get that. Some people don't believe that service men read your paper and are not interested in curves, but wanted something to read. I always look forward to getting your magazine and always find good dope in it. I am not particularly interested in curves, as I consider actual reception conditions vary receiver performance a great deal. For instance, we have one location in town where you can get nearly anything you want, while farther down in the country it takes a long aerial to get anywhere near normal volume on reception. Quite often I find a set with a partial short in it, which will reduce the voltage on the output of the 280 tube 50 to 100 volts, making the set weak and causing excess heating. Often the short is insufficient to blow the fuse, if the receiver is equipped with one. Did you ever have one of the Atwater-Kent 55 sets which caused trouble by a reduction in volume? I had this and searched all over and could not find anything which varied until I looked in the first audio bias resistor, which is a flat wire-wound resistor, one end of which is grounded. This resistor had been dipped and never cleaned. Another cause of variation in volume is a dirty local-distance switch on some receivers. Some of the Grebe SK-4 receivers which faded were troubled with a defective local-distance switch.

Carl Roemer, Lakewood, Ohio: I have a set of superheterodyne intermediate transformers which are peaked at 37.3 kc, using a .0075 fixed condenser, and I wish to know if these may be peaked at 175 kc and, if so, what capacity condenser to use. Ans. The calculations show the inductance of these coils to be 2.39 millihenrys. Therefore, the required capacity will be in the neighborhood of .00034.

Harold Mantz, West Bend, Ia.: 1. In charging a 6 volt battery from the a-c line by means of a step-down transformer of 12 volts output and a rectifier, is this too much for a 6 volt battery? 2. I have a 6 to 12 volt dynamic speaker and would like to use this step-down transformer along with a rectifier to furnish field excitation. Would it be satisfactory? 3. With item 2 I should probably need a condenser to filter out hum. What would you suggest? 4. Should the rectifier be rated at 2½ amperes and would one of 3 amperes capacity be better? I am asking you these questions because I know the answers I get will be reliable. Ans. A transformer having 12 volts output on a suitable rectifier is perfectly satisfactory on a 6 volt storage battery. Since your dynamic speaker is rated from 6 to 12 volts, such a rectifier may be used. It is always advisable to use a high capacity low voltage electrolytic condenser for filtration, and we suggest one with a value in the neighborhood of 2500 to 3000 mfd. The best results will be obtained from the rectifier of highest rating because of the prolonged life.

(Continued on next page)

Brief Items Continued

Synthane Corp., Oaks, Pa., manufacturers of Synthane laminated bakelite, have prepared a valuable data chart on "Standards of Quality, Properties and Applications of Laminated Phenolic Sheets." Copies may be secured free by addressing Synthane Corp.

H. B. Duncan, Wilmington, Del.: I have noted with great interest your article on page 38 of the January, 1932, issue regarding a special type of aerial installation to mitigate electrical interference. However, the size of the transformer given as a 3 inch diameter tube seems too large. Could a smaller size be used? As a service man I would appreciate as many articles on construction and use of testing equipment as would be consistent with your program. Ans. Constants for the transformer need not be held to very close limits, but we suggest approximately 200 to 300 microhenrys inductance. If you have had the issues of the CALL BOOK beginning with October, at which time it became a monthly publication, you will find a very comprehensive library on equipment for service men.

Theo. P. Long, 210 W. Collins St., Oxford, Ohio, desires to buy either a ½ kw or 1 kw transformer and a rotary gap without a motor for his high school radio club.

Steven Grek, Chicago, Ill.: What causes a set to vibrate on certain stations? To make myself a little more clear, the program sounds as if it came over a tightly strung wire that was twanged continually as a harp. Ans. We presume you are having trouble with microphonism. Try changing the detector tube or, if necessary, mount the receiver on soft pads. Microphonism is caused by mechanical vibration of tube elements in the detector or audio stages. Many times it is brought about by the vibration of the plates of the gang condenser, especially if the plates are of thin material.

There seems to be some mistake about the price given in our last issue on letter-size blue print performance curves on any receivers so far run in the monthly issues. The price is 6c each, or 24c per set of four for a receiver.

O. M. Owen, Hastings, W. Va.: I have been a reader of your magazine for about nine years and have always looked forward to the next copy until recently. It does not contain the "thrill" such as was contained in the September, 1930, issue, in which you describe how to modernize a Victoreen superheterodyne. As an experimenter I am interested in such articles. When radio settles down to a cut and dried proposition, such as most magazines are now treating the subject, it will cease to be more than a drab subject. Imagine a magazine treating on pianos and phonographs. However, as a service man I do get some good from your publication, but the big interest factor is gone. A recent letter in your Brief Items columns describes the matter pretty thoroughly.

L. S. Lustic, Chicago, Ill.: Thanks for the past information shown by you. Your schematic wiring diagrams are the best. I have subscribed to all kinds of publications, but they seem to be afraid to show capacity and resistance values on their diagrams. The tube curves and characteristics in the January issue were fine, but please be a little careful because all of us are not mathematicians.

Electrad, Inc., 175 Varick St., New York, N. Y., has prepared a new resistor handbook. This book is 5 by 8 inches and designed to fit into the service man's pocket or kit. Supplements will be issued four times a year.

(Continued on next page)

Brief Items Continued

Electrad states: "The Resistor Replacement Handbook contains circuit diagrams, useful information and resistor values used in practically all models of all popular makes of radio receivers now on the market, as well as many obsolete models still in use, which you may be called on to service.

Single copies, $1.00; in quantities of 6 or more, 75c each. Each subscription covers one year's service for 1932, consisting of first edition and four 1932 supplements.

D. V. Chambers, New York City: I am very pleased with the new order of things, the monthly issue and thereby more diagrams, since diagrams are the service man's standby. If a condenser or resistor becomes defective, how else would one find the value? If you would put the circuit diagrams on only one side of the page and the articles on the reverse side, it would simplify filing. As it is, it is necessary to compile an index, for I don't save the magazines but I do the diagrams, with some of the articles that I want, or put ads or anything on the reverse side.

R. F. Renuad, Syracuse, N. Y.: Your design of multi-range volt milliammeters and voltmeters is all very interesting and let's hope a future issue of your magazine will carry a design for utilizing the Weston universal a-c and d-c meter. The Brief Items columns are just what you have needed for a long time and I sincerely hope you continue to publish it.

Henry Schroeder, Whitehaven, Tenn.: I notice in your response curves you have a dotted line called "low 1000 kc." Does this curve refer to the fidelity when the tone control is turned to its maximum bass position? Ans. Yes, and 400 cycles is used as a reference point as usual.

Hammond Mathews, Silverton, Colo.: I am obliged to write you after having to use your Call Book for the last three or four months and tell you where you have failed in part of it, with the sincere hope that you will see your way clear to bring out the next issues in 100% manner. Page 10 of the January issue is about useless, in that after one may gaze at any kilocycle number, he has to then spend a number of minutes in finding out where in heck "PONUTELL" is located. If you will do as the old issues did, you will have a better issue and certainly one which will be appreciated by the writer and thousands of others. Ans. There would be no difficulty, of course, in adding the wavelength in meters as was heretofore given, but in keeping with the trend of the times, which is ever for advancement, we have eliminated what we consider antiquated material. We have found that it does not require more than ten seconds to obtain the information you mention for any station. Other comments desired.

W. C. Edens, Magness, Ark.: We have a set which plays perfectly for a couple of hours, when it will suddenly break out with the most outlandish noise, similar to an a-c hum, only amplified a thousand times. Sometimes a sudden jar will start this noise, but usually it starts after an hour or two of operation with the set undisturbed. Ans. Your complaint is one of quite common occurrence and may be due to a defective tube, but more likely it is a condenser with a very bad leakage or a resistor which is not firmly fastened at its ends. Since a time interval is necessary to cause the noise, it is logical to assume that the heating of the chassis by the power transformer and tubes causes sufficient expansion to open some circuit at least partially.

(Continued on next page)

Brief Items Continued

Jas. A. Robinson, Methuen, Mass.: Keep up the schematics, but add values of resistors and condensers. Cut response curves smaller and put in voltage charts of tube voltages. Service men appreciate your efforts. Ans. Every schematic we publish has all the values of resistors and condensers which are available from the manufacturers. You will find in this issue the inauguration of the publication of 12 voltage analysis charts, which will be continued from this time on.

Jack Bender, Evansville, Ind.: It is gratifying to note that there is one organization in the field of engineering that can be depended upon for reports on modern radio equipment. Hence, we do not have to depend upon the biased (probably) measurements made by some manufacturers of today. Also many times they are very misleading in their assertions as to the performance of their products. It is too bad that some of these manufacturers cannot see the futility in building such things as signal generators without having them carefully rechecked at such places as the Bureau of Standards or at *Radio Call Book Magazine's* laboratory. The engineers of such plants take for granted that they are equipped with sufficient knowledge and data to build test equipment equal to that of men who have specialized in nothing else for many years. The word "almost" expresses the whole theme of this letter, for one slight mistake in strays or leakage will cause much grief when it comes to a problem of mass production.

Radio Service Laboratories, formerly located at 440 S. Dearborn St., Chicago, Ill., are now at Clinton, Ia., in their own factory.

Jos. Daniel, New York City: I appreciate the monthly publication of your interesting radio magazine. I am glad that you have changed it from a quarterly and I am certainly a satisfied subscriber. In the January issue the article on page 33 is very interesting to read. Ans. We are happy to learn from your letter that you found the article on page 33 of benefit and we hope that each succeeding issue will prove of more value to our readers. With reference to your suggestion on the wave trap, we are always glad to review ideas and write-ups on equipment which are sent in to us.

Harry E. Edsal, Bellefontaine, Ohio: In your *Radio Call Book Magazine and Technical Review* there was an article describing the Scott All-Wave Model 31, a superheterodyne all-wave receiver. In one of the paragraphs you used symbols uh and uuf. These are strange to me and I wish that you would enlighten me since none of my technical books use these representative letters. Ans. The symbol u is the closest approach in Arabic to mu, which stands for one millionth. Therefore, uh represents microhenrys or millionths of a henry, uf represents microfarads or millionths of a farad, and uuf represents micromicrofarads, trillionths of a farad or millionths of microfarads. You have probably seen the latter term abbreviated mmfd.

RMA Television Notes

WORKING toward early and orderly development of television, recommendations of television frequency assignments and engineering standards are being made by the Radio Manufacturers Association to the Federal Radio Commission for consideration at the International Communications Conference next May in Madrid. The engineering proposals were drafted at a recent meeting of the RMA Television Committee of which Mr. D. E. Replogle of Newark, N. J., is chairman, and are being transmitted to the Radio Commission at Washington by Dr. C. E. Brigham, Chief of the RMA Engineering Division.

Chairman Replogle has issued the following summary of the television engineering proposals:

"From data secured it is apparent that the present television wave length assignments are inadequate to give satisfactory television broadcasting service;

1st—Because of interference between stations at distant points.

2nd—Because of phantom images and fading sent up by reflections of television signals from the heavy side layer. These reflections arrive at a different time from the ground wave of the transmitting station which causes several images to appear and shift back and forth except in areas close to the broadcasting stations. These are quite annoying and entirely upset the detail of the received pictures when present.

3rd—The narrow channels of 100 kc, while wide in comparison with voice channels, are still too narrow to permit satisfactory picture transmission.

4th—In the spectrum assigned to television there are too few channels to assign to sufficient television stations to adequately supply one city without considering the many cities that will want service. This has become quite apparent and there has been a definite surge for other channels in the ether not now occupied that can be used for television.

"This search for new channels during the past year has brought to light sufficient data to make necessary the calling of a special meeting of the RMA Television Section of the General Standards Committee to consider the request for television bands that can be expected to meet requirements in this art for the next five years. It was necessary to make these requirements at this time because of the start of the International Radio Conference in Madrid, Spain, next spring which will set the various international radio channels for the next five years."

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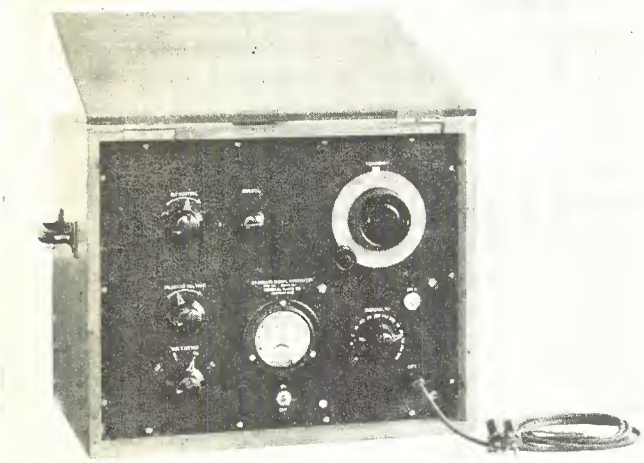

TYPE 601-A STANDARD-SIGNAL GENERATOR

THIS inexpensive standard-signal generator makes standard sensitivity measurements on radio receivers at any frequency between 90 kc. and 6000 kc. by the use of interchangeable inductors. Two inductors are in place in the instrument and either may be selected by means of a switch on the panel. For instance, the broadcast band and the intermediate-frequency superheterodyne band can both be in position, thus facilitating checking on the production line.

Aircraft operating companies also find this instrument useful because it enables them to make thorough sensitivity tests as a part of their rigorous maintenance-inspection schedules. Its low price enables them to keep one at every terminal.

Price $210.00, without inductors

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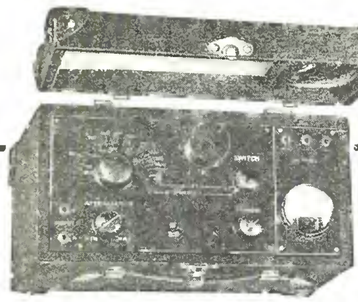

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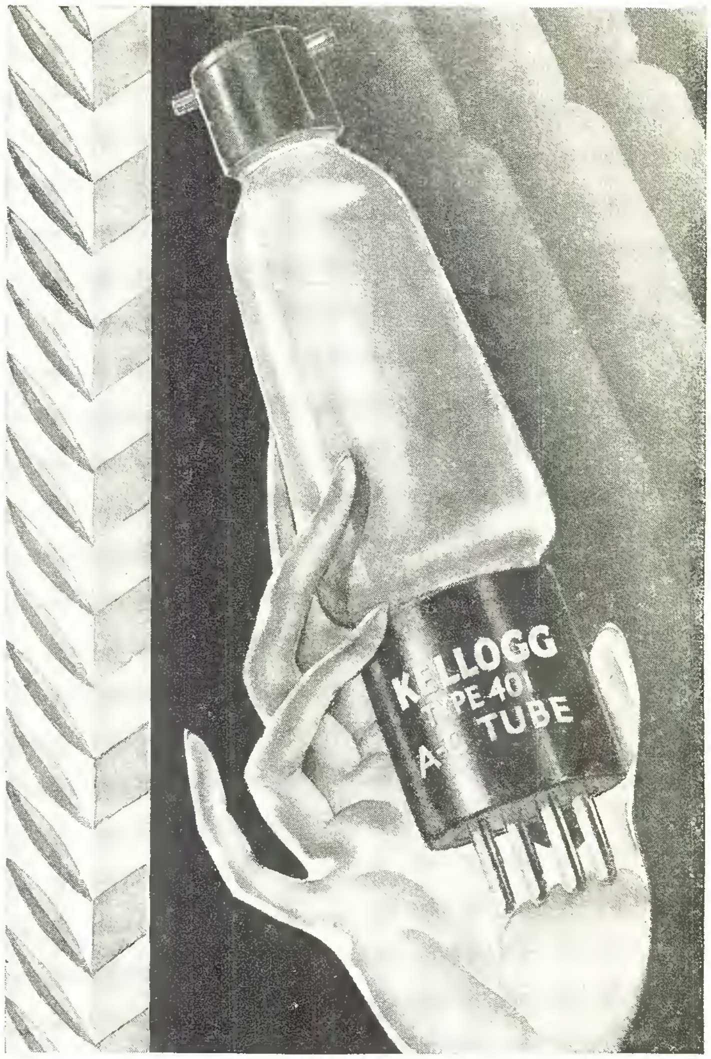

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The above drawings are intended for service purposes only and are not suitable for the construction of receivers from miscellaneous parts. They will be sent postpaid by return mail upon receipt of the proper amount. C. O. D. orders not accepted.

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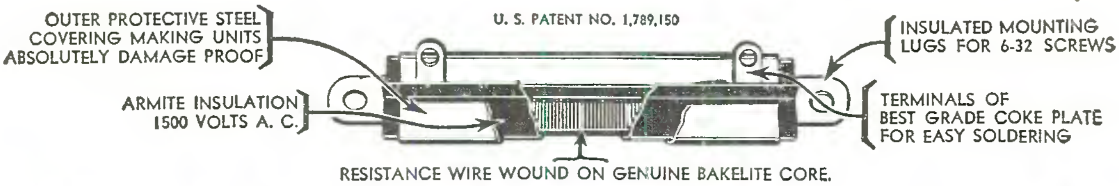

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710	100	2	.20	.40
715	150	1	.20	.20
720	200	2	.20	.40
721	250	1	.20	.20
722	300	2	.20	.40
723	400	1	.20	.20
724	500	4	.20	.80
725	600	1	.20	.20
726	750	4	.20	.80
728	1000	5	.20	1.00
730	1250	1	.20	.20
760	1500	3	.40	1.20
762	2000	4	.40	1.60
764	2500	4	.40	1.60
765	3500	2	.40	.80
766	5000	4	.50	2.00
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770	10000	2	.50	1.00
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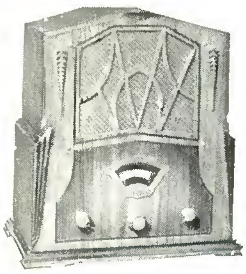

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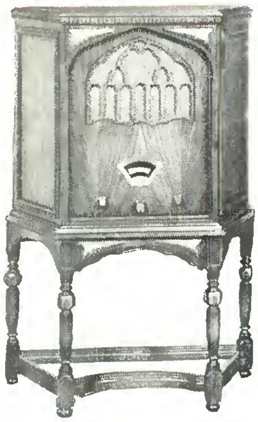

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