CITIZENS

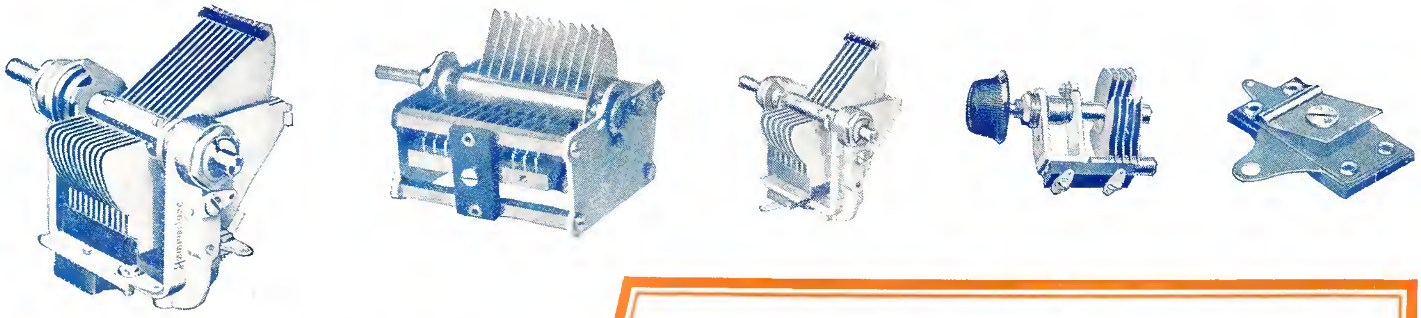
Radio Call Book Magazine

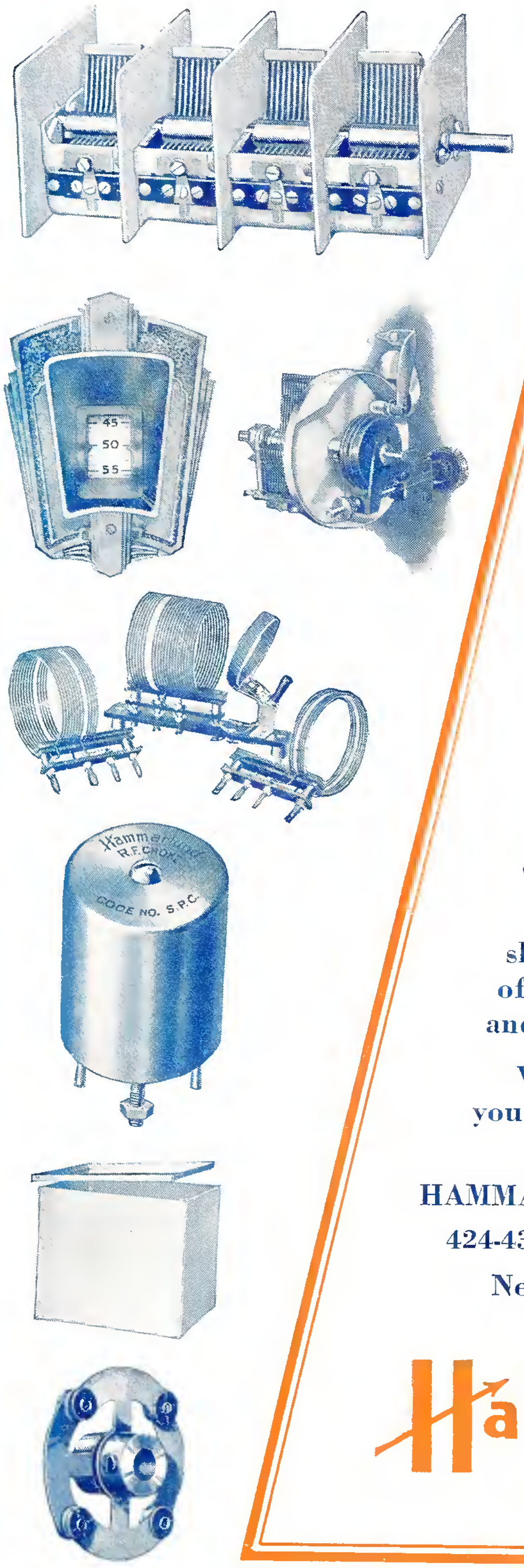
and TECHNICAL REVIEW

SPRING EDITION

50¢

SERVICE - REPAIR - ENGINEERING





SUCCESS

to the SERVICE MAN

As Good Tools Help to Make a Good Mechanic, Good Parts are Essential to Efficient Service Work

EVERY service man knows how much his work is simplified and his reputation sustained by parts he can rely on. "Cheapness" in anything is the most expensive in the long run.

In making replacements, remember *Hammarlund reliability.*

Since radio began, Hammarlund has been condenser headquarters. Later came coils, dials, chokes, shields, couplings and the famous "HiQ" Custom-Built Receivers—*all leaders in their field.*

Send 25c for HiQ-31 Manual. A Mint of Helpful Information

Not by chance has Hammarlund leadership been maintained—but by the power of better *engineering*, better *manufacturing* and better *values.*

Will you give us the opportunity to assist you? We shall welcome it.

HAMMARLUND MFG. CO.
424-438 West 33rd Street
New York, N. Y.

MAIL COUPON for Data

For Better Radio
Hammarlund
PRECISION
PRODUCTS

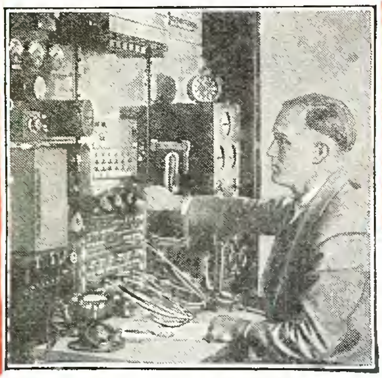
HAMMARLUND MFG. COMPANY,
Dept. CB-1,
424-438 W. 33rd St., New York.

Please send me free literature on Hammarlund Parts. If HiQ-31 Manual is wanted check here ☐ and enclose 25c *(cash or stamps).*

Name ....

Address ....

Citizens Radio Call Book Magazine and Technical Review, January, 1931. Published 4 times yearly, January 1, March 1, September 1, November 1. Volume XII, No. 1. Published at Chicago, Ill. Subscription price, $2.00 yearly. Entered as second-class matter January 24, 1930, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Citizens Radio Service Bureau, Inc., Publishers, 508 S. Dearborn St., Chicago.



Broadcasting Stations offer fascinating jobs paying from $1,800 to $5,000 a year.

You're Wanted

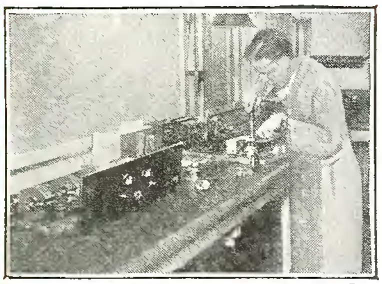
Take your pick of these fine Big Pay Radio Jobs

You have seen how the men and young men who got into the automobile, motion picture and other industries when they were started had the first chance at the key jobs—are now the $5,000, $10,000 and $15,000 a year men. Radio offers you the same chance that made men rich in those businesses. Its growth has already made men independent and will make many more wealthy in the future. Its amazing growth can put you ahead too. Don't pass up this opportunity for a good job and future financial independence.

Operating on board ship gives you world-wide travel without expense and a salary of $85 to $200 a month besides.

Hundreds of $50 to $100 a week jobs Opening Every Year

Radio needs more trained men badly. Why slave your life away for $25 to $40 a week in a no-future job when you can get ready in a short time for Radio where the good jobs pay $50, $60, $75 and $100 a week? And many of these jobs can quickly lead to $150 to $200 a week. Hundreds of fine jobs are opening every year for men with the right training—the kind of training I'll give you.



Spare time set servicing is paying N. R. I. men $200 to $1,000 a year for their spare time. Earnings begin almost at once after enrolling.

I Am Doubling and Tripling Salaries

Where you find big growth you always find many big opportunities. I am doubling and tripling the salaries of many men every year. After training with me only a short time they are able to make $1,000 to $3,000 a year more than they were getting before. Figure out for yourself what an increase like this would mean to you—the many things that mean so much in happiness and comfort that you could buy with an additional $1,000 to $3,000 a year.

Many Make $10 to $25 a week Extra Almost at Once

The day you start I'll show you how to do ten jobs common in most every neighborhood that you can do in your spare time. I'll show you how to repair and service all makes of sets and do many other jobs all through my course. I'll give you the plans and ideas that are making $200 to $1,000 for my students while they are taking my course. G. W. Page, 107 Raleigh Apts., Nashville, Tenn., writes: "I made $935 in my spare time while taking your course."

You Have Many Jobs to Choose From

Broadcasting stations use engineers, operators, station managers. Radio manufacturers continually need testers, inspectors, foremen, engineers, service men, buyers and managers. Shipping companies use hundreds of operators and give them world-wide travel with practically no expense and a good salary besides. There are hundreds of opportunities for you to have a spare time or full time Radio business of your own. I'll show you how to start one with practically no capital. My book tells you of other opportunities. Be sure to get it at once.

Commercial Land Stations are being opened very rapidly in our leading cities. Trans-Oceanic telephone offers many attractive jobs.

$400 a Month

"I spent fifteen years as traveling salesman and was making good money but could see the opportunities in Radio. Believe me I am not sorry, for I have made more money than ever before. I have made more than $400 each month and it really was your course that brought me to this. I can't say too much for your school."

J. G. Dahlstead,
1484 South 15th St.,
Salt Lake City, Utah.

$800 in Spare Time

"Money could not pay for what I got out of your course. I did not know a single thing about Radio before I enrolled, but I have made $800 in my spare time although my work keeps me away from home from 6:00 A. M. to 7:00 P. M. Every word I ever read about your course I have found true."

Milton I. Leiby, Jr.,
Topton, Pa.

Seldom Under $100 a week

"My earnings in Radio are many times greater than I ever expected them to be. In November I made $577, December $645, January $465. My earnings seldom fall under $100 a week. I say the N. R. I. course is thorough and complete. You give a man more for his money than anybody else."

E. E. Winborne,
1267 W. 48th St., Norfolk, Va.

Radio factories employ thousands. Salaries for well trained men range from $1,800 to $5,000 a year.

for a Big Pay Radio Job

I will train you AT HOME free book gives facts and proof

I Will Train you at Home in Your Spare Time

Hold your job. There is no need for you to leave home. I will train you quickly and inexpensively during your spare time. You don't have to be a high school graduate. My course is written in a clear, interesting style that most anyone can grasp. I'll give you practical experience under my 50-50 method of training—one-half from lesson books and one-half from practical experiments. When you graduate you won't have to take any kind of a job to get experience—you will be trained and experienced ready to take your place beside men who have been in the field for years.

Television and Talking Movies Included

My course not only gives you a thorough training in Radio—all you need to know to get and hold a good job—but also your choice without extra charge, of any one of these special courses: Television, Aircraft Radio, Broadcasting, Commercial and Ship Radio Stations, Sound Pictures and Public Address Systems, and advanced Radio Servicing and Merchandising. You won't be a "one job" man when you finish my course. You'll know how to handle a job in any one of Radio's 20 different branches of opportunity.

Lifetime Employment Service to All Graduates

When you finish my course you won't be turned loose to shift for yourself. Then is when I will step in and help you find a job through my Employment Department. This Employment Service is free of extra charge both to you and the employer. My Employment Department is getting three times as many calls for graduates this year as last year.

Your Money Back if Not Satisfied

You do not risk a penny when you enroll with me. I will give you an agreement in writing, legal and binding upon the institute, to refund every penny of your money upon completing my course if you are not satisfied with my Lessons and Instruction Service. The resources of the N. R. I., Pioneer and World's Largest Home-Study Radio, training organization stands back of this agreement.

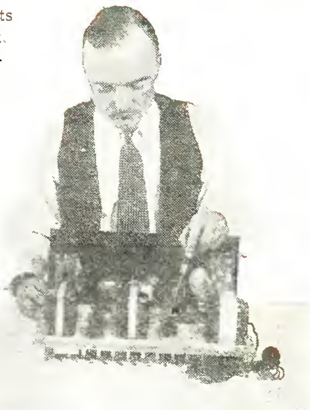
Find Out What Radio Offers You—Get My Book at Once

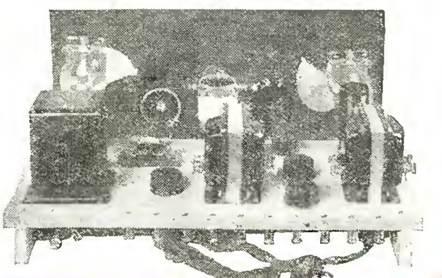
One copy of my valuable book "Rich Rewards in Radio" is free to anyone interested in making more money. It tells you where the good jobs are, what they pay, how you can quickly and easily fit yourself to get one. The coupon below will bring you a copy. Send it at once. Your request does not obligate you in any way. Act NOW.

J. E. SMITH, President
Dept. 1AE
National Radio Institute
Washington, D. C.

I give You 8 Big Outfits of Radio parts for a home Experimental Laboratory

You can build over 100 circuits with the outfits I give you. You learn from actual experience about A.C. Screen Grid Circuits, push-pull amplification and the other features in modern sets. You work out with your hands the principals, diagrams and circuits you learn from my lesson books. You get as much practical experience under this unequaled method of home training, in a few months, as the average fellow gets in two to four years in the field.





Salary Three Times Larger

"Before I completed your course I went to work for a Radio dealer. Now I am assistant Service Manager of the Sparks-Withington Company. My salary is three times what it was before taking your course. I could not have obtained this position without it. I owe my success to N. R. I. training."

H. A. Wilmoth,
Sparks-Withington Co.,
Jackson, Mich.

Clip and mail NOW for FREE INFORMATION

J. E. SMITH, President
National Radio Institute, Dept. 1AE
16th & U Streets, N. W., Washington, D. C.

Dear Mr. Smith:—Send me "Rich Rewards in Radio." Tell me more about Radio's opportunities for good jobs and quick promotion; also about your practical method of Home training. I understand this request does not obligate me and that no agent will call on me.

Name..

Address..

City.............................*State*..............................

Citizens Radio Call Book Magazine

AND TECHNICAL REVIEW

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Established 1921

C. O. STIMPSON, President
H. ANHEISER, Treasurer
F. A. HILL, Editor
RICHARD K. PEW, Technical Editor

Executive Offices:
508 So. Dearborn St., Chicago, Ill.
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Chicago—A. B. Mills, 508 S. Dearborn
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JANUARY, 1931 Published January, March, September, November Vol. 12, No. 1

Contents This Issue

Be sure to read every page of it

SEND FOR BIG FREE CATALOG

You are not fully equipped without our 40 page Catalog

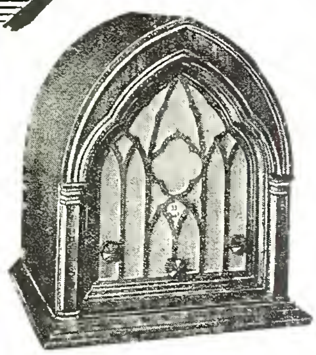
Going Big!

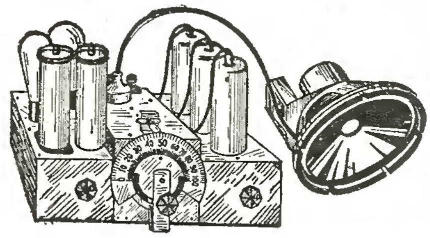
THE NEW MELORAD

Cathedral Tone

TRIPLE SCREEN-GRID
TONE CONTROL
MATCHED DYNAMIC SPEAKER

MANTLE SET





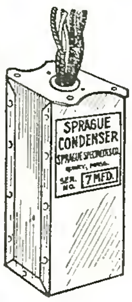
Dealers and Servicemen!

Be prepared to meet the great demand for this popular radio set during the holiday season. Equals the performance of any console receiver and yet you can sell it for less than $75.00 completely installed and still *double your investment.* Order your sample to-day and avoid the last-minute rush.

Housed in this gorgeous walnut Gothic Cabinet 16½" high, 14½" wide and 10¼" deep. Only .... **$26.95** | **$24.50**

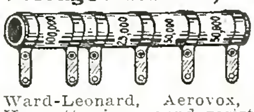
Chassis uses 3-224, 1-245 and 1-280 tubes and is equipped with matched dynamic speaker. For chassis and speaker. Tubes, $2.50 extra.

REPLACEMENT Condenser Blocks



Peerless Courier, as illustrated, ea.	$1.75
A K 37	4.80
Majestic B	2.95
Victor R32	3.25
R C A 18, 33 and 51	1.50
R C A 17.........	4.95
R C A 41	4.25
R C A 60, 62	5.95
Zenith 11E	3.25
Brandes B15	2.95
Kolster 6H	2.95
Kolster K21	2.50
Kolster K43	3.25
Kolster K22, 20, 42	3.25

Voltage Dividers, Fixed Resistances and GRID Suppressors

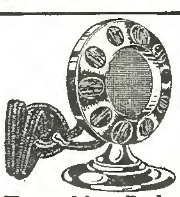


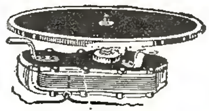
Ward-Leonard, Aerovox, Ohmite and Hy-watt wire wound resistances from 33 to 250,000 Ohms for all standard sets at 20 to 50c each. Full description in our catalog.

Centralab, Frost, Yaxley, Clarostat, Bradleyohm, Carter and Electrad Variable Volume Controls and Potentiometers

All sizes from 2 to 500,000 ohms carried in stock for replacements in all standard sets. Prices from 20 to 45c each.
ALSO Wire Wound and Carbon pigtail resistances from 10 ohms to 5 megohms at $1.50 per dozen.

FOR PRICES GET OUR CATALOG





We Carry a Complete Line of Microphones, Turntables, Pick-ups and Amplifiers for Public Address Systems and Theatres.

Universal Baby Mike. A real microphone, single button, with covers and 25 ft. of cable. List, $7.50. Our Price, $4.50.

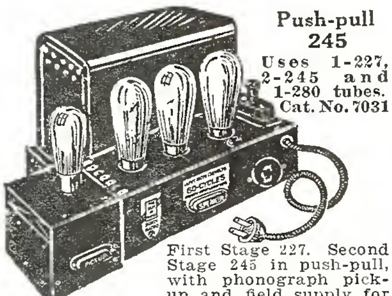
Carryola Synchronous Motor

Complete with turn-table. Silent, sturdy and compact, only 1¼" thick. No brushes. Only $4.25.

Bosch Power Amplifier

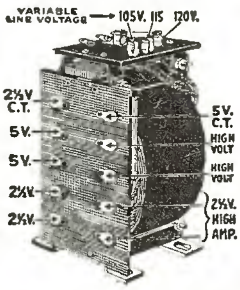
Push-pull 245

Uses 1-227, 2-245 and 1-280 tubes. Cat. No. 7031



First Stage 227. Second Stage 245 in push-pull, with phonograph pick-up and field supply for 2500 ohm D. C. dynamic speaker with or without input transformer (specify which).
Also furnishes filament and plate voltage for 224, 227 tubes.
Can be used to convert any battery set into an up-to-date A. C. receiver with 245 push-pull audio.
OUR NET PRICE, $19.50

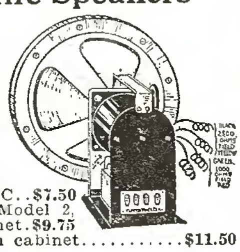
Power Transformers For all Standard Sets Carried in Stock



Model illustrated is for A C Dayton Navigator and other sets using 224, 227, 245 and 280 tubes, $3.85.

Freshman Q	$ 6.75
Freshman QD	7.85
Philco sets	3.75
Zenith 33, 35	3.25
Radiola 44, 46	4.95
RCA Double Choke	.95
AK40-42 Power Pack	11.50
AK46 Power Pack	15.00
Sonora B33	4.75
RCA Audio	.55
Earl 21, 22	2.25
Radiola 60, 62	5.95
Kolster K20	2.25
Stromberg-Carlson 642	3.95
Step down 220 to 110V	3.95
Kolster 6H	7.50

Dynamic Speakers



Peerless Giant Auditorium, 12" Diaphragm, 110 V., A. C. $14.50
D. C. with 1000 and 2500 ohm fields ... $10.00
Peerless Courier, 7", D. C. . $7.50
Baldwin, 9", A. C. . $7.50
Temple A. C., Model 2, in Walnut Cabinet . $9.75
Peerless 17A, in cabinet $11.50

MAIL YOUR ORDER TO

Federated Purchaser

114 Reade Street New York, N. Y.

TERMS:—20% with order, balance C.O.D. 2% discount allowed for full remittance with order only.

Here's the Very Set That Did It—the New

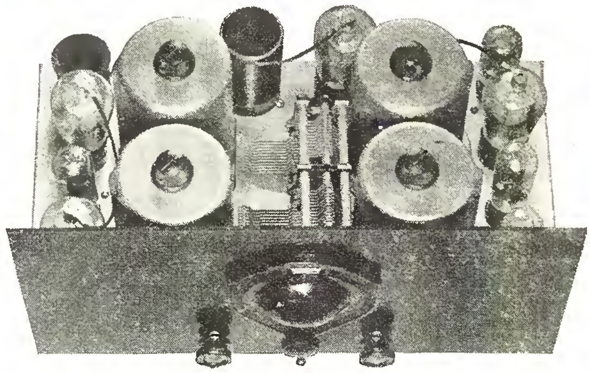
Lincoln D.C.8~Super

"Too Good to Be True" But It's True—

that marvelous Test Report in this issue of the Call Book—so far surpassing others as to defy belief. To see, for once, how *genuine* 10 KC selectivity looks in an engineering test—turn to page 41; and notice too, the beautiful tone-quality and sensitivity curves of this new D.C. Lincoln!

Self-Contained Power —No A.C. Line Interference

Crystal-clear long-distance reception, free from the cracks, growls and sputter of A.C. line interference and fluctuations—that's the gift of the new Lincoln DC-8. And since it uses the new low-amperage 2 volt D.C. tubes (filament supply operates from oxygen in the air—no acids—no charging) you can assemble it in a console with ***self-contained power*** and forget it for a year. Now, indeed, there's real reward in a D.C. set!

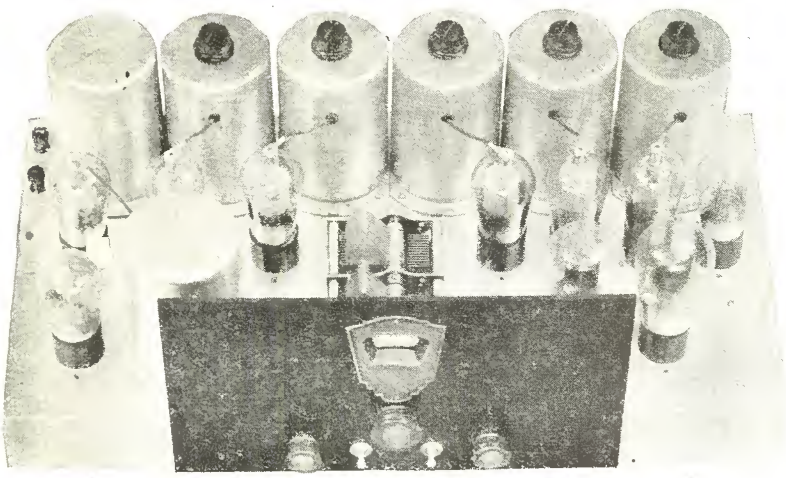


GET THE AMATEUR PHONE BAND

(80 Meters)—By Just Throwing a Switch!

There's a new principle entirely in this marvelous new D.C. Lincoln Super—without changing a coil, just by snapping a switch on the panel, we have tuned in at the Lincoln laboratory hundreds of amateur phone stations, including all nine districts of the U. S.! It's uncanny—having the 80 meter phone band spread over 60 degrees of the dial, with all the hum-free D.C. clearness—then flipping the switch back and finding yourself again with the 90 broadcast channels laid out before you like so many tracks in a great railroad stations! Just standard broadcast parts, too—no short-wave coils to fool with—and oh, what a difference it makes in listening, to have the very set that gave those marvelous performance curves!

LABORATORY BUILT CHASSIS (Less Tubes) LIST PRICE $80.00



Write for full descriptive matter and special discounts to distributors at once. Dept. C12

Lincoln De Luxe 31

Utilizing Six Screen Grid Tubes in the most powerful, selective receiver known today

Excerpts from letters received this week:

Detroit, Mich. . . . We are located on a main street car line, also within 3 miles of WWJ, the Detroit News, and are picking up Mexico City with this station in operation. Have also picked up KFI and KPO as early as 8:55 P.M. Eastern Standard time. Your machine is nothing short of a wonder. Shamrock, Texas . . . I have verified reception from KXO, El Centro, Cal., with only 100 watts output, get WGY with WFAA on air 10 KC away; get WEAF, WJZ, WFRB; WBZ with KDKA on air; KXO, KJR, and plenty of Mexican stations and some with only 100 watts. Also get Cuban stations and Canadian stations.

Lynn, Mass. . . . Your set arrived November 14th in good condition and is set up and running fine. Very much pleased with performance and workmanship. It certainly beats everything in radio. Near center of city in noisy locality, set brings in stations with fine volume and clarity in daytime never before listenable on any other set I have heard. Tone quality fine, separation of stations perfect. Look for some more orders from me very soon.

Cincinnati, Ohio. . . . I have a Lincoln Deluxe "31" for the family end think it absolutely the best I ever heard of all makes.

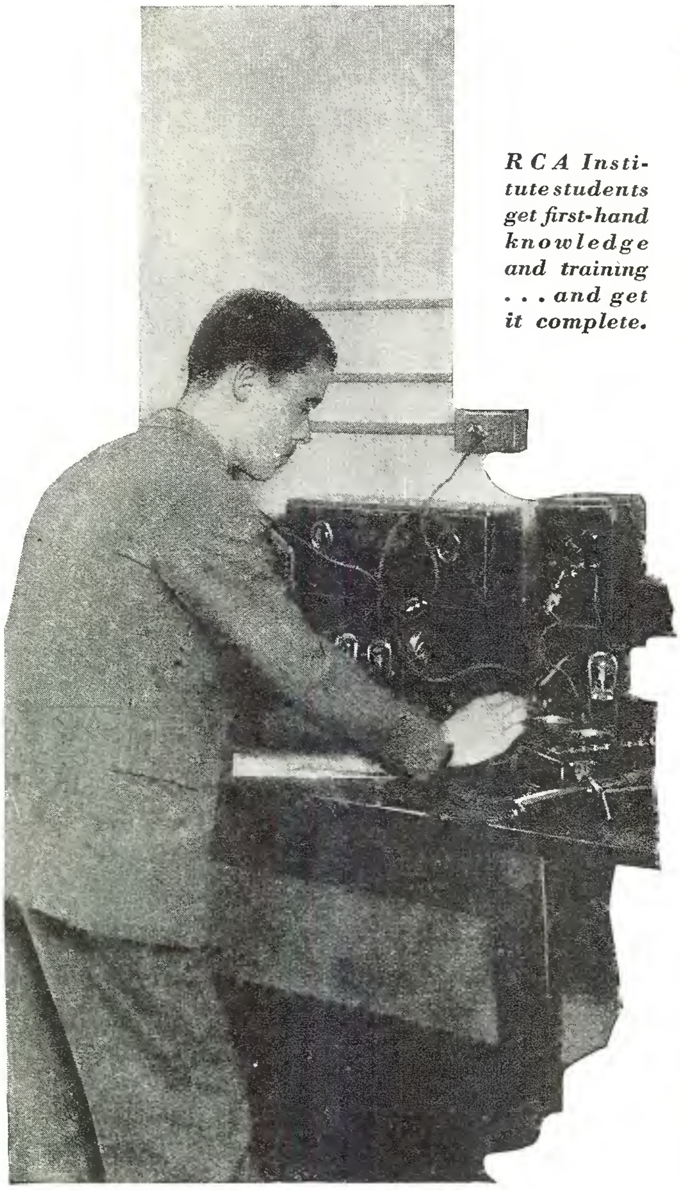
Oklahoma City, Okla. . . . Your new chassis and power pack received recently and certainly works fine. Have logged stations from all four corners of the United States and more.

LINCOLN RADIO CORPORATION

329 SOUTH WOOD ST. - CHICAGO - ILLINOIS

W[illegible] N[illegible] RA[illegible] S[illegible] S[illegible]ESS?

Study radio in your spare time at home



RCA Institute students get first-hand knowledge and training . . . and get it complete.

ARE you satisfied with the position you now hold? Do you feel that you're worth more money? Are you pleased with yourself, your work, your associates . . . and your future? What does next year hold for you . . . and the year after that?

Are you content to merely plod along through the best years of your life . . . or do you want to get into far pleasanter work . . . meet more interesting people . . . and hold a well paid position?

The ambitious man ties his future to an industry that's developing rapidly . . . that's going *up and up!* Your life lies before you . . . will it be a losing game or a profitable adventure? . . . Will you GROW with a GROWING BUSINESS or will you waste your life and opportunities in an industry that is already fighting a losing battle?

If you are looking for a REAL opportunity . . . if you want to make the most of your life . . . to grasp the success that should be yours, *then we say to you, "Study Radio."*

Everyone knows that Radio is the fastest growing industry in the world today . . . countless opportunities are waiting for men who have the training and ability to grasp them. Where have you heard of any business that has developed as fast as this? Radio needs *trained* men and needs them NOW! *Think of the future Radio offers you!*

You can easily obtain the training you need under the direction of RCA Institutes, a division of Radio Corporation of America, which thoroughly trains men in every branch of radio and also assists them in obtaining employment. You learn radio by actual experience on the very latest types of radio equipment. You study under the direction of nationally known experts. You can learn all about radio servicing and selling, ship operating, shore station operating, radio telephony and telegraphy, and airplane radio equipment . . . also instruction in sound motion picture installation, maintenance and repair!

Study at Home in Your Spare Time

The RCA Institutes complete Home Laboratory Training Course gives you all you need to know about radio. The lessons are of absorbing interest . . . easy to learn. You rapidly progress, step by step . . . and you receive absolutely free the complete RCA Institutes Laboratory Equipment, a modern outlay of apparatus furnished to every student . . . enabling you to easily solve radio problems. This is the way for you to acquire, in your spare time, the commercial knowledge and ability that command good pay.

Home Training Course By America's oldest and foremost Radio training organization

This home training course and free laboratory equipment are backed by more than 20 years' experience. A signed agreement by RCA Institutes assures you of absolute satisfaction . . . furthermore, if after taking this course you are not satisfied in every way, your money will promptly be returned to you.

Read this free book

Everything you want to know about Radio . . . Describes in detail the home training that has placed thousands of men in good paying positions. Forty fascinating pages of pictures and text all about radio.

RCA INSTITUTES, Inc.
Dept. BC-1
75 Varick St., New York, N. Y.

Gentlemen: Please send me your big FREE 40-page book which tells about the many opportunities in Radio and about your famous laboratory method of radio instruction at home.

Name ______________________

Address ______________________

____

Occupation ______________________

Mail this coupon NOW . . . start on the road to success in radio TODAY!

READ … W … AND …

Study radio in the finest equipped schools in America

In order to make it easy for you to study radio, RCA Institutes has opened six completely equipped schools throughout the country . . . at New York, Chicago, Boston, Baltimore, Philadelphia and Newark, N. J. Each of these six schools has the very last word in radio equipment. They all offer exactly the same training in day or evening classes . . . you study under the personal direction of RCA experts. In this way you learn at the very heart of radio itself, because you study under the direction of RCA . . . the great corporation that sets the standards for the entire radio industry. The very progress of radio is measured by the achievements of the famous engineers in the great research laboratories of the Radio Corporation of America.

You get commercial training that prepares you for success in radio.

Only training course sponsored by Radio Corporation of America

Graduates of these schools are thoroughly posted in all the very latest developments, the newest inventions and greatest discoveries in radio, because they study in the finest equipped schools in America.

BOARD OF MANAGERS OF RCA INSTITUTES, Inc.

The names of these men are known throughout the world as the greatest names in radio. Their experience will guide you in your training

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Radiomarine Corporation of America

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Treasurer, Radio Corporation of America

E. A. NICHOLAS
President, E. A. NICHOLAS, Inc.

A. E. REOCH
Vice-President, RCA Photophone, Inc.

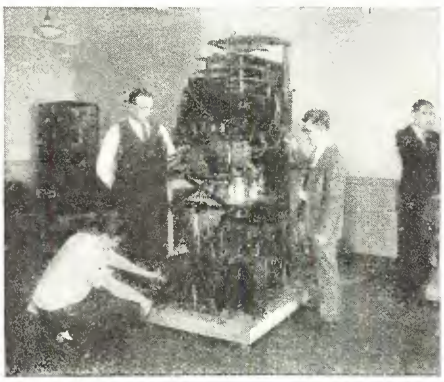
CHARLES HORN
General Engineer
National Broadcasting Company

That's what RCA Institutes does for you . . . that's the kind of training you want . . . the practical, thorough knowledge that you need for success in radio.

Opportunities for Trained *Men*

Graduates frequently obtain positions shortly after graduation. Every graduate receives the thorough training that gives him the knowledge and the confidence to hold a good paying position.

Come in today . . . See for yourself!



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Distribution of Broadcast Chains by Cities

	Chain	Kilo-cycles
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WFJC	National	1450
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WWNC	Columbia	570
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WGST	Columbia	890
WSB	National	740
Atlantic City, N. J.		
WPG	Columbia	1100
Baltimore, Md.		
WBAL	National	1060
WCAO	Columbia	600
Bangor, Me.		
WLBZ	Columbia	620
Bay City, Mich.		
WBCM	Columbia	1410
Birmingham, Ala.		
WAPI	National	1140
WBRC	Columbia	930
Boston, Mass.		
WEEI	National	590
WBZA	National	990
WNAC	Columbia	1230
Buffalo, N. Y.		
WBEN	National	900
WKBW	Columbia	1480
WMAK	Columbia	900
Charlotte, N. C.		
WBT	National	1080
Chattanooga, Tenn.		
WDOD	Columbia	1280
Chicago, Ill.		
WGN	National	720
WLIB	National	720
WENR	National	870
WLS	National	870
KYW	National	1020
KFKX	National	1020
WCFL	National	970
WIBO	National	560
WMAQ	Columbia	670
WBBM	Columbia	770
WJJD	Columbia	1130
Cincinnati, Ohio		
WLW	National	700
WSAI	National	1330
WKRC	Columbia	550
Clearwater, Fla.		
WFLA	National	620
WSUN	National	620
Cleveland, Ohio		
WTAM	National	1070
WHK	Columbia	1390
Columbus, Ohio		
WAIU	Columbia	640
WCAH	Columbia	1430
Council Bluffs, Iowa		
KOIL	Columbia	1260
Covington, Ky.		
WCKY	National	1490
Dallas, Texas		
WFAA	National	800
KRLD	Columbia	1040
WRR	Columbia	1280
Davenport, Iowa		
WOC	National	1000
Denver, Colo.		
KLZ	Columbia	560
KOA	National	830
Des Moines, Iowa		
WHO	National	1000
Detroit, Mich.		
WWJ	National	920
WJR	National	750
WXYZ	Columbia	1240
Fargo, N. Dak.		
WDAY	Columbia	940
Ft. Wayne, Ind.		
WOWO	Columbia	1160
Ft. Worth, Texas		
WBAP	National	800
Harrisburg, Pa.		
WHP	Columbia	1430
Hartford, Conn.		
WTIC	National	1060
Hopkinsville, Ky.		
WFIW	Columbia	940
Hot Springs, Ark.		
KTHS	National	1040
Houston, Texas		
KPRC	National	920
KTRH	Columbia	1120
Indianapolis, Ind.		
WFBM	Columbia	1230
Jackson, Miss.		
WJDX	National	1270
Jacksonville, Fla.		
WJAX	National	900
Kansas City, Mo.		
KMBC	Columbia	950
WDAF	National	610
Lawrence, Kan.		
WREN	National	1220
Lincoln, Neb.		
KFAB	National	770
Little Rock, Ark.		
KLRA	Columbia	1390
London, Can.		
CJGC	Columbia	910
Los Angeles, Calif.		
KECA	National	1430
KFI	National	640
KHJ	Columbia	900
Louisville, Ky.		
WHAS	National	820
Memphis, Tenn.		
WMC	National	780
WREC	Columbia	600
Miami, Fla.		
WIOD	National	1300
WQAM	Columbia	560
Milwaukee, Wis.		
WTMJ	National	620
WISN	Columbia	1120
Minneapolis, Minn.		
WCCO	Columbia	810
WRHM	Columbia	1250
Montreal, Can.		
CKAC	Columbia	730
Nashville, Tenn.		
WSM	National	650
WLAC	Columbia	1470
New Haven, Conn.		
WDRC	Columbia	1330
New Orleans, La.		
WSMB	National	1320
WDSU	Columbia	1250
New York, N. Y.		
WEAF	National	660
WJZ	National	760
WABC	Columbia	860
Norfolk, Va.		
WTAR	Columbia	780
Oil City, Pa.		
WLBW	Columbia	1260
Oklahoma City, Okla.		
WKY	National	900
KFJF	Columbia	1480
Omaha, Neb.		
WOW	National	590
Orlando, Fla.		
WDBO	Columbia	1120
Philadelphia, Pa.		
WFI	National	560
WLIT	National	560
WCAU	Columbia	1170
WFAN	Columbia	610
Phoenix, Ariz.		
KTAR	National	620
Pittsburgh, Pa.		
WCAE	National	1220
KDKA	National	980
WJAS	Columbia	1290
Portland, Me.		
WCSH	National	940
Portland, Ore.		
KGW	National	620
KOIN	Columbia	940
Providence, R. I.		
WJAR	National	890
WEAN	Columbia	780
Raleigh, N. C.		
WPTF	National	680
Richmond, Va.		
WRVA	National	1110
Roanoke, Va.		
WDBJ	Columbia	930
Rochester, N. Y.		
WHAM	National	1150
WHEC	Columbia	1440
Salt Lake City, Utah		
KSL	National	1130
KDYL	Columbia	1290
San Diego, Calif.		
KFSD	National	600
San Antonio, Texas		
WOAI	National	1190
KTSA	Columbia	1290
San Francisco, Calif.		
KGO	National	790
KPO	National	680
KFRC	Columbia	610
Savannah, Ga.		
WTOC	Columbia	1260
Schenectady, N. Y.		
WGY	National	790
Seattle, Wash.		
KOL	Columbia	1270
KOMO	National	920
Sioux City, Iowa		
KSCJ	Columbia	1330
Spokane, Wash.		
KHQ	National	590
KFPY	Columbia	1340
Springfield, Mass.		
WBZ	National	990
St. Louis, Mo.		
KSD	National	550
KWK	National	1350
KMOX	Columbia	1090
St. Paul, Minn.		
KSTP	National	1460
Superior, Wis.		
WEBC	National	1290
Syracuse, N. Y.		
WFBL	Columbia	1360
Tacoma, Wash.		
KVI	Columbia	760
Tallmadge, Ohio		
WADC	Columbia	1320
Tampa, Fla.		
WDAE	Columbia	1220
Toledo, Ohio		
WSPD	Columbia	1340
Toronto, Can.		
CKGW	National	690
CFRB	Columbia	960
Topeka, Kan.		
WIBW	Columbia	580
Tulsa, Okla.		
KVOO	National	1140
Washington, D. C.		
WRC	National	950
WMAL	Columbia	630
Waterloo, Ia.		
WMT	Columbia	600
Wichita, Kan.		
KFH	Columbia	1300
Worcester, Mass.		
WTAG	National	580
Yankton, S. Dak.		
WNAX	Columbia	570
Youngstown, Ohio		
WKBN	Columbia	570

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.

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., D. Faulding, 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, "On the Air, Goes Everywhere.

KECA
1430 kc, Los Angeles, Calif., Pacific Development Radio Co., 1000 w, P.

KELW
780 kc, Burbank, Calif., Earl L. White, 500 w, P, "The White Spot of the San Fernando Valley."

KEX
1180 kc, Portland, Ore., Western Broadcasting Co., 5000 w, P, "A Public Service Necessity."

KFAB
770 kc, Lincoln, Nebr., KFAB Broadcasting Co., 5,000 w, C, "Home Sweet Home."

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, "The Voice of Puget Sound."

KFDM
560 kc, Beaumont, Tex, Magnolia Petroleum Co., 500 w, C, "Kall for Dependable Magnolene."

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

KFEL
920 kc, Denver, Colo., Eugene P. O'Fallon, Inc., 500 w, M, "The Argonaut Station."

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

KFGQ
1310 kc, Boone, Iowa, Boone Biblical College. 100 w, C.

KFH
1300 kc, Wichita, Kan., Radio Station KFH Co., 1000 w, C, "Kansas' Finest Hotel, in the Very Heart of God's Country."

KFI
640 kc, Los Angeles, Calif., Earl C. Anthony, Inc., 5000 w, P, "National Institution."

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, "Marshalltown, the Heart of Iowa."

KFJF
1480 kc, Oklahoma City, Okla., National Radio Mfg. Co., 5000 w, C, "Radio Headquarters of Oklahoma."

KFJI
1370 kc, Astoria, 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 & Son, 500 w, P.

KFJY
1310 kc, Ft. Dodge, Iowa, C. S. Tunwal, 100 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. Shared.

KFKB
1050 kc, Milford, Kan., KFKB Brdcstg. Assn., 5000 w, C, "The Sunshine Station in the Heart of the Nation."

KFKU
1220 kc, Lawrence, Kan., University of Kansas, 500 w, C, "Up at Lawrence on the Kaw."

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, "Known for Neighborly Folks."

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

KFOX
1250 kc, Long Beach, Calif., Nichols & Warriner, Inc., 1000 w, P, "Where Your Ship Comes In."

KFPL
1310 kc, Dublin, Texas, C. C. Baxter, 100 w, C, "Baxter's Place."

KFPM
1310 kc, Greenville, Texas, The New Furniture Co., 15 w, C, "Biggest Little Ten Watts on the Air."

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, "Gateway to Alaska and the Orient."

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

KFRU
630 kc, Columbia, Mo., Stephens College, 500 w, C, "Where Friendliness Is Broadcast Daily."

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, "The Church of the Air."

KFUL
1290 kc, Galveston, Texas, W. H. Ford, 500 w, C, "The City of Perpetual Sunshine."

KFUM
1270 kc, Colorado Springs, Colo., W. D. Corley, 1000 w, M, "Known for Unsurpassed Mountain Scenery."

KFUO
550 kc, St. Louis, Mo., Concordia Theological Seminary, 500 w, C, "The Gospel Voice."

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, "The City of Opportunity."

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, Service Radio Co., 50 w, M.

KFXF
920 kc, Denver, Colo., Colorado Radio Co., 500 w, M, "The Voice of Denver."

KFXJ
1310 kc, Edgewater, Colo., Western Slope Broadcasting Co., 50 w, M, "America's Scenic Center."

KFXM
1210 kc, San Bernardino, Calif., Lee Bros. Broadcasting Co., 100 w, P, "The Voice of the Orange Empire."

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 kl, Abilene, Texas, Kirksey Bros., 100 w, C, "Breckenridge, the Dynamo of West Texas."

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, "Way Out on the Desert."

KGB
1330 kc, San Diego, Calif., Pickwick Broadcasting Corp., 250 w, P, "Music for the Sick."

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. "The Swine and Poultry Station."

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

KGCR
1210 kc, Watertown, S. D., Cutler's Radio Broadcasting Service, Inc., 100 w.

KGCU
1200 kc, Mandan, N. D., Mandan Radio Association, 100 w, M, "The Voice of the West."

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., Loesch & Wright, 15 w, C.

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

KGEK
1200 kc, Yuma, Colo., Beehler Elec. Equip. Co., 50 w, M. Shared.

KGER
1360 kc, Long Beach, Calif., C. Merwin Dobyns, 1000 w, P, "The Service Club of the Air."

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

KGEZ
1310 kc, Kalispell, Mont., Chamber of Commerce, 100 w, M, "Located in the Switzerland of America—The Beautiful Flathead Valley."

KGFF
1420 kc, Alva, Okla., D. R. Wallace, 100 w, C.

KGFG
1370 kc, Oklahoma City, Okla., Oklahoma Broadcasting Co. Inc., 100 w, C, "The Whole Gospel to the Whole World."

KGFI
1500 kc, Corpus Christi, Texas, Eagle Broadcasting Co., 100 w, C, "The Voice of West Texas."

KGFJ
1200 kc, Los Angeles, Calif., Ben S. McGlashan, 100 w, P, "Keeps Good Folks Joyful"

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

KGFL
1370 kc, Raton, N. Mex., W. E. Whitmore, 50 w, M.

KGFW
1310 kc, Ravenna, Neb., Sothman & McConnell, 50 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., Berean Bible Class, 100 w.

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

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

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., 50 w, C.

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

KGKB
1500 kc, Brownwood, Tex., Eagle Publ. Co., 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, C. E. Twiss and F. H. McCann, 100 w, P.

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

KGMB
1320 kc, Honolulu, Hawaii, Honolulu Broadcasting Co., 500 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. Shared.

KGU
940 kc, Honolulu, Hawaii, Marion Mulrony, Advertising Publ. Co., 1000 w, "In the Land of Sunshine, the Future Playground of America."

KGW
620 kc, Portland, Ore., Oregonian Pub. Co., 1000 w, P, "Keep Growing Wiser."

KGY
1200 kc, Lacey, Wash., St. Martins College, 10 w, P, "Out Where the Cedars Meet the Sea."

KHJ
900 kc, Los Angeles, Calif., Don Lee, Inc., 1000 w, P, "Kindness, Happiness, Joy."

KHQ
590 kc, Spokane, Wash., Louis Wasmer, Inc., 1000 w, P, "In the Friendly City."

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
1250 kc, Boise, Idaho, Boise Broadcasting Station, 1000 w, P.

KIT
1310 kc, Yakima, Wash., C. E. Haymond, 50 w, P.

KJBS
1070 kc, San Francisco, Calif., Julius Brunton & Sons Co., 100 w, P. "The Voice of the Storage Battery."

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

KLCN
1290 kc, Blytbeville, Ark., C. L. Lintzenich, 50 w, C.

KLO
1400 kc, Ogden, Utah, Peery Building Co., 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, "The City of Golden Opportunity."

KLX
880 kc, Oakland, Calif., Tribune Pub. Co., 500 w, P, "Where Rail and Water Meet."

KLZ
560 kc, Denver, Colo., Reynolds Radio Co., Inc., 1000 w, M, "The Pioneer Station of the West."

KMA
930 kc, Shenandoah, Iowa, May Seed & Nursery Co., 500 w, C, "Keeps Millions Advised."

KMAC
1370 kc, San Antonio, Texas, W. W. McAllister, 100 w, C, "Radio Sam at San Antonio."

KMBC
950 kc, Kansas City, Mo., Midland Broadcasting Co., 1000 w, C, "Kansas City's Most Powerful Public Service Broadcasting Station."

KMCS
1120 kc, Inglewood, Calif., Dalton's, Inc., 500 w, P.

KMED
1310 kc, Medford, Ore., Mrs. W. J. Virgin, 50 w, P, 'See Crater Lake."

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

KMLB
1200 kc, Monroe, La., J. C. Liner, 50 w, C.

KMMJ
740 kc, Clay Center, Neb., The M. M. Johnson Co., 1000 w, C, The Old Trusty Station."

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, "Your Friend in Hollywood."

KNX
1050 kc, Hollywood, Calif., Western Broadcast Co., 5000 w, P, "The Voice of Hollywood."

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

KOAC
550 kc, Corvallis, Ore., Oregon State Agricultural College, 1000 w, P, "Science for Service."

KOB
1180 kc, State College, N. M., N. M. College of Agri. & Mech. Arts, 20,000 w, M, "The Sunshine State of America."

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

KOH
1380 kc, Reno, Nevada, Jay Peters, Inc., 500 w.

KOIL
1260 kc, Council Bluffs, Iowa, Mona Motor Oil Co., 1000 w, C, "The Hilltop Studio."

KOIN
940 kc, Portland, Ore., KOIN, Inc., 1000 w, P, "The Station of the Hour."

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, "Kind Friends Come Back."

KPCB
650 kc, Seattle, Wash., Wescoast Broadcasting Co., 100 w, P. Shared.

KPJM
1500 kc, Prescott, Ariz., Miller & Klahn, 100 w, M.

KPO
680 kc, San Francisco, Calif., Hale Bros. & The Chronicle, 5000 w, P, "The City of the Golden Gate."

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, "Kotton Port Rail Center."

KPSN
1360 kc, Pasadena, Calif., Pasadena Star-News, 1000 w, P.

KQV
1380 kc, Pittsburgh, Pa., Doubleday-Hill Elec. Co., 500 w, E, "The Smoky City Station."

KQW
1010 kc, San Jose, Calif., Pacific Agric. Foundation, 500 w, P, "For God and Country."

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, "Down Where the Blue Bonnets Grow."

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, KSEI Broadcasting Assn., 250 w, M, "Kummunity Southeast Idaho."

KSL
1130 kc, Salt Lake City, Utah, Radio Service Corp., 5000 w, M, "The Voice of the Intermountain Empire."

KSMR
1200 kc, Santa Maria, Calif., Santa Maria Radio Co., 100 w, P, "The Valley of Gardens."

KSO
1380 kc, Clarinda, Iowa, Berry Seed Co., 500 w, C. "Keep Serving Others."

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, "Knowledge, Truth and Beauty."

KTAP
1420 kc, San Antonio, Texas. Alamo Broadcasting Co., 100 w, C, "The World's Biggest Little Station."

KTAR
620 kc, Phoenix, Ariz., KTAR Broadcasting Co., 500 w, M, "Phoenix, Where Winter Never Comes."

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

KTBI
1300 kc, Los Angeles, Calif., Bible Institute of Los Angeles, 1000 w, P.

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

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

KTHS
1040 kc, Hot Springs, Ark., Chamber of Commerce, 10,000 w, C, "Kum to Hot Springs."

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

KTM
780 kc, Los Angeles, Calif., Pickwick Broadcasting Corp., 500 w, P, "The Station with a Smile."

KTNT
1170 kc, Muscatine, Iowa, Norman Baker, 5000 w C, "The Voice of the Iowa Farmers' Union."

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
1270 kc, Seattle, Wash., First Presbyterian Church, 1000 w, P.

KUJ
1500 kc, Longview, 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., Rice Hotel, 100 w, C.

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

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

KVOA
1260 kc, Tuscon, Ariz., R. M. Riculfi, 500 w.

KVOO
1140 kc, Tulsa, Okla., Southwestern Sales Corp., 5000 w, C, "The Voice of Oklahoma."

KVOS
1200 kc, Bellingham, Wash., KVOS, Inc., 100 w, M.

KWCR
1310 kc, Cedar Rapids, Iowa, Harry F. Paar, 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, "The Voice from Broadway."

KWK
1350 kc, St. Louis, Mo., Greater St. Louis Broadcasting Corp., 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 Washinyton, 1000 w, P, "The Voice of the Cougars."

KWWG
1260 kc, Brownsville, Texas, Brownsville Herald Publishing Co., 500 w, C, "Good Night, World."

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

KXL
1420 kc, Portland, Ore., KXL Broadcasters, Inc., 100 w, P, "The Voice of Portland."

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.

KZM
1370 kc, Hayward, Calif., Leon P. Tenney, 100 w, P.

NAA
690 kc, 434.5 m, United States Navy Department, Washington, D. C., 1000 w, "Where the Time Signals Originate," E.

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

WAAM
1250 kc, Newark, N. J., WAAM, Inc., 1000 w, E, "Sunshine Station."

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, "Pioneer Market Station of the West."

WABC
860 kc, New York City, N. Y., Atlantic Broadcasting Corp., 5000 w, E.

WABI
1200 kc, Bangor, Maine, Pine Tree Broadcasting Co., 100 w, E, "The Pine Tree Wave."

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, "Watch Akron Develop Commercially."

WAIU
640 kc, Columbus, Ohio, American Insurance Union, 500 w, E, "The Radio Voice of the American Insurance Union."

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., WASH Broadcasting Corp., 500 w, C.

WAWZ
1350 kc, New York, N. Y., Pillar of Fire, 250 w, E, "The Voice of the Heart of New York."

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

WBAK
1430 kc, Harrisburg, Pa., Pennsylvania State Police, 500 w, E, "The Voice of Pennsylvania."

WBAL
1060 kc, Baltimore, Md., Consolidated Gas, Elec. Co., 10,000 w, E, "The Station of Good Music."

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, "In Wyoming Valley, Home of the Anthracite."

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

WBBL
1210 kc, Richmond, Va., Grace Covenant Presbyterian Church, 100 w, E, "Richmond, the Gateway North and South."

WBBM
770 kc, Chicago, Ill., Atlass Co., Inc., 25,000 w, C.

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

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

WBCM
1410 kc, Bay City, Mich., James E. Davidson, 500 w, E, "Where the Summer Trail Begins."

WBCN
See under WENR.

WBEN
900 kc, Buffalo, N. Y., Buffalo Evening News, 1000 w, E.

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

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.

WBOQ
See under WABC.

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

WBRC
930 kc, Birmingham, Ala., Birmingham Broadcasting Co., 500 w, C, "The Biggest Little Station in the World."

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

WBSO
920 kc, Needham, Mass., Babson's Statistical Org., Inc., 250 w, E.

WBT
1080 kc, Charlotte, N. C., Station WBT, Inc., 5000 w, E, shared, "The Queen City of the South."

WBTM
1370 kc, Danville, Va., Clarke Elec. Co., 100 w, E.

WBZ
990 kc, Springfield, Mass., Westinghouse E. & M. Co., 15,000 w, E, "The Broadcasting Station of New England."

WBZA
990 kc, Boston, Mass., Westinghouse E. & M. Co., 500 w, E.

WCAC
600 kc, Storrs, Conn., Connecticut Agricultural College, 250 w, E, "Voice from the Nutmeg State."

WCAD
1220 kc, Canton, N. Y., St. Lawrence University, 500 w, E, "The Voice of the North Country."

WCAE
1220 kc, Pittsburgh, Pa., Kaufman & Baer Co. 1000 w, E, "Where Prosperity Begins."

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, "The College on the Hill."

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

WCAO
600 kc, Baltimore, Md., Monumental Radio, Inc., 250 w, E, "The Gateway of the South."

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, "Where Cheer Awaits U."

WCAX
1200 kc, Burlington, Vt., University of Vermont, 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., 7500 w, C, "Service to the Northwest."

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

WCFL
970 kc, Chicago, Ill., Chicago Federation of Labor, 1500 w, C, "The Voice of Labor."

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, "The Watch Tower—Radio WORD."

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, "The Voice of Culver."

WCOA
1340 kc, Pensacola, Fla., City of Pensacola, 500 w, E, "Wonderful City of Advantages."

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

WCOD
1200 kc, Harrisburg, Pa., N. R. Hoffman Co., 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., Jordan & Burk, 500 w, E.

WCSH
940 kc, Portland, Me., Congress Square Hotel Co., 1000 kc, E, "The Voice From Sunrise Land."

WDAE
1220 kc, Tampa, Fla., Tampa Publishing Co., 1000 w, E, "WDAE, the Voice of the Times at Tampa."

WDAF
610 kc, Kansas City, Mo., Kansas City Star Co., 1000 w, C, "Enemies of Sleep."

WDAG
1410 kc, Amarillo, Texas, National Radio & Broadcasting Corp., 250 w, C, "Where Dollars Always Grow."

WDAH
1310 kc, El Paso, Texas, Eagle Broadcasting Co., 100 w, M.

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

WDBJ
930 kc, Roanoke, Va., Richardson-Wayland Elec. Corp., 250 w, E, "The Magic City."

WDBO
1120 kc, Orlando, Fla., Orlando Broadcasting Co., 1000 w, E, "Down Where the Oranges Grow."

WDEL
1120 kc, Wilmington, Del., WDEL, Inc., 250 w, E, "First City of the First State."

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

WDIX
1500 kc, Tupelo, Miss., Blair & Anderson, 100 w, C.

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

WDRC
1330 kc, New Haven, Conn., Doolittle Radio Corp., 500 w, E.

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

WDWF
1210 kc, Providence, R. I., Dutee W. Flint and The Lincoln Studios, 100 w, E.

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, "We Entertain a Nation."

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, "We Extend Buffalo's Regards."

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, "The Friendly Voice."

WEHC
1200 kc, Emory, Va., Emory and Henry College, 100 w, E.

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

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

WELL
1420 kc, Battle Creek, Mich., Enquirer-News Co., 50 w, E.

WENR
870 kc, Chicago, Ill., Great Lakes Radio Broadcasting Co., 50,000 w, C, "Voice of Service."

WEPS
See under WORC.

WEVD
1300 kc, New York, 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, "Working for All Alike."

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, WFBE, Inc., 100 w, E.

WFBG
1310 kc, Altoona, Pa., William F. Gable Co., 100 w, E, "The Original Gateway to the West and We Wish You All the Very Best."

WFBL
1360 kc, Syracuse, N. Y., The Onondaga Co., Inc., 1000 w, E, "When Feeling Blue, Listen."

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

WFBR
1270 kc, Baltimore, Md., Baltimore Radio Show, Inc., 250 w, E, "Home of the Star Spangled Banner."

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

WFDV
1370 kc, Rome, Ga., Dolies Goings, 100 w, E.

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

WFI
560 kc, Philadelphia, Pa., Strawbridge & Clothier, 500 w, E.
"Key City of Industry."

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

WFJC
1450 kc, Akron, Ohio, WGAR Broadcasting Co., 500 w, E.

WFLA
620 kc, Clearwater, Fla., Clearwater Chamber of Commerce and St. Petersburg Chamber of Commerce, 1000 w, E, "Inviting the World to the Springtime City."

WGAL
1310 kc, Lancaster, Pa., WGAL, Inc., 100 w, E, "World's Gardens at Lancaster."

WGBB
1210 kc, Freeport, N. Y., Harry H. Carman, 100 w, E, "The Voice of the Sunrise Trail."

WGBC
1430 kc, Memphis, Tenn., Memphis Broadcasting Co., 500 w, C. Shared.

WGBF
630 kc, Evansville, Ind., Evansville on the Air, Inc., 500 w, E, "Gateway to the South."

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

WGBS
600 kc, New York, N. Y., General Broadcasting System, Inc., 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, "World's Greatest Entertainment Service."

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, "The Southern School with the National Reputation."

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

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, "Ohio's Highest Point."

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., Citizens Bank, 100 w, C, "First Hoosier Bank on the Air."

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., Wm. Hood Dunwoody Ind. Inst., 500 w, C.

WHDL
1420 kc, Tupper Lake, N. Y., Tupper Lake Broadcasting Corp., 10 w, E.

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

WHFC
1420 kc, Cicero, Ill., Triangle Broadcasters, 100 w, C.

WHIS
1420 kc, Bluefield, W. Va., Daily Telegraph Printing Co., 100 w, E.

WHK
1390 kc, Cleveland. Ohio. Radio Air Service Corp., 1000 w, E, "Cleveland's Pioneer Station."

WHN
1010 kc, New York, N. Y., Marcus Loew Booking Review, 250 w, E, "Voice of the Great White Way."

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., Pennsylvania Broadcasting Co., 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., St. Paul's Church, 50 w, E.

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

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

WIBR
1420 kc, Steubenville, Ohio, G. W. Robinson, 50 w. E, "Where Investments Bring Results."

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

WIBW
580 kc, Topeka, Kan., Topeka Broadcasting Assn., Inc., 1000 w, C, "Topeka—Where Investment Brings Wealth."

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

WICC
1190 kc, Bridgeport, Conn.. Bridgeport Broadcasting Station, Inc.. 500 w, E. "The Industrial Capital of Connecticut."

WIL
1200 kc, St. Louis, Mo., Missouri Broadcasting Co., 100 w, C, "A Wave Length Ahead."

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, "Wonderful Isle of Dreams."

WIP
610 kc, Philadelphia, Pa., Gimbel Bros., Inc., 500 w, E, "Watch Its Progress."

WIS
1010 kc, Columbia, S. C., George T. Barnes, Inc., 500 w, E.

WISJ
560 kc, South Madison, Wis., Wisconsin State Journal Broadcasting Co., 500 w. C.

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

WJAC
1310 kc, Johnstown, Pa., Johnstown Automobile Co., 100 w, E, "The Voice of the Friendly City."

WJAG
1060 kc, Norfolk, Neb., Norfolk Daily News, 1000 w, C, "Home of the Printer's Devil."

WJAK
1310 kc, Marion, Ind., Marion Brdcst. Co., 50 w.

WJAR
890 kc, Providence, R. I., The Outlet Co., 250 w, E, "The Southern Gateway of New England."

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

WJAX
900 kc, Jacksonville, Fla., City of Jacksonville. 1000 w, E, "WJAX—W for Wonderful, JAX for Jacksonville."

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

WJAZ
1490 kc, Chicago, Ill., Zenith Radio Corp., 5000 w, C.

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, "In the Heart of the Keystone State."

WJBW
1200 kc, New Orleans, La., C. Carlsen, Jr., 30 w, C, "The Serve You Broadcasting Sttaion at New Orleans.

WJBY
1210 kc, Gadsden, Ala., Gadsden Broadcasting Co., 50 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, "Every Child Is Entitled to a High School Education and a Trade."

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

WJR
750 kc, Detroit, Mich., The Goodwill Station, Inc. 5000 w, E.

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

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. 500 w. E. "Porto Rico, The Island of Enchantment in the Caribbean Sea."

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

WKAV
1310 kc, Laconia, N. H., Laconia Radio Club, 100 w, E, "The Voice of the Winnepesaukee Lake Region."

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, "We Keep Building Friendships."

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

WKBI
1420 kc, Chicago, Ill., Fred L. Schoenwolf, 100 w, C.

WKBN
570 kc, Youngstown, Ohio, W. P. Williamson, Jr., 500 w, E.

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

WKBQ
1350 kc, New York, N. Y., Standard Cahill Co., Inc., 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., Kirk Johnson & Co., 100 w, E.

WKRC
550 kc, Cincinnati, Ohio, WKRC, Inc., 1000 w, E, "WKRC, K—Kodel, R—Radio, C—Corporation."

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

WKZO
590 kc, Berrien Springs, Mich., WKZO, Inc., 1000 w, C, "The Radio Lighthouse."

WLAC
1470 kc, Nashville, Tenn., Life & Casualty Ins. Co., 5000 w, C, "The Thrift Station."

WLAP
1200 kc, Louisville, Ky., American Broadcasting Corp. of Kentucky, 100 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, "Where Listeners Become Friends."

WLBG
1200 kc. Petersburg, Va., Robert Allen Gamble. 100 w. E.

WLBL
900 kc. Stevens Point, Wis., Wisconsin Department of Markets, 2000 w, daytime. C, "Wisconsin. Land of Beautiful Lakes."

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.

WLEX
1410 kc, Lexington, Mass., Lexington Air Station, 500 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, "The Quaker City Siren."

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

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

WLSI
See under WDWF.

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.

WMAF
1410 kc, So. Dartmouth, Mass., Round Hills Radio Corp., 500 w, E.

WMAK
1040 kc, Buffalo, N. Y., WMAK Broadcasting System, 1000 w, E.

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

WMAQ
670 kc, Chicago, Ill., WMAQ Inc., 5000 w, C.

WMAZ
890 kc, Macon, Ga., Macon Junior Chamber of Commerce, 250 w, E, shared, "Watch Mercer Attain Zenith."

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

WMBC
1420 kc, Detroit, Mich., Michigan Broadcasting Co., Inc., 100 w, E.

WMBD
1440 kc, Peoria Heights, Ill., Peoria Heights Radio Laboratory, 500 w.

WMBF
See under WIOD.

WMBG
1210 kc, Richmond, Va., Havens & Martin, Inc., 100 w, E, "The Daytime Station."

WMBH
1420 kc, Joplin, Mo., Edwin Dudley Aber, 100 w, C, "Where Memories Bring Happiness."

WMBI
1080 kc, Chicago, Ill., Moody Bible Institute Radio Station, 5000 w, C, shared, "The West Point of Christian Service."

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

WMBO
1310 kc, Auburn, N. Y., Radio Service Laboratories, 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, "WMBR, Everything for Radio at Tampa, Fla."

WMC
780 kc, Memphis, Tenn., Memphis Commercial Appeal, Inc., 500 w, C, "WMC, Memphis, Down in Dixie."

WMCA
570 kc, New York, N. Y., Knickerbocker Broadcasting Co., Inc., 500 w, E, "Where the White Way Begins."

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

WMPC
1500 kc, Lapeer, Mich., First Methodist Protestant Church, 100 w, E, "Where Many Preach Christ."

WMRJ
1210 kc, Jamaica, N. Y., Peter J. Prinz, 10 w, E, "The Gateway of the Sunrise Trail."

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, "The Voice of Soonerland."

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, "The Voice of the Triple Cities."

WNBH
1310 kc, New Bedford, Mass., New Bedford Broadcasting Co., 100 w, E, shared, "The Gateway to Cape Cod."

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, "The Voice of Newark."

WNOX
560 kc, Knoxville, Tenn., Sterchi Bros., 1000 w, C, "Smoky Mountain Station."

WNYC
570 kc, New York, N. Y., Department of Plant & Structures, 500 w, E, "Municipal Broadcasting Station of the City of New York."

WOAI
1190 kc, San Antonio, Texas, Southern Equipment Co., 50,000 w, C, "The Winter Playground of America."

WOAN
See WREC.

WOAX
1280 kc, Trenton, N. J., WOAX, Inc., 500 w, E, "Trenton Makes, the World Takes."

WOBT
1310 kc, Union City, Tenn., Titsworth's Radio & Music Shop, 100 w, C.

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, 25 w, E.

WODA
1250 kc, Paterson, N. J., Richard E. O'Dea, 1000 w, E, "The Voice of the Silk City."

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, Poughkeepsie, N. Y., Hudson Valley Broadcasting Corp., 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, "The Voice of the Whispering Pines."

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, "Watch Our State."

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, "The Omaha Station."

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, "The City of Diversified Industries."

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. Penn Broadcasting Co., 100 w, E, "First Wireless School in America."

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.

WPSC
1230 kc, State College, Pa., Pennsylvania State College, 500 w, day, E, "The Voice of the Nittany Lion."

WPTF
680 kc, Raleigh, N. C., Durham Life Insurance Co., 1,000 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, 5 w, E.

WQDX
1210 kc, Thomasville, Ga., Stevens Luke, 50 w, E.

WRAF
1200 kc, La Porte, Ind., Chas. Middleton, 100 w, C.

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

WRAW
1310 kc, Reading, Pa., Reading Broadcasting Co., 50 w, E, "The Schuylkill Valley Echo."

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

WRBI
1310 kc, Tifton, Ga., Kent's Furniture & Music Store, 20 w, E.

WRBJ
1370 kc, Hattiesburg, Miss., Woodruff Furniture Co., 10 w, C.

WRBL
1200 kc, Columbus, Ga., David Parmer, 50 w, E.

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

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

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

WRC
950 kc, Washington, D. C., National Broadcasting Co., 500 w, E, "The Voice of the Capital."

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, "Welcome Rosedale Hospital, Minneapolis."

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, "Carry Me Back to Old Virginny."

WSAI
1330 kc, Cincinnati, Ohio, Crosley Radio Corp., 500 w, E, "The Gateway to Dixie."

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

WSAN
1440 kc, Allentown, Pa., Allentown Call Pub. Co., 250 w, E, "We Serve Allentown Nationality." ity."

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, "The Voice of the South."

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

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

WSDA
See under WSGH.

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

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

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

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, "We Shield Millions."

WSMB
1320 kc, New Orleans, La., Saenger Theaters, Inc., & Maison Blanche Co., 500 w, C, "America's Most Interesting City."

WSMK
1380 kc, Dayton, Ohio, Stanley M. Krohn, Jr., 200 w, C, "The Home of Aviation."

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

WSPA
1420 kc, Spartanburg, S. C., 100 w, E, "The Voice of South Caroline."

WSPD
1340 kc, Toledo, Ohio, Toledo Broadcasting Co., 500 w, E.

WSSH
1410 kc, Boston, Mass., Tremont Temple Baptist Church, 500 w, E, "Stranger's Sunday Home."

WSUI
880 kc, Iowa City, Iowa, State Univ. of Iowa, 500 w, C, "The Old Gold Studio."

WSUN
See under WFLA.

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

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

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

WTAG
580 kc, Worcester, Mass., Worcester Telegram Pub. Co., Inc., 250 w, E, "The Voice From the Heart of the Commonwealth."

WTAM
1070 kc, Cleveland, Ohio, National Broadcasting Co., 50,000 w, E, "The Voice from the Storage Battery."

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, Toccoa, Ga., Toccoa Falls Institute, 500 w, E.

WTIC
1060 kc, Hartford, Conn., Travelers Broadcasting Service Corp., 50,000 w, E, "The Insurance City."

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

WTNT
1470 kc, Nashville, Tenn., Tenn. Pub. Co., 5000 w, C.

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

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

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

WWL
850 kc, New Orleans, La., Loyola University, 5000 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.

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.

Consolidated Broadcast List

Call Town

KBPS—Portland, Ore.
KBTM—Paragould, Ark.
KCRC—Enid, Okla.
KCRJ—Jerome, Ariz.
KDB—Santa Barbara, Calif.
KDFN—Casper, Wyo.
KDKA—Pittsburgh, Pa.
KDLR—Devils Lake, N. D.
KDYL—Salt Lake City, Utah
KECA—Los Angeles, Calif.
KELW—Burbank, Calif.
KEX—Portland, Ore.
KFAB—Lincoln, Neb.
KFBB—Great Falls, Mont.
KFBK—Sacramento, Calif.
KFBL—Everett, Wash.
KFDM—Beaumont, Tex.
KFDY—Brookings, S. D.
KFEL—Denver, Colo.
KFEQ—St. Joseph, Mo.
KFGQ—Boone, Iowa
KFH—Wichita, Kans.
KFI—Los Angeles, Calif.
KFIO—Spokane, Wash.
KFIU—Juneau, Alaska
KFIZ—Fond du Lac, Wis.
KFJB—Marshalltown, Iowa.
KFJF—Oklahoma City, Okla.
KFJI—Astoria, Ore.
KFJM—Grand Forks, N. D.
KFJR—Portland, Ore.
KFJY—Fort Dodge, Ia.
KFJZ—Fort Worth, Tex.
KFKA—Greeley, Colo.
KFKB—Milford, Kans.
KFKU—Lawrence, Kans.
KFKX—Chicago, Ill.
KFLV—Rockford, Ill.
KFLX—Galveston, Tex.
KFMX—Northfield, Minn.
KFNF—Shenandoah, Ia.
KFOR—Lincoln, Neb.
KFOX—Long Beach, Calif.
KFPL—Dublin, Tex.
KFPM—Greenville, Tex.
KFPW—Ft. Smith, Ark.
KFPY—Spokane, Wash.
KFQD—Anchorage, Alaska
KFQU—Holy City, Calif.
KFQW—Seattle, Wash.
KFRC—San Francisco, Calif.
KFRU—Columbia, Mo.
KFSD—San Diego, Calif.
KFSG—Los Angeles, Calif.
KFUL—Galveston, Tex.
KFUM—Colorado Spgs., Colo.
KFUO—St. Louis, Mo.
KFUP—Denver, Colo.
KFVD—Culver City, Calif.
KFVS—Cape Girardeau, Mo.
KFWB—Hollywood, Calif.
KFWF—St. Louis, Mo.
KFWI—San Francisco, Calif.
KFXD—Nampa, Idaho.
KFXF—Denver, Colo.
KFXJ—Edgewater, Colo.
KFXM—San Bernardino, Calif.
KFXR—Oklahoma City, Okla.
KFXY—Flagstaff, Ariz.
KFYO—Abilene, Tex.
KFYR—Bismarck, N. D.
KGA—Spokane, Wash.
KGAR—Tucson, Ariz.
KGB—San Diego, Calif.
KGBU—Ketchikan, Alaska
KGBX—St. Joseph, Mo.
KGBZ—York, Neb.
KGCA—Decorah, Ia.
KGCR—Watertown, S D
KGCU—Mandan, N. D.
KGCX—Wolf Point, Mont.
KGDA—Mitchell, S. D.
KGDE—Fergus Falls, Minn.
KGDM—Stockton, Calif.
KGDY—Huron, S. D.
KGEF—Los Angeles, Calif.
KGEK—Yuma, Colo.
KGER—Long Beach, Calif.
KGEW—Fort Morgan, Colo.
KGEZ—Kalispell, Mont.
KGFF—Alva, Okla.
KGFG—Oklahoma City, Okla.
KGFI—Corpus Christi, Tex.
KGFJ—Los Angeles, Calif.
KGFK—Moorhead, Minn.
KGFL—Raton, N. M.
KGFW—Ravenna, Neb.
KGFX—Pierre, S. D.
KGGC—San Francisco, Cal.
KGGF—So. Coffeyville, Okla.
KGGM—Albuquerque, N. M.
KGHF—Pueblo, Colo.
KGHI—Little Rock, Ark.
KGHL—Billings, Mont.
KGIQ—Twin Falls, Idaho
KGIR—Butte, Mont.
KGIW—Trinidad, Colo.
KGIX—Las Vegas, Nev.
KGIZ—Grant City, Mo.
KGJF—Little Rock, Ark.
KGKB—Brownwood, Tex.
KGKL—San Angelo, Tex.
KGKO—Wichita Falls, Tex.
KGKX—Sandpoint, Idaho
KGKY—Scottsbluff, Nebr.
KGMB—Honolulu, Hawaii.
KGMP—Elk City, Okla.
KGNF—North Platte, Nebr.
KGNO—Dodge City, Kans.
KGO—San Francisco, Calif.
KGRS—Amarillo, Tex.
KGU—Honolulu, T. H.
KGW—Portland, Ore.
KGY—Lacey, Wash.
KHJ—Los Angeles, Calif.
KHQ—Spokane, Wash.

Call Town

KICK—Red Oak, Ia.
KID—Idaho Falls, Idaho
KIDO—Boise, Idaho
KIT—Yakima, Wash.
KJBS—San Francisco, Calif.
KJR—Seattle, Wash.
KLCN—Blytheville, Ark.
KLO—Ogden, Utah
KLPM—Minot, N. D.
KLRA—Little Rock, Ark.
KLS—Oakland, Calif.
KLX—Oakland, Calif.
KLZ—Denver, Colo.
KMA—Shenandoah, Ia.
KMAC—San Antonio, Tex.
KMBC—Kansas City, Mo.
KMCS—Inglewood, Calif.
KMED—Medford, Ore.
KMJ—Fresno, Calif.
KMLB—Monroe, La.
KMMJ—Clay Center, Neb.
KMO—Tacoma, Wash.
KMOX—St. Louis, Mo.
KMPC—Beverly Hills, Calif.
KMTR—Los Angeles, Calif.
KNX—Hollywood, Calif.
KOA—Denver, Colo.
KOAC—Corvallis, Ore.
KOB—State College, N. M.
KOCW—Chickasha, Okla.
KOH—Reno, Nev.
KOIL—Council Bluffs, Ia.
KOIN—Portland, Ore.
KOL—Seattle, Wash.
KOMO—Seattle, Wash.
KONO—San Antonio, Tex.
KOOS—Marshfield, Ore.
KORE—Eugene, Ore.
KOY—Phoenix, Ariz.
KPCB—Seattle, Wash.
KPJM—Prescott, Ariz.
KPO—San Francisco, Calif.
KPOF—Denver, Colo.
KPPC—Pasadena, Calif.
KPQ—Wenatchee, Wash.
KPRC—Houston, Tex.
KPSN—Pasadena, Calif.
KQV—Pittsburgh, Pa.
KQW—San Jose, Calif.
KRE—Berkeley, Calif.
KREG—Santa Ana, Calif.
KRGV—Harlingen, Tex.
KRLD—Dallas, Tex.
KRMD—Shreveport, La.
KROW—Oakland, Calif.
KRSC—Seattle, Wash.
KSAC—Manhattan, Kans.
KSCJ—Sioux City, Ia.
KSD—St. Louis, Mo.
KSEI—Pocatello, Idaho
KSL—Salt Lake City, Utah
KSMR—Santa Maria, Calif.
KSO—Clarinda, Ia.
KSOO—Sioux Falls, S. D.
KSTP—St. Paul, Minn.
KTAB—San Francisco, Calif.
KTAP—San Antonio, Tex.
KTAR—Phoenix, Ariz.
KTAT—Ft. Worth, Tex.
KTBI—Los Angeles, Calif.
KTBR—Portland, Ore.
KTBS—Shreveport, La.
KTHS—Hot Springs, Ark.
KTLC—Houston, Tex.
KTM—Los Angeles, Calif.
KTNT—Muscatine, Ia.
KTRH—Houston, Tex.
KTSA—San Antonio, Tex.
KTSL—Shreveport, La.
KTSM—El Paso, Tex.
KTW—Seattle, Wash.
KUJ—Longview, Wash.
KUOA—Fayetteville, Ark.
KUSD—Vermillion, S. D
KUT—Austin, Tex.
KVI—Tacoma, Wash.
KVL—Seattle, Wash.
KVOA—Tucson, Ariz.
KVOO—Tulsa, Okla.
KVOS—Bellingham, Wash.
KWCR—Cedar Rapids, Ia.
KWEA—Shreveport, La.
KWG—Stockton, Cal.
KWJJ—Portland, Ore.
KWK—St. Louis, Mo.
KWKC—Kansas City, Mo.
KWKH—Shreveport, La.
KWLC—Decorah, Ia.
KWSC—Pullman, Wash.
KWWG—Brownsville, Tex.
KXA—Seattle, Wash.
KXL—Portland, Ore.
KXO—El Centro, Calif.
KXRO—Aberdeen, Wash.
KXYZ—Houston, Tex.
KYA—San Francisco, Calif.
KYW—Chicago, Ill.
KZM—Hayward, Calif.
WAAF—Chicago, Ill.
WAAM—Newark, N. J.
WAAT—Jersey City, N. J.
WAAW—Omaha, Neb.
WABC—New York City, N. Y.
WABI—Bangor, Me.
WABO—Rochester, N. Y.
WABZ—New Orleans, La.
WACO—Waco, Tex.
WADC—Tallmadge, Ohio
WAIU—Columbus, Ohio
WALR—Zanesville, Ohio.
WAPI—Birmingham, Ala.
WASH—Grand Rapids, Mich.
WAWZ—New York, N. Y.

Call Town

WBAA—Lafayette, Ind.
WBAK—Harrisburg, Pa.
WBAL—Baltimore, Md.
WBAP—Fort Worth, Tex.
WBAX—Wilkes-Barre, Pa.
WBBC—Brooklyn, N. Y.
WBBL—Richmond, Va.
WBBM—Chicago, Ill.
WBBR—Brooklyn, N. Y.
WBBZ—Ponca City, Okla.
WBCM—Bay City, Mich.
WBCN—Chicago, Ill.
WBEN—Buffalo, N. Y.
WBGF—Glens Falls, N. Y.
WBIG—Greensboro, N. C.
WBIS—Boston, Mass.
WBMS—Hackensack, N. J.
WBOQ—New York, N. Y.
WBOW—Terre Haute, Ind.
WBRC—Birmingham, Ala.
WBRE—Wilkes-Barre, Pa.
WBSO—Needham, Mass.
WBT—Charlotte, N. C.
WBTM—Danville, Va.
WBZ—Springfield, Mass.
WBZA—Boston, Mass.
WCAC—Storrs, Conn.
WCAD—Canton, N. Y.
WCAE—Pittsburgh, Pa.
WCAH—Columbus, Ohio
WCAJ—Lincoln, Neb.
WCAL—Northfield, Minn.
WCAM—Camden, N. J.
WCAO—Baltimore, Md.
WCAP—Asbury Park, N. J.
WCAT—Rapid City, S. D.
WCAU—Philadelphia, Pa.
WCAX—Burlington, Vt.
WCAZ—Carthage, Ill.
WCBA—Allentown, Pa.
WCBD—Zion, Ill.
WCBM—Baltimore, Md.
WCBS—Springfield, Ill.
WCCO—Minneapolis, Minn.
WCDA—New York, N. Y.
WCFL—Chicago, Ill.
WCGU—Brooklyn, N. Y.
WCHI—Chicago, Ill.
WCKY—Covington, Ky.
WCLB—Long Beach, N. Y.
WCLO—Janesville, Wis.
WCLS—Joliet, Ill.
WCMA—Culver, Ind.
WCOA—Pensacola, Fla.
WCOC—Meridian, Miss.
WCOD—Harrisburg, Pa.
WCOH—Yonkers, N. Y.
WCRW—Chicago, Ill.
WCSC—Charleston, S. C.
WCSH—Portland, Me.
WDAE—Tampa, Fla.
WDAF—Kansas City, Mo.
WDAG—Amarillo, Tex.
WDAH—El Paso, Tex.
WDAY—Fargo, N. D.
WDBJ—Roanoke, Va.
WDBO—Orlando, Fla.
WDEL—Wilmington, Del.
WDGY—Minneapolis, Minn.
WDIX—Tupelo, Miss.
WDOD—Chattanooga, Tenn.
WDRC—New Haven, Conn.
WDSU—New Orleans, La.
WDWF—Providence, R. I.
WDZ—Tuscola, Ill.
WEAF—New York, N. Y.
WEAI—Ithaca, N. Y.
WEAN—Providence, R. I.
WEAO—Columbus, Ohio
WEBC—Superior, Wis.
WEBQ—Harrisburg, Ill.
WEBR—Buffalo, N. Y.
WEDC—Chicago, Ill.
WEDH—Erie, Pa.
WEEI—Boston, Mass.
WEHC—Emory, Va.
WEHS—Evanston, Ill.
WELK—Philadelphia, Pa.
WELL—Battle Creek, Mich.
WENR—Chicago, Ill.
WEPS—Worcester, Mass.
WEVD—New York, N. Y.
WEW—St. Louis, Mo.
WEXL—Royal Oak, Mich.
WFAA—Dallas, Tex.
WFAN—Philadelphia, Pa.
WFBC—Knoxville, Tenn.
WFBE—Cincinnati, Ohio
WFBG—Altoona, Pa.
WFBL—Syracuse, N. Y.
WFBM—Indianapolis, Ind.
WFBR—Baltimore, Md.
WFDF—Flint, Mich.
WFDV—Rome, Ga.
WFDW—Talladega, Ala.
WFI—Philadelphia, Pa.
WFIW—Hopkinsville, Ky.
WFJC—Akron, Ohio
WFLA—Clearwater, Fla.
WGAL—Lancaster, Pa.
WGBB—Freeport, N. Y.
WGBC—Memphis, Tenn.
WGBF—Evansville, Ind.
WGBI—Scranton, Pa.
WGBS—New York, N. Y.
WGCM—Gulfport, Miss.
WGCP—Newark, N. J.
WGES—Chicago, Ill.
WGH—Newport News, Va.
WGL—Fort Wayne, Ind.
WGMS—Minneapolis, Minn.
WGN—Chicago, Ill.
WGR—Buffalo, N. Y.
WGST—Atlanta, Ga.
WGY—Schenectady, N. Y.
WHA—Madison, Wis.

Call Town

WHAD—Milwaukee, Wis.
WHAM—Rochester, N. Y.
WHAP—New York, N. Y.
WHAS—Louisville, Ky.
WHAT—Philadelphia, Pa.
WHAZ—Troy, N. Y.
WHB—Kansas City, Mo.
WHBC—Canton, Ohio
WHBD—Mt. Orab, Ohio
WHBF—Rock Island, Ill.
WHBL—Sheboygan, Wis.
WHBQ—Memphis, Tenn.
WHBU—Anderson, Ind.
WHBY—Green Bay, Wis.
WHDF—Calumet, Mich.
WHDH—Boston, Mass.
WHDI—Minneapolis, Minn.
WHDL—Tupper Lake, N. Y.
WHEC—Rochester, N. Y.
WHFC—Cicero, Ill.
WHIS—Bluefield, W. Va.
WHK—Cleveland, Ohio
WHN—New York, N. Y.
WHO—Des Moines, Iowa
WHOM—Jersey City, N. J.
WHP—Harrisburg, Pa.
WIAS—Ottumwa, Ia.
WIBA—Madison, Wis.
WIBG—Elkins Park, Pa.
WIBM—Jackson, Mich.
WIBO—Chicago, Ill.
WIBR—Steubenville, Ohio
WIBU—Poynette, Wis.
WIBW—Topeka, Kans.
WIBX—Utica, N. Y.
WICC—Bridgeport, Conn.
WIL—St. Louis, Mo.
WILL—Urbana, Ill.
WILM—Wilmington, Del.
WIOD—Miami, Fla.
WIP—Philadelphia, Pa.
WIS—Columbia, S. C.
WISJ—South Madison, Wis.
WISN—Milwaukee, Wis.
WJAC—Johnstown, Pa.
WJAG—Norfolk, Neb.
WJAK—Marion, Ind.
WJAR—Providence, R. I.
WJAS—Pittsburgh, Pa.
WJAX—Jacksonville, Fla.
WJAY—Cleveland, Ohio
WJAZ—Chicago, Ill.
WJBC—LaSalle, Ill.
WJBI—Red Bank, N. J.
WJBK—Highland Park, Mich.
WJBL—Decatur, Ill.
WJBO—New Orleans, La.
WJBT—Chicago, Ill.
WJBU—Lewisburg, Pa.
WJBW—New Orleans, La.
WJBY—Gadsden, Ala.
WJDX—Jackson, Miss.
WJJD—Chicago, Ill.
WJKS—Gary, Ind.
WJR—Detroit, Mich.
WJSV—Alexandria, Va.
WJW—Mansfield, Ohio
WJZ—New York, N. Y.
WKAQ—San Juan, P. R.
WKAR—E. Lansing, Mich.
WKAV—Laconia, N. H.
WKBB—Joliet, Ill.
WKBC—Birmingham, Ala.
WKBF—Indianapolis, Ind.
WKBH—La Crosse, Wis.
WKBI—Chicago, Ill.
WKBN—Youngstown, Ohio
WKBO—Jersey City, N. J.
WKBQ—New York, N. Y.
WKBS—Galesburg, Ill.
WKBV—Connersville, Ind.
WKBW—Buffalo, N. Y.
WKBZ—Ludington, Mich.
WKJC—Lancaster, Pa.
WKRC—Cincinnati, Ohio
WKY—Oklahoma City, Okla.
WKZO—Berrien Springs, Mich.
WLAC—Nashville, Tenn.
WLAP—Louisville, Ky.
WLB—Minneapolis, Minn.
WLBC—Muncie, Ind.
WLBF—Kansas City, Kans.
WLBG—Petersburg, Va.
WLBL—Stevens Point, Wis.
WLBW—Oil City, Pa.
WLBX—Long Island City, N. Y.
WLBZ—Bangor, Me.
WLCI—Ithaca, N. Y.
WLEX—Lexington, Mass.
WLEY—Lexington, Mass.
WLIB—Chicago, Ill.
WLIT—Philadelphia, Pa.
WLOE—Boston, Mass.
WLS—Chicago, Ill.
WLSI—Providence, R. I.
WLTH—Brooklyn, N. Y.
WLVA—Lynchburg, Va.
WLW—Cincinnati, Ohio
WLWL—New York, N. Y.
WMAC—Syracuse, N. Y.
WMAF—S. Dartmouth, Mass.
WMAK—Buffalo, N. Y.
WMAL—Washington, D. C.
WMAQ—Chicago, Ill.
WMAZ—Macon, Ga.
WMBA—Newport, R. I.
WMBC—Detroit, Mich.
WMBD—Peoria Heights, Ill.
WMBF—Miami, Fla.
WMBG—Richmond, Va.
WMBH—Joplin, Mo.
WMBI—Chicago, Ill.
WMBJ—Wilkinsburg, Pa.
WMBO—Auburn, N. Y.
WMBQ—Brooklyn, N. Y.
WMBR—Tampa, Fla.

Call Town

WMC—Memphis, Tenn.
WMCA—New York, N. Y.
WMMN—Fairmont, W. Va.
WMPC—Lapeer, Mich.
WMRJ—Jamaica, N. Y.
WMSG—New York, N. Y.
WMT—Waterloo, Ia.
WNAC—Boston, Mass.
WNAD—Norman, Okla.
WNAX—Yankton, S. D.
WNBF—Binghamton, N. Y.
WNBH—New Bedford, Mass.
WNBO—Silver Haven, Pa.
WNBR—Memphis, Tenn.
WNBW—Carbondale, Pa.
WNBX—Springfield, Vt.
WNBZ—Saranac Lake, N. Y.
WNJ—Newark, N. J.
WNOX—Knoxville, Tenn.
WNYC—New York, N. Y.
WOAI—San Antonio, Tex.
WOAN—Memphis, Tenn.
WOAX—Trenton, N. J.
WOBT—Union City, Tenn.
WOBU—Charleston, W. Va.
WOC—Davenport, Ia.
WOCL—Jamestown, N. Y.
WODA—Paterson, N. J.
WODX—Mobile, Ala.
WOI—Ames, Ia.
WOKO—Poughkeepsie, N. Y.
WOL—Washington, D. C.
WOMT—Manitowoc, Wis.
WOOD—Grand Rapids, Mich.
WOPI—Bristol, Tenn.
WOQ—Kansas City, Mo.
WOR—Newark, N. J.
WORC—Worcester, Mass.
WOS—Jefferson City, Mo.
WOV—New York, N. Y.
WOW—Omaha, Neb.
WOWO—Ft. Wayne, Ind.
WPAD—Paducah, Ky.
WPAP—New York, N. Y.
WPAW—Pawtucket, R. I.
WPCC—Chicago, Ill.
WPCH—New York, N. Y.
WPEN—Philadelphia, Pa.
WPG—Atlantic City, N. J.
WPOE—Patchogue, N. Y.
WPOR—Norfolk, Va.
WPSC—State College, Pa.
WPTF—Raleigh, N. C.
WQAM—Miami, Fla.
WQAN—Scranton, Pa.
WQAO—New York, N. Y.
WQBC—Vicksburg, Miss.
WQDM—St. Albans, Vt.
WQDX—Thomasville, Ga.
WRAF—La Porte, Ind.
WRAK—Williamsport, Pa.
WRAW—Reading, Pa.
WRAX—Philadelphia, Pa.
WRBI—Tifton, Ga.
WRBJ—Hattiesburg, Miss.
WRBL—Columbus, Ga.
WRBQ—Greenville, Miss.
WRBT—Wilmington, N. C.
WRBX—Roanoke, Va.
WRC—Washington, D. C.
WRDO—Augusta, Me.
WRDW—Augusta, Ga.
WREC—Memphis, Tenn.
WREN—Lawrence, Kans.
WRHM—Minneapolis, Minn.
WRJN—Racine, Wis.
WRNY—New York, N. Y.
WROL—Knoxville, Tenn.
WRR—Dallas, Tex.
WRUF—Gainesville, Fla.
WRVA—Richmond, Va.
WSAI—Cincinnati, Ohio
WSAJ—Grove City, Pa.
WSAN—Allentown, Pa.
WSAR—Fall River, Mass.
WSAZ—Huntington, W. Va.
WSB—Atlanta, Ga.
WSBC—Chicago, Ill.
WSBT—South Bend, Ind.
WSDA—Brooklyn, N. Y.
WSEN—Columbus, Ohio
WSFA—Montgomery, Ala.
WSGH—Brooklyn, N. Y.
WSIX—Springfield, Tenn.
WSJS—Winston-Salem, N. C.
WSM—Nashville, Tenn.
WSMB—New Orleans, La.
WSMK—Dayton, Ohio
WSOC—Gastonia, N. C.
WSPA—Spartanburg, S. C.
WSPD—Toledo, Ohio
WSSH—Boston, Mass.
WSUI—Iowa City, Ia.
WSUN—Clearwater, Fla.
WSVS—Buffalo, N. Y.
WSYR—Syracuse, N. Y.
WTAD—Quincy, Ill.
WTAG—Worcester, Mass.
WTAM—Cleveland, Ohio
WTAQ—Eau Claire, Wis.
WTAR—Norfolk, Va.
WTAW—College Station, Tex
WTAX—Springfield, Ill.
WTBO—Cumberland, Md.
WTEL—Philadelphia, Pa.
WTFI—Toccoa, Ga.
WTIC—Hartford, Conn.
WTMJ—Milwaukee, Wis.
WTNT—Nashville, Tenn.
WTOC—Savannah, Ga.
WWAE—Hammond, Ind.
WWJ—Detroit, Mich.
WWL—New Orleans, La.
WWNC—Asheville, N. C.
WWRL—Woodside, N. Y.
WWVA—Wheeling, W. Va.
WXYZ—Detroit, Mich.

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, WISJ.

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, WGBS

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

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, WMAZ, WGST, KGJF, 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

1020 Kilocycles, 293.9 Meters:
KYW, KFKX, WRAX

1030 Kilocycles, 291.1 Meters—Canadian Wave:

1040 Kilocycles, 288.3 Meters:
WKAR, KTHS, KRLD, WMAK

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

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, KTNT

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

1190 Kilocycles, 252.0 Meters:
WICC, WOAI

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

1210 Kilocycles, 247.8 Meters—Canadian Shared:
WJBI, WGBB, WCOH, WOCL, WLCI, WPAW, WDWF, 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.

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

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, KIDO, KFOX, WDSU

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

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

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

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

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

1310 Kilocycles, 228.9 Meters:
WKAV, WEBR, WNBH, WOL, WGH, WFDC, WHAT, WFBG, WRAW, WGAL, WSAJ, WBRE, WKBC, WOBT, KRMD, KFPM, WDAH, KFPL, KFXR, WKBS, WRBI, 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.

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

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, WKBQ, KWK, WAWZ.

1360 Kilocycles, 220.4 Meters:
WQBC, WJKS, WGES, KGIR, KGER, KPSN, WFBL, WCSC.

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

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

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

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

1410 Kilocycles, 212.6 Meters:
KGRS, WDAG, KFLV, WHBL, WBCM, WODX, WSFA, WLEX, WSSH, WMAF, WRBX.

1420 Kilocycles, 211.1 Meters:
WTBO, WKBI, WIBR, WEDH, WMBC, KGFF, WHIS, KTAP, KFYO, KICK, WIAS, KGGC, WLBF, WMBH, KFIZ, KORE, WILM, KGIW, KGKX, KFQW, KLPM, KXL, WHDL, WHFC, WEHS, KFQU, KFXD, KGIX, WJBO, WELL, WFDW, WPAD, WSPA, KBPS, KFXY, KXYZ

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

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

1450 Kilocycles, 206.8 Meters:
WBMS, WNJ, WKBO, WSAR, WFJC, 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, WJAZ, WCHI

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

U. S. Broadcasting Stations Listed by States

ALABAMA
Birmingham, WBRC, WKBC, WAPI
Gadsden, WJBY
Mobile, WODX
Montgomery, WSFA
Talladega, WFDW

ALASKA
Anchorage, KFQD
Juneau, KFIU
Ketchikan, KGBU

ARIZONA
Flagstaff, KFXY
Jerome, KCRJ
Phoenix, KTAR, KOY
Prescott, KPJM
Tuscon, KGAR, KVOA

ARKANSAS
Blytheville, KLCN
Fayetteville, KUOA
Fort Smith, KFPW
Hot Springs, KTHS
Little Rock, KLRA, KGHI, KGJF
Paragould, KBTM

CALIFORNIA
Berkeley, KRE
Beverley Hills, KMPC
Burbank, KELW
Culver City, KFVD
El Centro, KXO
Fresno, KMJ
Hayward, KZM
Hollywood, KNX, KFWB
Holy City, KFQU
Inglewood, KMCS
Long Beach, KFOX, KGER
Los Angeles, KFI, KFSG, KGEF, KGFJ, KHJ, KTBI, KECA, KMTR, KTM
Oakland, KLS, KLX, KROW
Pasadena, KPPC, KPSN
Sacramento, KFBK
San Bernardino, KFXM
San Diego, KFSD, KGB
San Francisco, KFRC, KFWI, KJBS,i KPO, KGGC, KYA, KGO, KTAB
San Jose, KQW
Santa Ana, KREG
Santa Barbara, KDB
Santa Maria, KSMR
Stockton, KGDM, KWG

COLORADO
Colorado Springs, KFUM
Denver, KFEL, KFUP, KFXF, KOA, KPOF, KLZ
Edgewater, KFXJ
Fort Morgan, KGEW
Greeley, KFKA
Pueblo, KGHF
Trinidad, KGIW
Yuma, KGEK

CONNECTICUT
Bridgeport, WICO
Hartford, WTIC
New Haven, WDRC
Storrs, WCAC

DELAWARE
Wilmington, WDEL, WILM

DISTRICT OF COLUMBIA
Washington, NAA, WMAL, WRC, WOL

FLORIDA
Clearwater, WFLA, WSUN
Gainesville, WRUF
Jacksonville, WJAX
Miami, WIOD, WMBF, WQAM
Orlando, WDBO
Pensacola, WCOA
Tampa, WDAE, WMBR,

GEORGIA
Atlanta, WGST, WSB
Augusta, WRDW
Columbus, WRBL
Macon, WMAZ
Rome, WFDV
Savannah, WTOC
Thomasville, WQDX
Tifton, WRBI
Toccoa, WTFI

HAWAII
Honolulu, KGU, KGMB

IDAHO
Boise, KIDO
Idaho Falls, KID
Nampa, KFXD
Pocatello, KSEI
Sandpoint, KGKX
Twin Falls, KGIQ

ILLINOIS
Carthage, WCAZ
Chicago, KYW, WAAF, WCFL, WCRW, WEDC, WENR, WGES, WKBI, WPCC, WGN, WMAQ, WMBI, WBBM, WSBC, WBCN, WIBO, WJAZ, WJBT, WLIB, WLS, KFKX, WJJD, WCHI
Cicero, WHFC
Decatur, WJBL
Evanston, WEHS
Galesburg, WKBS
Harrisburg, WEBQ
Joliet, WCLS, WKBB
La Salle, WJBC
Peoria Heights, WMBD
Quincy, WTAD
Rockford, KFLV
Rock Island, WHBF
Springfield, WCBS, WTAX
Tuscola, WDZ
Urbana, WILL
Zion, WCBD

INDIANA
Anderson, WHBU
Connersville, WKBV
Culver, WCMA
Evansville, WGBF
Fort Wayne, WGL, WOWO
Gary, WJKS
Hammond, WWAE
Indianapolis, WFBM, WKBF
Lafayette, WBAA
La Porte, WRAF
Marion, WJAK
Muncie, WLBC
South Bend, WSBT
Terre Haute, WBOW

IOWA
Ames, WOI
Boone, KFGQ
Cedar Rapids, KWCR
Clarinda, KSO
Council Bluffs, KOIL
Davenport, WOC
Decorah, KGCA, KWLC
Des Moines, WHO
Ft. Dodge, KFJY
Iowa City, WSUI
Marshalltown, KFJB
Muscatine, KTNT
Ottumwa, WIAS
Red Oak, KICK
Shenandoah, KFNF, KMA
Sioux City, KSCJ
Waterloo, WMT

KANSAS
Dodge City, KGNO
Kansas City, WLBF
Lawrence, KFKU, WREN
Manhattan, KSAC
Milford, KFKB
Topeka, WIBW
Wichita, KFH

KENTUCKY
Covington, WCKY
Hopkinsville, WFIW
Louisville, WHAS, WLAP
Paducah, WPAD

LOUISIANA
Cedar Grove, KGGH
Monroe, KMLB
New Orleans, WABZ, WCBE, WJBO, WJBW, WSMB, WWL, WDSU
Shreveport, KTSL, KWEA, KRMD, KTBS, KWKH

MAINE
Augusta, WRDO
Bangor, WABI, WLBZ
Portland, WCSH

MARYLAND
Baltimore, WCAO, WCBM, WBAL, WFBR
Cumberland, WTBO

MASSACHUSETTS
Boston, WBZA, WEEI, WNAC, WSSH, WBIS, WHDH, WLOE
Fall River, WSAR
Lexington, WLEX, WLEY
Needham, WBSO
New Bedford, WNBH
So. Dartmouth, WMAF
Springfield, WBZ
Worcester, WTAG, WORC, WEPS

MICHIGAN
Battle Creek, WELL
Bay City, WBCM
Berrien Springs, WKZO
Calumet, WHDF
Detroit, WMBC, WWJ, WJR, WXYZ
East Lansing, WKAR
Flint, WFDF
Grand Rapids, WASH, WOOD
Highland Park, WSBK
Jackson, WIBM
Lapeer, WMPC
Ludington, WKBZ
Royal Oak, WEXL

MINNESOTA
Anoka, WCCO
Fergus Falls, KGDE
Minneapolis, WDGY, WHDI, WLB, WRHM, WOCO, WGMS
Moorhead, KGFK
Northfield, KFMX, WCAL
St. Paul, KSTP

MISSISSIPPI
Greenville, WRBQ
Gulfport, WGCM
Hattiesburg, WRBJ
Jackson, WJDX
Meridian, WCOC
Tupelo, WDIX
Vicksburg, WQBC

MISSOURI
Cape Girardeau, KFVS
Columbia, KFRU
Grant City, KGIZ
Jefferson City, WOS
Joplin, WMBH
Kansas City, KWKC, WDAF, WOQ, WHB, KMBC
St. Joseph, KGBX, KFEQ
St. Louis, KFWF, KSD, KWK, WEW, WIL, KMOX, KFUO

MONTANA
Billings, KGHL
Butte, KGIR
Great Falls, KFBB
Kalispell, KGEZ
Wolf Point, KGCX

NEBRASKA
Clay Center, KMMJ
Lincoln, KFAB, KFOR, WOAJ
Norfolk, WJAG
North Platte, KGNF
Omaha, WAAW, WOW
Ravenna, KGFW
Scottsbluff, KGKY
York, KGBZ

NEVADA
Las Vegas, KGIX
Reno, KOH

NEW HAMPSHIRE
Laconia, WKAV

NEW JERSEY
Asbury Park, WCAP
Atlantic City, WPG
Camden, WCAM
Hackensack, WBMS
Jersey City, WAAT, WKBO, WHOM
Newark, WAAM, WGCP, WNJ, WOR
Paterson, WODA
Red Bank, WJBI
Trenton, WOAX

NEW MEXICO
Albuquerque, KGGM
Raton, KGFL
State College, KOB

NEW YORK
Auburn, WMBO
Binghamton, WNBF
Brooklyn, WBBC, WLTH, WMBQ, WSGH, WSDA, WBBR, WCGU
Buffalo, WEBR, WGR, WKBW, WSVS, WBEN, WMAK
Canton, WCAD
Freeport, WGBB
Glens Falls, WBGF
Ithaca, WLCI, WEAI
Jamaica, WMRJ
Jamestown, WOCL
Long Beach, WCLB
Long Island City, WLBX
New York, WHN, WJZ, WKBQ, WMCA, WMSG, WNYC, WPCH, WRNY, WABC, WOV, WQAO, WLWL, WBOQ, WCDA, WEAF, WEVD, WGBS, WHAP, WPAP, WAWZ
Patchogue, WPOE
Poughkeepsie, WOKO
Rochester, WHAM, WHEC
Saranac Lake, WNBZ
Schenectady, WGY
Syracuse, WFBL, WSYR, WMAC
Tupper Lake, WHDL
Troy, WHAZ
Utica, WIBX
Woodhaven, WEVD
Woodside, WWRL
Yonkers, WCOH

NORTH CAROLINA
Asheville, WWNC
Charlotte, WBT
Gastonia, WSOC
Greensboro, WBIG
Raleigh, WPTF
Wilmington, WRBT
Winston-Salem, WSJS

NORTH DAKOTA
Bismarck, KFYR
Devils Lake, KDLR
Fargo, WDAY
Grand Forks, KFJM
Mandan, KGCU
Minot, KLPM

OHIO
Akron, WFJC
Canton, WHBC
Cincinnati, WKRC, WSAI, WLW, WFBE
Cleveland, WHK, WJAY, WTAM
Columbus, WAIU, WCAH, WEAO, WSEN
Dayton, WSMK
Mansfield, WJW
Middleton, WSRO
Mt. Orab, WHBD
Steubenville, WIBR
Tallmadge, WADC
Toledo, WSPD
Youngstown, WKBN
Zanesville, WALR

OKLAHOMA
Alva, KGFF
Chickasha, KOCW
Elk City, KGMP
Enid, KCRC
Norman, WNAD
Oklahoma City, KFJF, KFXR, KGCB, KGFG, WKY
Ponca City, WBBZ
South Coffeyville, KGGF
Tulsa, KVOO

OREGON
Astoria, KFJI
Corvallis, KOAC
Eugene, KORE
Marshfield, KOOS
Medford, KMED
Portland, KEX, KOIN, KFJR, KGW, KTBR, KWJJ, KXL, KBPS

PENNSYLVANIA
Allentown, WCBA, WSAN
Altoona, WFBG
Carbondale, WNBW
Elkins Park, WIBG
Erie, WEDH
Frankford, WFKD
Grove City, WSAJ
Harrisburg, WCOD, WBAK, WHP
Johnstown, WJAC
Lancaster, WGAL, WKJC
Le Moyne, WHP
Lewisburg, WJBU
Oil City, WLBW
Philadelphia, WCAU, WFI, WIP, WLIT, WRAX, WPEN, WFAN, WELK, WHAT, WTEL
Pittsburgh, KQV, WCAE, WJAS, KDKA
Reading, WRAW
Scranton, WGBI, WQAN
Silver Haven, WNBO
State College, WPSC
Wilkes-Barre, WBAX, WBRE
Wilkinsburg, WMBJ
Williamsport, WRAK

PORTO RICO
San Juan, WKAQ

RHODE ISLAND
Cranston, WDWF
Newport, WMBA
Pawtucket, WPAW
Providence, WEAN, WJAR, WDWF

SOUTH CAROLINA
Charleston, WCSC
Columbia, WIS
Spartanburg, WSPA

SOUTH DAKOTA
Brookings, KFDY, KGCR
Huron, KGDY
Mitchell, KGDA
Pierre, KGFX
Rapid City, WCAT
Sioux Falls, KSOO
Vermillion, KUSD
Watertown, KGCR
Yankton, WNAX

TENNESSEE
Bristol, WOPI
Chattanooga, WDOD
Knoxville, WFBC, WNOX, WROL
Memphis, WGBC, WHBQ, WMC, WNBR, WOAN, WREC
Nashville, WLAC, WSM, WTNT
Springfield, WSIX
Union City, WOBT

TEXAS
Abilene, KFYO
Amarillo, KGRS, WDAG
Austin, KUT
Beaumont, KFDM
Brownsville, KWWG
Brownwood, KGKB
College Station, WTAW
Corpus Christi, KGFI
Dallas, KRLD, WFAA, WRR
Dublin, KFPL
El Paso, WDAH, KTSM
Fort Worth, KFJZ, WBAP, KTAT
Galveston, KFLX, KFUL
Greenville, KFPM
Harlingen, KRGV
Houston, KPRC, KTLC, KTRH, KXYZ
San Angelo, KGFI, KGKL
San Antonio, KTAP, KTSA, WOAI, KONO
Waco, WACO, KMAC
Wichita Falls, KGKO

UTAH
Ogden, KLO
Salt Lake City, KDYL, KSL

VERMONT
Burlington, WCAX
St. Albans, WQDM
Springfield, WNBX

VIRGINIA
Alexandria, WJVS
Arlington, NAA
Danville, WBTM
Emory, WEHC
Lynchburg, WLVA
Newport News, WGH
Norfolk, WTAR, WPOR
Petersburg, WLBG
Richmond, WBBL, WMBG, WRVA
Roanoke, WDBJ, WRBX

WASHINGTON
Aberdeen, KXRO
Bellingham, KVOS
Everett, KFBL
Lacey, KGY
Longview, KUJ
Pullman, KWSC
Seattle, KOL, KFQW, KPQ, KJR, KOMO, KPCB, KRSC, KTW, KVL, KXA
Spokane, KFIO, KFPY, KGA, KHQ
Tacoma, KMO, KVI
Wenatchee, KPQ
Yakima, KIT

WEST VIRGINIA
Bluefield, WHIS
Charleston, WOBU
Fairmont, WMMN
Huntington, WSAZ
Wheeling, WWVA

WISCONSIN
Eau Claire, WTAQ
Fond Du Lac, KFIZ
Green Bay, WHBY
Janesville, WCLO
La Crosse, WKBH
Madison, WHA, WIBA
Manitowac, WOMT
Milwaukee, WHAD, WISN, WTMJ
Poynette, WIBU
Racine, WRJN
Sheboygan, WHBL
South Madison, WISJ
Stevens Point, WLBL
Superior, WEBC

WYOMING
Casper, KDFN

FOREIGN BROADCAST STATIONS

ARGENTINA

Call		Meters
LP1	Buenos Aires	476
LP3	Buenos Aires	545
LP4	Buenos Aires	448
LP5	Buenos Aires	209.8
LP6	Buenos Aires	509
LR1	Buenos Aires	380
LR2	Buenos Aires	344.8
LR3	Buenos Aires	315.8
LR4	Buenos Aires	303
LR5	Buenos Aires	361.5
LR6	Buenos Aires	330
LR7	Buenos Aires	400
LR8	Buenos Aires	261
LR9	Buenos Aires	291.2
LS1	Buenos Aires	425
LS2	Buenos Aires	252.1
LS3	Buenos Aires	236.2
LS4	Buenos Aires	270.4
LS5	Buenos Aires	280.5
LS6	Buenos Aires	220.4
LS7	Buenos Aires	229.2
LS8	Buenos Aires	243.8
LS9	Buenos Aires	215.8
LT2	La Plata	438
LT3	Rosario	275.3
LT4	Mendoza	380
LT5	Parana	240
LT6	Mar Del Plata	212.7
LT8	La Plata	450
LV5	Rosario	218.9

AUSTRALIA

Call		Meters
7ZL	Hobart	516
3AR	Hobart	337
7HO	Melbourne	484
3LO	Melbourne	375
3UZ	Melbourne	322
3DB	Melbourne	255
2FC	Sydney	451
2BL	Sydney	350
2GB	Sydney	316
2UE	Sydney	293
2KY	Sydney	280
2UW	Sydney	267
6WF	Perth	435
6ML	Perth	297
5CL	Adelaide	412
5DN	Adelaide	313
5KA	Adelaide	250
5AD	Adelaide	229
4QG	Brisbane	394.5
4BC	Brisbane	233
4BK	Brisbane	217
4RK	Rockhampton	322
4GR	Toowoomba	294
7LA	Launceton	273
2MK	Bathurst	260
4CH	Charleville	256
4MK	Mackay	252
2NC	Newcastle	241
2HD	Newcastle	212
4TO	Townsville	238
3WR	Wangaratta	238
3TR	Trafalgar	234

Call		Meters
3BA	Ballarat	231
2AY	Albury	227
2XN	Carlton	222
3KZ	Lismore	224
3GL	Geelong	214
3BO	Bendigo	207
2MV	Moss Vale	205.4
2GN	Goulburn	201.3
2MO	Gunnedah	200
2CA	Canberra	285

AUSTRIA

	Graz	352
	Innsbruck	283
	Insbruck	218
	Klagenfurt	453
	Linz	246
	Vienna	517

BELGIUM

ON4ED	Anvers	250
ON4GT	Bruxells	260
ON4RB	Bruxells	508.5
ON4RC	Bruxells	215
BAV	Bruxells	589.4
ON4FO	Bruxells	230
ON4CE	Chatelineau	220
ON4FG	Dampremy	210
ON4RG	Gand	275
ON4RW	Liege	280
ON4BQ	Marchienne-Docherie	290
ON4EX	Ottomont	225
ON4CF	Verviers	215

BOLIVIA

	La Paz	175
	La Paz	300

BRAZIL

PRAM	Amparo	470
PRAH	Bahia	445
PRAN	Curytiba	340
PRAZ	Franca	270
PRAJ	Juiz de Fora	350
PRAY	Mogy das Cruzes	300
PRAD	Pelotas	326
PRAG	Porto Alegre	275
PRAF	Belem, Para	356
PRAP	Recife	400
PRAI	Ribeirao Preto	280
PRAA	Rio de Janeiro	400
PRAB	Rio de Janeiro	320
PRAC	Rio de Janeiro	350
PRAK	Rio de Janeiro	260
PRAX	Rio de Janeiro	220
PRAS	Santos	338
PRAE	Sao Paulo	368
PRAR	Sao Paulo	298
	Campinas	256

BRITISH COLONIES

TJW	Hamilton, Bermuda	545
ZBW	Victoria Peak, Hong Kong	350
7LO	Narobi	90
1SE	Singapore	330

BRITISH INDIA

VUB	Bombay	357.1
VUC	Calcutta	370.4
7CA	Calcutta	370.8
VPB	Colombo	480
VUR	Rangoon	398

CANAL ZONE

NBA	Panama	355

CANADA

CKX	Brandon	556
CNRC	Calgary	435
CFCN	Calgary	435
CJCJ	Calgary	435
CHCA	Calgary	435
CFAC	Calgary	435
CHCK	Charlottetown	313
CFCY	Charlottetown	313
CFCO	Chatham	246
CHWK	Chilliwack	246
CKMC	Cobalt	246
CJRW	Fleming	500
CFNB	Fredericton	246
CHMA	Edmonton	517
CKUA	Edmonton	517
CJCA	Edmonton	323
CNRE	Edmonton	323
CHNS	Halifax	323
CNRH	Halifax	323
CHCS	Hamilton	341
CHML	Hamilton	341
CKOC	Hamilton	341
CFCH	Iroquois Falls	500
CFJC	Kamloops	268
CFRC	Kingston	323
CFRB	King, York Co.	313
CNRX	King, York Co.	313
CJOC	Lethbridge	268
CJGC	London	330
CNRL	London	330
CNRA	Moncton	476
CKPR	Midland	323
CFCF	Montreal	291
CKAC	Montreal	411
CHYC	Montreal	411
CNRM	Montreal	411
CJRM	Moose Jaw	500
CHWC	Pilot Butte	313
CFLC	Prescott	297
CKPC	Preston	246
CKCO	Ottawa	337
CNRO	Ottawa	500
CHRC	Quebec	341
CKCI	Quebec	341
CKCV	Quebec	341
CNRQ	Quebec	341
CNRD	Red Deer	357
CKLC	Red Deer	357
CHCT	Red Deer	357
CKCK	Regina	313
CJBR	Regina	313
CNRR	Regina	313
CFQC	Saskatoon	330
CNRS	Saskatoon	330
CJOR	Sea Island	246
CFBO	St. John	337
CHGS	Summerside	268
CJCB	Sydney	341
CNRT	Toronto	357
CFCA	Toronto	357
CKOW	Toronto	357
CKGW	Toronto	435
CJBC	Toronto	435
CJSC	Toronto	435
CKCL	Toronto	517
CKNC	Toronto	517

Call		Meters
CFCL	Toronto	517
CNRV	Vancouver	291
CKCD	Vancouver	411
CHLS	Vaucouver	411
CKFC	Vancouver	411
CKMO	Vancouver	411
CKWK	Vancouver	411
CFCT	Victoria	476
CKCR	Waterloo	297
CKY	Winnipeg	385
CNRW	Winnipeg	385
CKIC	Wolfville	323
CJGX	Yorkton	476

CHILE

CMAO	Antofagasta	
	Asuncion	
CMAI	Concepcion	345
CMAD	Santiago	320
CMAE	Santiago	280
CMAB	Santiago	498
CMAC	Santiago	365
CMAF	Santiago	400
CMAT	Tacna	550
CMAK	Temuco	245
	Valparaiso	400

CHINA

COHB	Harbin	445
COMK	Mukden	425
	Shanghai	342
XGAH	Shanghai	328
XOL	Tientsin	480
GEC	Tientsin	280

COSTA RICA

NRH	Heredia	306
TIC	San Jose	340

CUBA

CMHD	Caibarien	325
CMJC	Camaguey	227
CMJA	Camaguey	225
CMHF	Camajuani	200
CMGE	Cardenas	218
CMJB	Ciego de Avila	224
CMJD	Ciego de Avila	192
CMHA	Cienfuegos	260
CMHH	Cifuentes	345
CMGA	Colon	360
CMCG	Guanabacoa	244.7
CMCT	Guanabacoa	201.6
CMAA	Guanajay	275
CMBH	Havana	201.6
CMBP	Havana	201.6
CMBL	Havana	201.6
CMCM	Havana	201.6
CMBE	Havana	213.4
CMBY	Havana	213.4
CMBI	Havana	213.4
CMBA	Havana	222.9
CMCD	Havana	222.9
CMCS	Havana	222.9
CMBF	Havana	222.9
CMCU	Havana	222.9
CMGR	Havana	233.4
CMBJ	Havana	233.4
CMCY	Havana	223
CMGE	Havana	233.4
CMBM	Havana	233.4
CMCW	Havana	233.4
CMCA	Havana	244.7
CMBX	Havana	244.7
CMCE	Havana	233
CMCR	Havana	233
CMQ	Havana	244.7
CMCN	Havana	244.7
CMBC	Havana	265.3
CMBT	Havana	265.3
CMCB	Havana	280.3
CMCC	Havana	280.3
CMBZ	Havana	280
CMBD	Havana	296.8
CMCK	Havana	313.8
CMCQ	Havana	313.8
CMX	Havana	314
CMCF	Havana	333.1
CMC	Havana	333.1
CMBS	Havana	245.8
CMK	Havana	379.5
CMW	Havana	410.8
CMBN	Havana	510
CMCO	Los Pinos	213.4
CMBK	Marianao	454.3
CMBM	Marianao	244.7
CMBQ	Marianao	233
CMBW	Marianao	233
CMBY	Marianao	296.8
CMGF	Marianao	213
CMGC	Matanzas	286
CMGD	Matanzas	282
CMGB	Matanzas	263
CMAB	Matanzas	263
CMBR	Pinar del Rio	240
CMHB	Reparto Poey	213.4
CMHE	Sagua la Grande	200
CMHI	Santa Clara	210
CMKA	Santa Clara	270
CMKB	Santiago de Cuba	205
CMKC	Saniago de Cuba	250
CMKD	Santiago de Cuba	231
CMBG	Santiago de Cuba	273
CHMC	Santiago de las Vegas	280
	Tuinuco	379

CZECHOSLOVAKIA

OKR	Bratislava	279
OKB	Brno	342
	Kosice	293
	Moravska-Ostrava	263
OKP	Praha	487
	Prague	250

DANZIG

	Danzig	453

DENMARK

	Kalundborg	1153.8
	Kobenhavn	281
	Soro	1153.8

DOMINICAN REPUBLIC

HIX	Santo Domingo	448

DUTCH EAST INDIES

PFC	Batavia	220.7
PLE	Bandoeng	31.86
PLE	Bandoeng	15.93
	Bandoeng	310
PLF	Malabar	17
	Surabaya	140

EGYPT

SRE	Cairo	255

Call		Meters

ESTONIA

	Tallinn	401
	Tartu	285

FINLAND

OFA	Helsinki	221
OFC	Jakobstad	291
OFB	Lahti, Suomi	1796
OFD	Pori	218
OFE	Tampere	453
OFG	Turku	246
OFH	Viipuri	291

FRANCE

	Bordeaux-Lafayette	304.3
PTT	Ecole Superieure	447
	Grenoble	328.2
	Lille	265.5
	Limoges	293.6
	Lyon La-Doua	465.8
	Marseille	315.8
	Montpellier	286
	Petit Parisien	326
	Radio-Agen	311.5
	Radio-Beziers	212
	Radio Juan-les-Pins	248
	Badio L. L.	368.1
	Radio Lyon	285.8
	Radio-Mont-de-Marsan	400
	Radio-Montpellier	250.1
	Radio-Nimes	240
	Badio Normandie	213.5
	Radio-Paris	1724
	Radio-Sud-Quest	237.2
	Radio Toulouse	380.7
	Eiffel	1444
	Badio Vitus	309
	Rennes	22
	Strasbourg	345.2
	Toulouse-Pyrenees	255.3

FRENCH COLONIES

8DB	Algiers	363.7
8KR	Constantine	42.8
	Haiphong	320
	Radio S. Denis, Reunion	500
TUA	Tunis	1450

GERMANY

	Aachen	453
	Augsburg	560
	Berlin I	419
	Berlin II	284
	Bremen	319
	Breslau	325
	Dresden	319
	Flensburg	218
	Frankfurt	390
	Freiburg	569
	Gleiwitz	253
	Hamburg	372
	Hanover	560
	Kaiserslautern	270
	Kassel	246
	Kiel	246
	Koln	227
	Konigsberg	276
	Konigswusterhausen	1635
	Langenberg	473
	Leipzig	259
	Magdeburg	283
	Munchen	533
	Munster	234
	Nordeich	1630
	Nurnberg	239
	Stettin	283
	Stuttgart	360
	Zeesen	1635

GREAT BRITAIN

2BD	Aberdeen	301
2BE	Belfast	242
6BM	Bournemouth	288.5
2LS	Bradford	288.5
5WA	Cardiff	310
5GB	Daventry	479
5XX	Daventry	1553
2DE	Dundee	288.5
2EH	Edinburgh	288.5
5SC	Glasgow	399
6KH	Hull	288.5
2LS	Leeds-Bradford	200
6LV	Liverpool	288.5
2LO	London	356
2ZY	Manchester	377
5NO	Newcastle	261
5PY	Plymouth	288.5
6FL	Sheffield	288.5
6ST	Stoke-on-Trent	288.5
5SX	Swansea	288.5

HAITI

HHK	Port au Prince	326

GUATEMALA

TGW	Guatemala	525

HOLLAND

	Bloemendaal	245.9
HDO	Hilversum	1071
	Hilversum	298
	Huizen	1875
	Scheveningen	1071

HUNGARY

	Lakihegy	550

ICELAND

	Akureyri	192
	Reykjavik	

IRISH FREE STATE

6CK	Cork	225
2BN	Dublin	413

ITALY

1BO	Bolzano	445.9
1GE	Genoa	385.1
1MI	Milan	500.8
1NA	Naples	331.4
	Palermo	209.8
1RO	Rome	441.1
1TO	Torino	275.2
	Trieste	256.4

JAPAN

JQAK	Dairen	395
JOFK	Hiroshima	353
JOJK	Kanazawa	423
JODK	Keijo	366
JOGK	Kumamoto	380
JOCK	Nagoya	370
JOBK	Osaka	400
JOIK	Sapporo	361
JOHK	Sendai	390
JOAK	Tokyo	345

Call		Meters
	JUGOSLAVIA	
	Belgrade	429
	Ljubljano	566
	Zagreb	308
	LATVIA	
YLZ	Riga	525
	LITHUANIA	
RYK	Kaunas	1935
	MEXICO	
XFF	Chihuahua	325
XEA	Guadalajara	250
XFC	Jalapa	373
XES	Tampico	337
XEY	Merida	548.6
XEX	Mexico City	231
XEN	Mexico City	425
XEB	Mexico City	333
XFG	Mexico City	470
XFI	Mexico City	367
XEO	Mexico City	445
XER	Mexico City	445
XEW	Mexico City	385
XEH	Monterey	265
XEI	Morelia	300
XEF	Oaxaca	265
XEE	Linares	300
YEZ	Mexico City	510
XFZ	Mexico City	349
XEV	Puebla	290
XED	Reynosa	312.2
XEQ	Cindad Juarez	400
XEU	Vera Cruz	375
XFE	Villahermosa	373
XEM	Tampico	357
XEJ	Cindad Juarez	350
XET	Monterey	337
YEK	Mexico City	300
XEG	Mexico City	291
XEL	Saltillo	275
XET	Nogales	273
XEC	Toluca	224
	MONACO	
	Monaco	237
	MOROCCO	
CNO	Casablanca	250
AIN	Casablanca	51
	Rabat	416
	Rabat	724.6
	NEW ZEALAND	
1YA	Auckland	333.3
1ZB	Auckland	275
1ZQ	Auckland	253
3YA	Christchurch	306.1
4YA	Dunedin	461.5
4ZB	Dunedin	277.8
4ZO	Dunedin	277
4ZM	Dunedin	253
4ZL	Dunedin	252
2ZE	Eketahura	248
2ZM	Gisborne	260
4ZP	Invercargill	258
4ZI	Invercargill	258
2YB	New Plymouth	244
2ZF	Palmerston North	285
2ZK	Wanganui	505
2YA	Wellington	416.7
	NORWAY	
LKA	Alesund	453
LKB	Bergen	364
LKF	Fredriksstad	394
LKH	Hamar	570
LKN	Notodden	283
LKO	Oslo	493
LKP	Porsgrund	453
LKR	Rjuken	447
LKM	Tromso	453
	Trondihen	1072
LKT	Trondelag Kringkoster	453.1

Call		Meters
	PERU	
OAX	Lima	380
	PHILIPPINE ISLANDS	
KZRC	Cebu	230.8
KZIB	Manila	260
KZKZ	Manila	270.3
KZRM	Manila	413
	POLAND	
	Krakow	313
	Krakow	244
	Kattowitz	408
SP6	Lodz	233.8
	Poznan	335
SP6	Lwow	385.1
SP8	Warsawa II	214
	Warszawa	1411
	Wilno	385.1
	PORTUGAL	
PIAA	Lisbon	305
	ROUMANIA	
	Bucharest	394
	Bucharest	226
	Jassy	211
	SALVADOR	
AQM	Salvador	482
RUS	Salvador	452
	SPAIN	
EAJ18	Almeria	251
EAJ13	Barcelona	462
EAJ1	Barcelona	344.8
EAJ12	Barcelona	268
EAJ9	Bilbao	434.8
EAJ3	Cadiz	400
EAJ16	Cartagena	246
EAR5	Las Palmas	250
EAR5	Las Palmas	350
EAJ7	Madrid	375
EAJ2	Madrid	424
EAJ25	Malaga	100
EAJ19	Oviedo	268
EAJ27	Salamanca	453
EAJ8	San Sebastian	349
EAJ17	Seville	368
	SWEDEN	
SBE	Boden	1200
SCA	Boras	231
SCB	Eskilstuna	246
SCC	Falum	322
SCD	Gavle	204.1
SBB	Goteborg	322
SCE	Halmstad	216
SCG	Halsingborg	231
SBH	Horby	257
SCF	Hudiksvall	270
SCH	Jonkoping	202
SCI	Kalmar	246
SCJ	Karlskrona	196
SCK	Karlstadt	218
SCL	Kiruna	246
SCM	Kristmehamm	203
SCN	Malmberget	436
SBC	Malmo	231
SBG	Motala	1348
SCO	Norrkoping	270
SCV	Orebro	237
SCW	Ornskoldsvik	218
SBF	Ostersund	770
SCP	Saffle	246
SCP	Stockholm	436
SBA	Sundsvall	542
SBD	Trollhattan	270
SCQ	Uddevalla	283
SCR	Umea	231
SCS	Uppsla	453
SCT	Varborg	283
SCU		
	SWITZERLAND	
HB3	Bale	1010
	Berne	403

Call		Meters
	Geneva	760
	Lausanne	680
HBZ	Zurich	459
	TURKEY	
	Angora	1806
TAL	Istanbul	1200
	Osmanieh	1200
	UNION OF SOVIET SOCIALIST REPUBLICS	
RV19	Achkhabad	899.1
RV26	Artemovsk	370
RV35	Astrakhan	690
RV8	Bakou	1380
RV30	Dnepropetrovsk	383
RV21	Erivan	750
RV40	Gomel	483
RV23	Groznyi	577
RV14	Irkoutsk	1600
RV31	Ivanovo-Voznesensk	337
RV17	Kazan	486
RV4	Kharkov	1304
RV20	Kharkov	426
RV9	Kiev	800
RV33	Krasnodar	461.5
RV3	Leningrad	1000
RV36	Leningrad	351
RV27	Makhatch Kala	443.8
RV10	Minsk	700
RV1	Moscow	1481
RV2	Moscow	720
RV37	Moscow	379
RV39	Moscow	379
RV42	Nijni-Novgorod	406
RV43	Nikolaev	366
RV6	Novosibirsk	1250
RV13	Odessa	411
RV44	Omsk	636
RV45	Orenbourg	650
RV22	Oufa	554.7
RV46	Petropavlovsk	437
RV29	Petrozavodsk	778
RV34	Piatigorsk	347
RV12	Rostov-sur-le-Don	848.7
RV16	Samara	417
RV18	Samarkand	875
RV24	Smolensk	565
RV32	Stavropol	545
RV49	Stchelkovo	938
RV5	Sverdlovsk	825
RV11	Tachkent	712
RV7	Tiflis	1060
RV48	Tomsk	465
RV41	Veliki Oustug	535.7
RV28	Vladivostok	480
RV25	Voronej	468.8
	URUGUAY	
CX 6	Montevideo	461.5
CX10	Montevideo	411
CX12	Montevideo	389.6
CX14	Montevideo	370.4
CX16	Montevideo	353
CX18	Montevideo	337
CX20	Montevideo	322.6
CX22	Montevideo	309.3
CX24	Montevideo	297
CX26	Montevideo	286
CX30	Montevideo	265.3
CX32	Montevideo	256
CX34	Montevideo	248
CX36	Montevideo	240
CX40	Montevideo	225.6
CX42	Montevideo	219
CX46	Montevideo	206.9
	UNION OF SOUTH AFRICA	
ZTC	Capetown	375
ZTD	Durban	406.5
ZTJ	Johannesburg	450
ZTJ	Johannesburg	32
	Pretoria	323
	VENEZUELA	
AYRE	Caracas	375

SHORT WAVE RELAY BROADCASTING STATIONS

United States

Call	Owner	Kilocycles	Meters
W2XAC	General Electric, Schenectady, N. Y.	8,690	34.5
W2XAD	General Electric, Schenectady, N. Y.	15,340	19.56
W2XAF	General Electric, Schenectady, N. Y.	9,530	31.48
W2XAL	Aviation Radio, Coytesville, N. J.	6,040	49.67
W2XAL	Aviation Radio, Coytesville, N. J.	11,800	25.42
W2XAL	Aviation Radio, Coytesville, N. J.	15,250	19.67
W2XAL	Aviation Radio, Coytesville, N. J.	21,460	13.97
W2XBR	Baruchrome Corporation, New York, N. Y.	6,020	49.83
W2XCX	L. Bamberger, Newark, N. J.	6,080	49.34
W2XE	Atlantic Broadcasting Co., Jamaica, N. Y.	11,840	25.34
W2XE	Atlantic Broadcasting Co., Jamaica, N. J.	15,280	19.63
W3XAL	Radio Corporation, New York, N. Y.	6,100	49.18
W3XAL	Radio Corporation, New York, N. Y.	9,570	31.35
W3XAL	Radio Corporation, New York, N. Y.	11,720	25.6
W3XAL	Radio Corporation, New York, N. Y.	15,130	19.83
W3XAL	Radio Corporation, New York, N. Y.	17,780	16.87
W3XAL	Radio Corporation, New York, N. Y.	21,500	13.95
W3XL	Radio Corporation, New York, N. Y.	6,020	49.83
W3XAU	Universal Broadcasting Co., Philadelphia, Pa.	6,060	49.5
W3XAU	Universal Broadcasting Co., Philadelphia, Pa.	9,590	30.1
W6XAL	Pacific-Western Broadcasting Fed., Westminster, Calif.	6,080	49.34
W6XAL	Pacific-Western Broadcasting Fed., Westminster, Calif.	15,250	19.67
W6XAL	Pacific-Western Broadcasting Fed., Westminster, Calif.	21,500	13.95
W6XN	General Electric, Oakland, Calif.	12,850	23.35
W8XAL	Crosley Radio Corporation, Cincinnati, Ohio	6,060	49.5
W8XK	Westinghouse, East Pittsburgh, Pa.	6,140	48.86
W8XK	Westinghouse, East Pittsburgh, Pa.	9,570	31.35
W8XK	Westinghouse, East Pittsburgh, Pa.	18,880	15.89
W8XK	Westinghouse, East Pittsburgh, Pa.	15,210	19.72
W8XK	Westinghouse, East Pittsburgh, Pa.	17,780	16.87
W8XK	Westinghouse, East Pittsburgh, Pa.	21,540	13.93
W9XA	General Electric, Denver, Colo.	9,530	31.48
W9XAA	Federation of Labor, Chicago, Ill.	6,080	49.34
W9XAQ	Chicago Daily News, Chicago, Ill.	6,040	49.67
W9XU	Mona Motor Oil Co., Council Bluffs, Iowa	6,060	49.5
W9XF	Great Lakes Broadcasting Co., Chicago, Ill.	6,020	49.83
W9XF	Great Lakes Broadcasting Co., Chicago, Ill.	11,800	25.42
W9XF	Great Lakes Broadcasting Co., Chicago, Ill.	21,500	13.95

Foreign

Call	Owner	Kilocycles	Meters
XFD	Mexico City, Mexico	6,667	45
XFD	Mexico City, Mexico	9,091	33
XFD	Mexico City, Mexico	11,111	27
XFA	Mexico City, Mexico	6,977	43
G5SW	Chelmsford, England	11,750	25.53
GBX	Rugby, England	10,770	27.86
PJZ	Curacao, Curacao	11,718.9	25.60
TJW	Hamilton, Bermuda	9,500	31.6
PCJ	Hilversum, Holland	15,220	19.71
PCJ	Hilversum, Holland	9,590	31.28
PHI	Huizen, Holland	17,775	16.88
OXQ	Kopenhavn, Denmark	9,520	31.51
OXQ	Kopenhavn, Denmark	6,090	49.26
	Lyngby, Denmark	9,520	31.51
	Koenigswusterhausen, Germany	9,560	31.38
	Koenigswusterhausen, Germany	15,200	19.74
	Koenigswusterhausen, Germany	21,500	13.95
VK3ME	Melbourne, Australia	9,510	31.55
VK6WF	Perth, Australia	3,000	100
VK2ME	Sydney, Australia	9,590	31.28
UOR2	Vienna, Austria	6,072	49.4
	Vienna, Austria	11,801	25.42
	Rome, Italy	11,810	25.40
	Paris, France	6,122	49.02
CJRX	Winnipeg, Canada	11,720	25.6
ZTD	Durban, South Africa	7,400	40.5
RV15	Khabarovsk, U. S. S. R.	4,273.5	70.2
RV38	Moscow, U. S. S. R.	5,514.7	54.4
NRH	Heredia	9,734	30.8
HRB	Tegucigalpa, Honduras	6,005	49.96

VISUAL BROADCASTING STATIONS

Call	Kilocycles	Meters	Owner
W3XK	2000-2100	150-143	Jenkins Laboratories, Wheaton, Md.
W2XBU	2000-2100	150-143	Harold E. Smith, Beacon, N. Y.
W2XCD	2000-2100	150-143	DeForest Radio Co., Passaic, N. J.
W9XAO	2000-2100	150-143	Western Television Corp., Chicago, Ill.
W2XAP	2000-2100	150-143	Jenkins Television Corp. (Portable).
W2XCR	2000-2100	150-143	Jenkins Television Corp., Jersey City, N. J.
W3XAD	2100-2200	143-136	RCA Victor Co., Camden, N. J.
W2XBS	2100-2200	143-136	National Broadcasting Co., New York City.
W3XAK	2100-2200	143-136	National Broadcasting Co., Bound Brook, N. J.
W8XAV	2100-2200	143-136	Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
W2XCW	2100-2200	143-136	General Electric Co., Schenectady, N. Y.
W9XAP	2100-2200	143-136	Chicago Daily News, Chicago, Ill.
W2XBC	2750-2850	109-105	United Research Corp., Long Island City, N. Y.
W9XAA	2750-2850	109-105	Chicago Federation of Labor, Chicago, Ill.
W9XC	2750-2850	109-105	Purdue University, W. LaFayette, Ind.
W1XAV	2850-2950	105-102	Short Wave & Television Laboratory, Boston, Mass.
W2XR	2850-2950	105-102	Radio Pictures, Inc., Long Island City, N. Y.
W9XR	2850-2950	105-102	Great Lakes Broadcasting Co., Chicago, Ill.

AIR-LINE DISTANCES IN STATUTE MILES

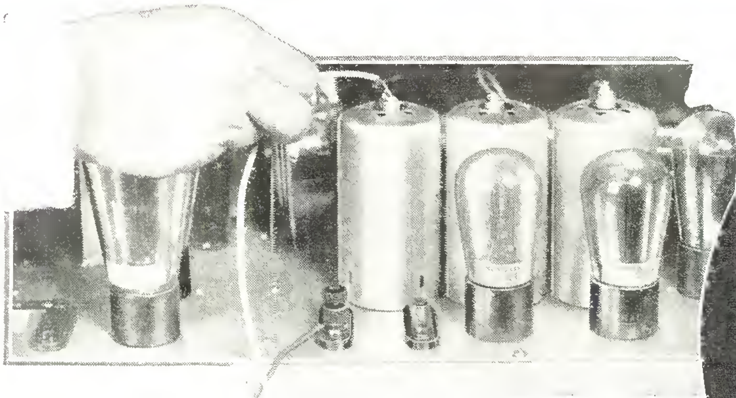
FROM/TO	Albuquerque, N. Mex.	Atlanta, Ga.	Baltimore, Md.	Boise, Idaho	Boston, Mass.	Brownsville, Tex.	Buffalo, N. Y.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Denver, Colo.	Des Moines, Iowa	Detroit, Mich.	El Paso, Tex.	Fargo, N. Dak.	Fort Worth, Tex.	Galveston, Tex.	Hastings, Nebr.	Hot Springs, Ark.	Houghton, Mich.	Jacksonville, Fla.	Kansas City, Mo.	Los Angeles Calif.	Louisville, Ky.	Memphis, Tenn.
Albuquerque, N. Mex.	......	1273	1670	774	1967	838	1577	1126	1248	1417	332	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938
Atlanta, Ga.	1273	......	575	1830	933	960	695	583	368	550	1208	738	595	1293	1112	750	688	901	498	947	286	675	1935	317	335
Baltimore, Md.	1670	575	......	2055	358	1525	273	603	423	305	1505	913	398	1750	1143	1239	1245	1154	964	808	682	962	2313	498	792
Boise, Idaho	774	1830	2055	......	2266	1610	1872	1453	1663	1754	637	1155	1671	969	975	1263	1538	934	1384	1367	2098	1158	663	1623	1506
Boston, Mass.	1967	933	358	2266	......	1881	398	849	737	550	1766	1159	613	2067	1304	1574	1598	1415	1302	922	1015	1250	2590	823	1133
Brownsville, Tex.	838	960	1525	1610	1881	......	1575	1234	1184	1402	1047	1102	1398	682	1445	471	287	1013	650	1543	1025	923	1370	1093	777
Buffalo, N. Y.	1577	695	273	1872	398	1575	......	454	392	175	1368	762	218	1690	923	1221	1289	1019	956	560	880	862	2195	483	802
Chicago, Ill.	1126	583	603	1453	849	1234	454	......	249	307	918	310	236	1249	571	820	954	566	585	367	861	413	1741	268	481
Cincinnati, Ohio	1248	368	423	1663	737	1184	392	249	......	218	1090	509	234	1333	818	839	897	742	569	589	628	541	1892	92	410
Cleveland, Ohio	1417	550	305	1754	550	1402	175	307	218	......	1223	617	94	1521	838	1046	1116	871	787	518	768	700	2044	309	627
Denver, Colo.	332	1208	1505	637	1766	1047	1368	918	1090	1223	......	607	1153	554	642	643	925	353	749	970	1468	555	828	1035	878
Des Moines, Iowa	833	738	913	1155	1159	1102	762	310	509	617	607	......	545	980	397	640	851	256	488	458	1024	180	1433	477	485
Detroit, Mich.	1360	595	398	1671	613	1398	218	236	234	94	1153	545	......	1475	745	1018	1111	800	761	427	832	643	1976	315	621
El Paso, Tex.	228	1293	1750	969	2067	682	1690	1249	1333	1521	554	980	1475	......	1161	543	723	757	302	1422	1481	836	702	1253	978
Fargo, N. Dak.	968	1112	1143	975	1304	1445	923	571	818	838	642	397	745	1161	......	973	1218	440	875	393	1400	548	1426	818	882
Fort Worth, Tex.	561	750	1239	1263	1574	471	1221	820	839	1046	643	640	1018	543	973	......	283	544	273	1093	943	460	1212	751	448
Galveston, Tex.	803	688	1245	1538	1598	287	1289	954	897	1116	925	851	1111	723	1218	283	......	808	375	1277	799	677	1423	807	492
Hastings, Nebr.	588	901	1154	934	1415	1013	1019	566	742	871	353	256	800	757	440	544	808	......	513	666	1178	226	1177	693	591
Hot Springs, Ark.	773	498	964	1384	1302	650	956	585	569	787	749	488	761	802	875	273	375	513	......	901	728	326	1437	480	176
Houghton, Mich.	1252	947	808	1367	922	1543	560	367	589	518	970	458	427	1422	393	1093	1277	666	901	......	1216	633	1787	636	830
Jacksonville, Fla.	1492	286	682	2098	1015	1025	880	861	628	768	1468	1024	832	1481	1400	943	799	1178	728	1216	......	952	2153	595	591
Kansas City, Mo.	717	675	962	1158	1250	923	862	413	541	700	555	180	643	836	548	460	677	226	326	633	952	......	1352	480	370
Los Angeles, Calif.	663	1935	2313	663	2590	1370	2195	1741	1892	2044	828	1433	1976	702	1426	1212	1423	1177	1437	1787	2153	1352	......	1825	1602
Louisville, Ky.	1174	317	498	1623	823	1093	483	268	92	309	1035	477	315	1253	818	751	807	693	480	636	595	480	1825	......	319
Memphis, Tenn.	938	335	792	1506	1133	777	802	481	410	627	878	485	621	978	882	448	492	591	176	830	591	370	1602	319	......
Miami, Fla.	1710	610	958	2368	1258	1100	1184	1190	957	1088	1732	1338	1156	1662	1721	1150	941	1468	983	1545	328	1247	2355	923	878
Minneapolis, Minn.	980	905	948	1140	1125	1335	733	356	603	632	699	235	542	1156	219	870	1087	399	722	272	1192	413	1522	605	700
Missoula, Mont.	895	1790	1947	252	2124	1706	1740	1348	1578	1640	670	1074	1552	1115	819	1312	1595	891	1385	1208	2070	1117	910	1550	1483
Nashville, Tenn.	1117	218	597	1631	941	952	626	394	239	456	1018	523	468	1169	900	643	666	697	370	760	502	472	1777	153	195
New Orleans, La.	1030	427	1001	1713	1359	536	1087	831	708	922	1079	825	938	986	1221	470	288	870	358	1187	511	678	1675	623	358
New York, N. Y.	1810	747	170	2153	188	1695	291	711	568	404	1628	1023	483	1902	1213	1398	1415	1275	1125	849	838	1097	2446	650	953
Norfolk, Va.	1696	507	167	2137	467	1465	435	696	474	429	1562	983	522	1755	1258	1226	1195	1216	955	946	548	1009	2352	528	778
Oklahoma, Okla.	518	753	1173	1138	1490	659	1117	689	755	946	503	469	905	578	786	188	456	357	260	926	988	293	1182	675	422
Omaha, Nebr.	718	815	1026	1044	1280	1061	883	432	620	738	485	122	666	875	390	590	828	135	490	547	1098	165	1312	579	529
Philadelphia, Pa.	1748	663	90	2113	268	1614	278	664	501	343	1575	972	444	1834	1186	1324	1335	1222	1051	827	758	1037	2388	580	878
Phoenix, Ariz.	330	1592	2002	733	2295	1023	1904	1451	1578	1745	585	1154	1685	347	1225	858	1065	901	1094	1550	1800	1045	357	1512	1264
Pittsburgh, Pa.	1498	520	194	1863	478	1424	178	411	258	115	1320	718	208	1592	952	1097	1140	967	825	630	703	784	2135	345	660
Portland, Me.	2015	1022	446	2282	100	1961	438	892	802	603	1803	1197	657	2126	1313	1642	1678	1454	1371	924	1113	1300	2631	892	1205
Portland, Oreg.	1107	2172	2367	349	2553	1944	2167	1765	1987	2063	985	1479	1975	1286	1248	1612	1885	1271	1733	1638	2442	1397	825	1953	1852
Richmond, Va.	1628	470	128	2060	471	1428	375	618	399	353	1488	905	445	1695	1180	1170	1154	1142	897	870	953	937	2283	457	722
St. Louis, Mo.	938	467	731	1389	1036	975	662	259	308	490	793	270	452	1033	658	568	697	455	325	591	755	238	1585	242	242
Salt Lake City, Utah	483	1580	1858	292	2099	1317	1701	1260	1450	1567	372	952	1490	689	865	977	1249	708	1116	1242	1840	922	577	1400	1250
San Francisco, Calif.	893	2133	2451	516	2696	1675	2298	1855	2037	2163	946	1547	2087	993	1447	1454	1693	1297	1648	1833	2375	1500	345	1983	1800
Schenectady, N. Y.	1823	840	278	2120	150	1770	249	702	605	408	1618	1012	467	1930	1157	1445	1487	1267	1175	776	960	1107	2445	695	1010
Seattle, Wash.	1178	2180	2341	405	2508	2015	2130	1743	1974	2035	1020	1470	1945	1373	1206	1658	1938	1288	1759	1588	2450	1505	956	1945	1867
Shreveport, La.	764	548	1064	1433	1410	510	1080	725	688	904	799	624	891	752	1002	209	233	615	142	1043	733	326	1420	598	279
Spokane, Wash.	1028	1960	2110	290	2279	1852	1900	1514	1746	1804	827	1243	1715	1238	976	1470	1753	1061	1552	1360	2239	1286	939	1720	1652
Springfield, Mass.	1889	863	282	2196	79	1805	325	774	659	473	1692	1085	540	1990	1240	1495	1524	1340	1224	860	957	1173	2515	745	1055
Vermillion, S. Dak.	742	917	1083	973	1314	1161	916	479	694	785	468	187	705	920	284	689	938	167	605	510	1203	280	1291	663	642
Washington, D. C.	1648	542	33	2045	392	1493	290	594	403	303	1490	985	397	1726	1141	1210	1214	1139	936	813	647	943	2295	473	763

AIR-LINE DISTANCES IN STATUTE MILES

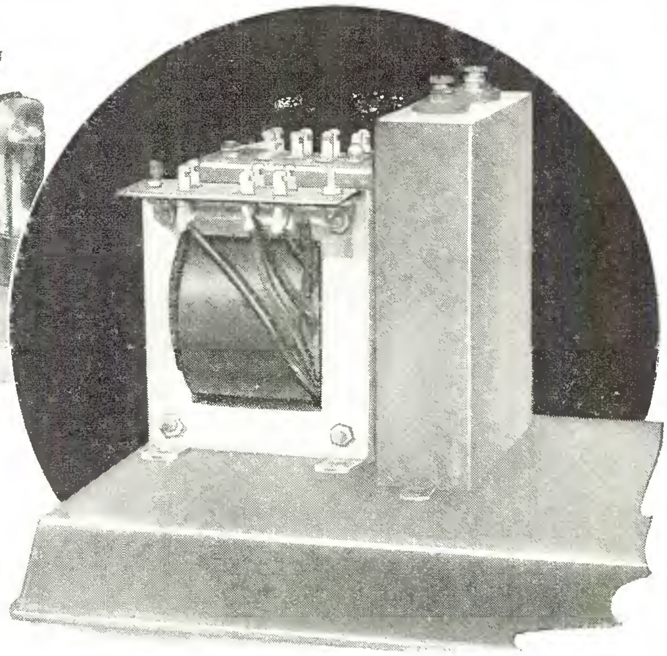
FROM/TO	Miami, Fla.	Minneapolis, Minn.	Missoula, Mont.	Nashville, Tenn.	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma, Okla.	Omaha, Nebr.	Philadelphia, Pa.	Phoenix, Ariz.	Pittsburgh, Pa.	Portland, Me.	Portland, Ore.	Richmond, Va.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Schenectady, N. Y.	Seattle, Wash.	Shreveport, La.	Spokane, Wash.	Springfield, Mass.	Vermillion, S. Dak.	Washington, D. C.
Albuquerque, N. Mex.	1710	980	895	1117	1030	1810	1696	518	718	1748	330	1498	2015	1107	1628	938	483	893	1823	1178	764	1028	1889	742	1648
Atlanta, Ga.	610	905	1790	218	427	747	507	753	815	663	1592	520	1022	2172	470	467	1580	2133	840	2180	548	1960	863	917	542
Baltimore, Md.	958	948	1947	597	1001	170	167	1173	1026	90	2202	194	446	2367	128	731	1858	2451	278	2341	1064	2110	282	1083	33
Boise, Idaho	2368	1140	252	1631	1713	2153	2137	1138	1044	2113	733	1863	2282	349	2060	1389	292	516	2120	405	1433	290	2196	973	2045
Boston, Mass.	1258	1125	2124	941	1359	188	467	1490	1280	268	2295	478	100	2553	471	1036	2099	2696	150	2508	1410	2279	79	1314	392
Brownsville, Tex.	1100	1335	1706	952	536	1695	1465	659	1061	1614	1023	1424	1961	1944	1428	975	1317	1675	1770	2015	510	1852	1805	1161	1493
Buffalo, N. Y.	1184	733	1740	626	1087	291	435	1117	883	278	1904	178	438	2167	375	662	1701	2298	249	2130	1080	1900	325	916	290
Chicago, Ill.	1190	356	1348	394	831	711	696	689	432	664	1451	411	892	1765	618	250	1260	1855	702	1743	725	1514	774	479	594
Cincinnati, Ohio	957	603	1578	239	708	568	474	755	620	501	1578	258	802	1987	399	308	1450	2037	605	1974	688	1746	659	694	403
Cleveland, Ohio	1088	632	1640	456	922	404	429	946	738	343	1745	115	603	2063	353	490	1567	2163	408	2035	904	1804	473	785	303
Denver, Colo.	1732	699	670	1018	1079	1628	1562	503	485	1575	585	1320	1803	985	1488	793	372	946	1618	1020	799	827	1692	468	1490
Des Moines, Iowa	1338	235	1074	523	825	1023	983	469	122	972	1154	718	1197	1479	905	270	952	1547	1012	1470	624	1243	1085	187	895
Detroit, Mich.	1156	542	1552	468	938	483	522	905	666	444	1685	208	657	1975	445	452	1490	2087	467	1945	891	1715	540	705	397
El Paso, Tex.	1662	1156	1115	1169	986	1902	1755	578	875	1834	347	1592	2126	1286	1695	1033	689	993	1930	1373	752	1238	1990	920	1726
Fargo, N. Dak.	1721	219	819	900	1221	1213	1258	786	390	1186	1225	952	1313	1248	1180	658	865	1447	1157	1206	1002	976	1240	284	1141
Fort Worth, Tex.	1150	870	1312	643	470	1398	1226	188	590	1324	858	1097	1642	1612	1170	568	977	1454	1445	1658	209	1470	1495	689	1210
Galveston, Tex.	941	1087	1595	666	288	1415	1195	456	828	1335	1065	1140	1678	1885	1154	697	1249	1693	1487	1938	233	1753	1524	938	1214
Hastings, Nebr.	1468	399	891	697	870	1275	1216	357	135	1222	901	967	1454	1271	1142	455	708	1297	1267	1288	615	1061	1340	167	1139
Hot Springs, Ark.	983	722	1385	370	358	1125	955	260	490	1051	1094	825	1371	1733	897	325	1116	1648	1175	1759	142	1552	1224	605	936
Houghton, Mich.	1545	272	1208	760	1187	849	946	926	547	827	1550	630	924	1638	870	591	1242	1833	776	1588	1043	1360	860	510	813
Jacksonville, Fla.	328	1192	2070	502	511	838	548	988	1098	758	1800	703	1113	2442	953	755	1840	2375	960	2450	733	2239	957	1203	647
Kansas City, Mo.	1247	413	1117	472	678	1097	1009	293	165	1037	1045	784	1300	1397	937	238	922	1500	1107	1505	326	1286	1173	280	943
Los Angeles, Calif.	2355	1522	910	1777	1675	2446	2352	1182	1312	2388	357	2135	2631	825	2283	1585	577	345	2445	956	1420	939	2515	1291	2295
Louisville, Ky.	923	605	1550	153	623	650	528	675	579	580	1512	345	892	1953	457	242	1400	1983	695	1945	598	1720	745	663	473
Memphis, Tenn.	878	700	1483	195	358	953	778	422	529	878	1264	660	1205	1852	722	242	1250	1800	1010	1867	279	1652	1055	642	763
Miami, Fla.	......	1516	2359	821	681	1095	802	1233	1402	1023	1998	1014	1357	2716	831	1067	2098	2603	1229	2740	950	2528	1210	1510	927
Minneapolis, Minn.	1516	......	1010	695	1050	1019	1047	692	291	985	1279	745	1145	1435	968	464	988	1585	975	1403	859	1173	1056	238	936
Missoula, Mont.	2359	1010	......	1582	1733	2030	2045	1162	978	1997	932	1754	2133	430	1967	1331	435	762	1978	395	1457	170	2060	887	1940
Nashville, Tenn.	821	695	1582	......	470	758	586	602	604	683	1445	472	1015	1970	526	253	1390	1958	820	1973	470	1752	863	704	567
New Orleans, La.	681	1050	1733	470	......	1173	932	575	845	1090	1318	923	1445	2063	899	599	1433	1923	1259	2098	280	1898	1287	960	968
New York, N. Y.	1095	1019	2030	758	1173	......	293	1324	1144	83	2142	313	277	2455	287	873	1972	2568	142	2419	1230	2190	120	1189	204
Norfolk, Va.	802	1047	2045	586	932	293	......	1186	1095	220	2027	316	565	2458	79	771	1925	2510	426	2440	1037	2211	411	1166	145
Oklahoma, Okla.	1233	692	1162	602	575	1324	1186	......	405	1256	843	1013	1550	1488	1122	456	862	1386	1354	1523	297	1324	1412	502	1150
Omaha, Nebr.	1402	291	978	604	845	1144	1095	405	......	1094	1032	837	1318	1373	1020	352	833	1425	1133	1372	617	1149	1205	115	1012
Philadelphia, Pa.	1023	985	1997	683	1090	83	220	1256	1094	......	2079	254	360	2419	205	808	1923	2518	205	2388	1153	2159	201	1143	122
Phoenix, Ariz.	1998	1279	932	1445	1318	2142	2027	843	1032	2079	......	1829	2345	1007	1960	1270	504	652	2152	1112	1067	1020	2220	1043	1980
Pittsburgh, Pa.	1014	745	1754	472	923	313	316	1013	837	254	1829	......	545	2174	242	561	1670	2264	350	2145	939	1918	400	891	188
Portland, Me.	1357	1145	2133	1015	1445	277	565	1550	1318	360	2345	545	......	2563	565	1094	2127	2725	197	2513	1484	2285	159	1345	480
Portland, Oreg.	2716	1435	430	1970	2063	2455	2458	1488	1373	2419	1007	2174	2563	......	2381	1723	636	536	2405	143	1783	295	2488	1293	2360
Richmond, Va.	831	968	1967	526	899	287	79	1122	1020	205	1960	242	565	2381	......	699	1850	2436	406	2362	985	2133	407	1089	96
St. Louis, Mo.	1067	464	1331	253	599	873	771	456	352	808	1270	561	1094	1723	699	......	1158	1738	898	1722	466	1500	958	450	710
Salt Lake City, Utah	2098	988	435	1390	1433	1972	1925	862	833	1923	504	1670	2127	636	1850	1158	......	592	1950	697	1155	548	2027	785	1845
San Francisco, Calif.	2603	1585	762	1958	1923	2568	2510	1386	1425	2518	652	2264	2725	536	2436	1738	582	......	2548	680	1655	730	2625	1383	2437
Schenectady, N. Y.	1229	975	1978	820	1259	142	426	1354	1133	205	2152	350	197	2405	406	989	1950	2548	......	2363	1290	2139	86	1165	313
Seattle, Wash.	2740	1403	395	1973	2098	2419	2440	1523	1372	2388	1112	2145	2513	143	2362	1722	697	680	2363	......	1820	229	2445	1282	2335
Shreveport, La.	950	859	1457	470	280	1230	1037	297	617	1153	1067	939	1484	1783	985	466	1155	1655	1290	1820	......	1621	1333	726	1035
Spokane, Wash.	2528	1173	170	1752	1898	2190	2211	1324	1149	2159	1020	1918	2285	295	2133	1500	548	730	2139	229	1621	......	2216	1055	2105
Springfield, Mass.	1210	1056	2060	863	1287	120	411	1412	1205	201	2220	400	159	2488	407	958	2027	2625	86	2445	1333	2216	......	1242	321
Vermillion, S. Dak.	1510	238	887	704	960	1189	1166	502	115	1143	1043	891	1345	1293	1089	450	785	1383	1165	1282	725	1055	1242	......	1073
Washington, D. C.	927	936	1940	567	968	204	145	1150	1012	122	1980	188	480	2360	96	710	1845	2437	313	2335	1035	2105	321	1073	......

—Compiled by Department of Commerce.

KC	Meters	STATIONS	DIALS 1	DIALS 2	KC	Meters	STATIONS	DIALS 1	DIALS 2
1500	199.9				1020	293.9			
1490	201.2				1010	296.9			
1480	202.6				1000	299.8			
1470	204.0				990	302.8			
1460	205.4				980	305.9			
1450	206.8				970	309.1			
1440	208.2				960	312.3			
1430	209.7				950	315.6			
1420	211.1				940	319.0			
1410	212.6				930	322.4			
1400	214.2				920	325.9			
1390	215.7				910	329.5			
1380	217.3				900	333.1			
1370	218.8				890	336.9			
1360	220.4				880	340.7			
1350	222.1				870	344.6			
1340	223.7				860	348.6			
1330	225.4				850	352.7			
1320	227.1				840	356.9			
1310	228.9				830	361.2			
1300	230.6				820	365.6			
1290	232.4				810	370.2			
1280	234.2				800	374.8			
1270	236.1				790	379.5			
1260	238.0				780	384.4			
1250	239.9				770	389.4			
1240	241.8				760	394.5			
1230	243.8				750	399.8			
1220	245.8				740	405.2			
1210	247.8				730	410.7			
1200	249.9				720	416.4			
1190	252.0				710	422.3			
1180	254.1				700	428.3			
1170	256.3				690	434.5			
1160	258.5				680	440.9			
1150	260.7				670	447.5			
1140	263.0				660	454.3			
1130	265.3				650	461.3			
1120	267.7				640	468.5			
1110	270.1				630	475.9			
1100	272.6				620	483.6			
1090	275.1				610	491.5			
1080	277.6				600	499.7			
1070	280.2				590	508.2			
1060	282.8				580	516.9			
1050	285.5				570	526.0			
1040	288.3				560	535.4			
1030	291.1				550	545.1			

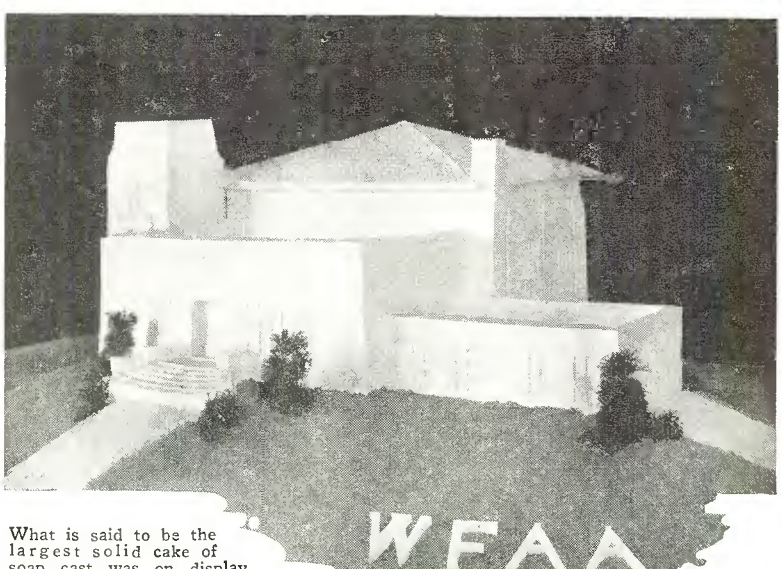


A quick test to determine location of trouble when receiver signals are weak, or the set dead, is to remove the antenna lead, and alternately tap it on the last r. f., second r. f. and then first r. f. Increased signal at any position will indicate trouble is ahead of that stage

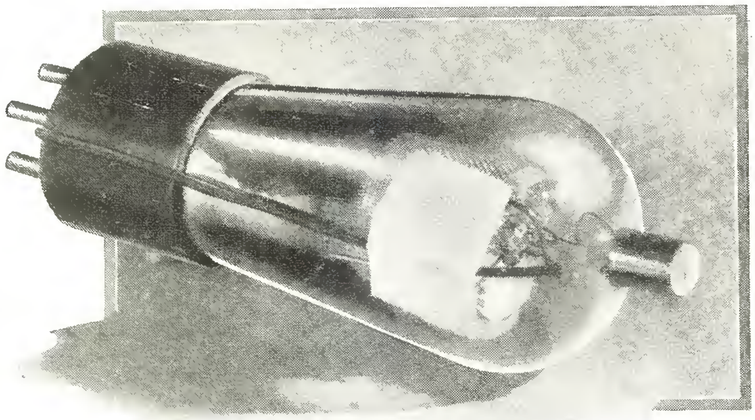


The dime store again comes in handy. An aluminum cake pan (you can get 'em in all sizes and shapes) can be used as a mounting for a power supply, as shown in the picture. Underneath all resistors, small condensers, etc., may be mounted

Engravers' wax may be used when it is desired to revive lettering or figures on instrument panels. Simply scrape out the old lettering with a fine pointed instrument, and refill the engraving cavities with the wax. The photograph shows how

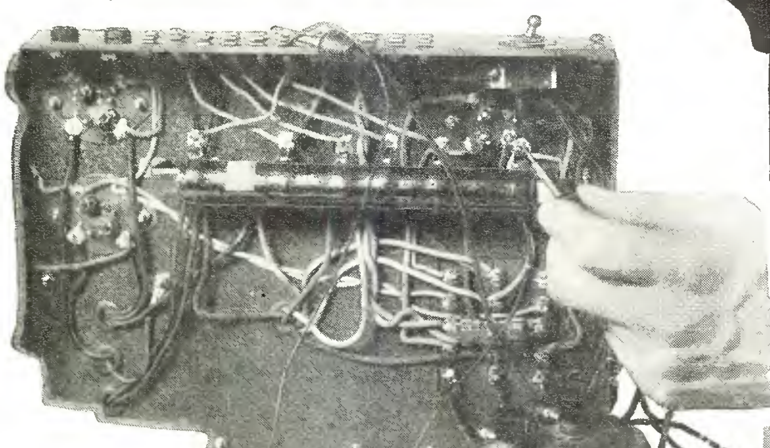


What is said to be the largest solid cake of soap cast was on display recently at the State Fair of Texas, the handiwork of 15 year old Mike Owen, Jr. More than 7000 pounds of soap were used. It is a replica of station WFAA owned by the Dallas News

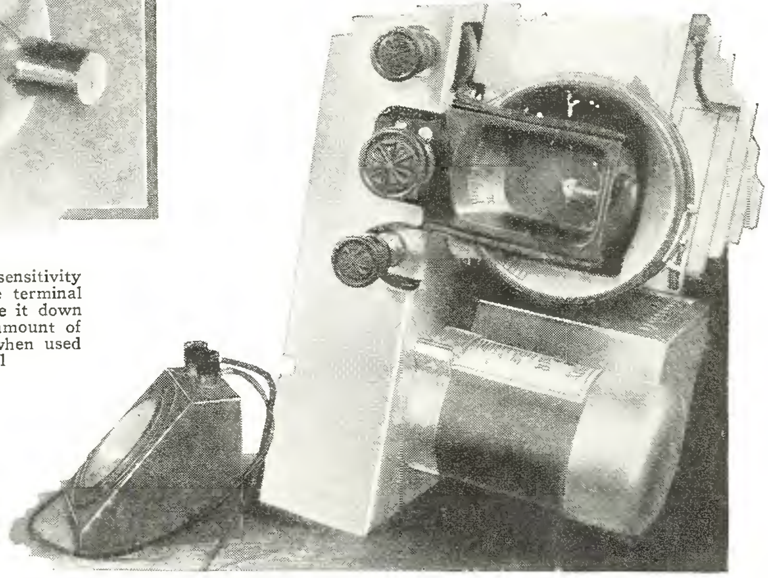


Hark ye DX hounds! How to increase (for fishing purposes) the sensitivity of your screen grid receiver. Run a very fine wire from the plate terminal up the side of the tube to within a short distance of the cap. Glue it down with tape. The proximity of the wire to the cap will govern the amount of regeneration increase of that 224 tube. This scheme is only good when used on a receiver having either cathode or screen volume control

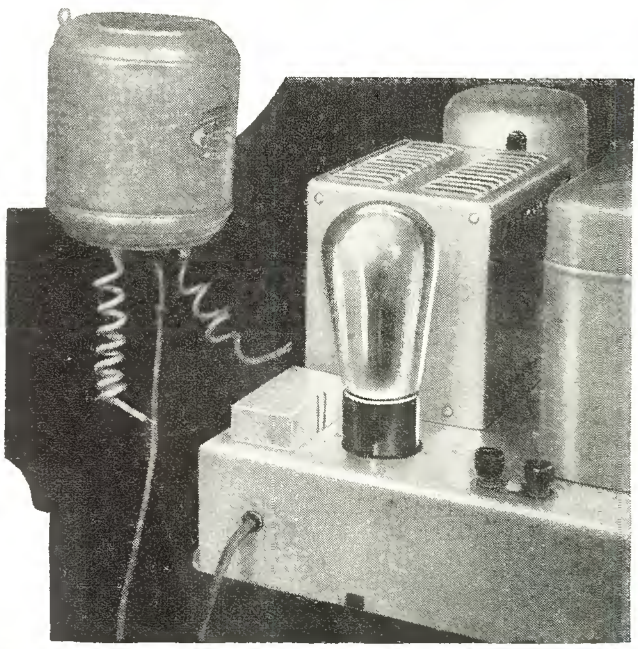
Microphone and vacuum tubes, magnifying sounds a hundred fold, have been combined with other delicate instruments to form an electrical ear to detect the faintest whisper of a knock and yet remain deaf to other engine noises. The apparatus was developed by researchists of the Atlantic Refining Co.



In some 280 power supplies no condenser is provided at the input end of the choke. On a 250 volt supply the voltage may be raised by as much as 60 volts by the addition of a 2 mfd. condenser from filament to plate of the rectifier. When replacing condensers in power supplies it may pay the service man to watch for jobs without input condensers



If a receiver hums when it is being tested, do not always blame the set, especially if it's tipped up as the one in the photograph. The cause of the hum is the electrolyte running off the elements of the electrolytic condenser and reducing its filtering capacity



In many receivers it is not always necessary to use an antenna. Sometimes the ground wire can be used. One manufacturer has designed what is known as the "ground-tenna," the device pictured at the left in this photograph, which may be installed inside the console of a receiver and which will give satisfactory operation over average distances. The two coiled wires go to antenna and ground binding posts of the receiver, while the straight wire goes to the ground connection. In the event an antenna compensator is used on the receiver it will probably be necessary to vary it because of the change in input conditions. Device made by Western Coil and Electrical Company

Power Amplifier Measurements

(PART I)

IN presenting the electrical fidelity response curves on these pages it is well to outline the conditions of measurement and from what these conditions were derived.

The logical method of measuring the electrical fidelity of an audio frequency amplifier is from a standpoint of maximum undistorted output. At the time, however, a suitable harmonic analyzer was not available, making it necessary to run the measurements under other conditions. If the amplifiers were perfect it would make no difference at what power level they were measured as long as the selected level did not exceed maximum undistorted output. Unfortunately, all amplifiers are not perfect

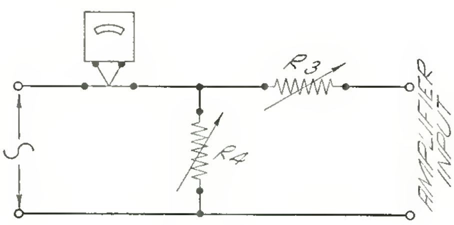


Figure 1

and therefore it would be unfair to measure a single 250 at the same power level as 250's in push-pull.

To determine the most satisfactory method of measurement a number of experimental measurements were made under varying conditions, results analyzed and the following procedure decided upon: The constant input-variable output method seemed most satisfactory. Value of power output selected as standard was one-third rated undistorted power output of the output tubes. When used in push-pull the Western Electric rating of three times the power output of a single tube was used. Since the constant input - variable output method was used the standard would only hold good for the reference level

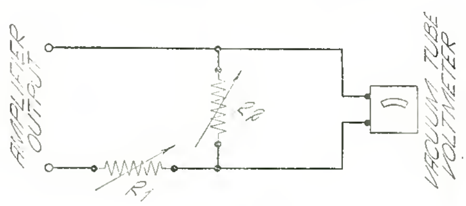


Figure 2

of 400 cps. (cycles per second). At this point of power output it is not likely any amplifier would be so designed that it would be operating in an overloaded condition, also there would be sufficient voltage input to cause the

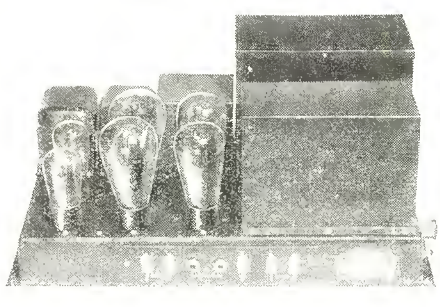
On account of the number of amplifiers to be measured and their division into two or more classes, it has become necessary to present this article in two parts. The remaining amplifiers will be treated in the March issue of this magazine.—Editor.

preceding tubes to be operating at a satisfactory point of grid swing. Also by this method a 245, 250 or push-pull combination of any tube may be measured on an equal basis. The input and output impedances were held to the manufacturer's rated value. The loads were purely resistive.

In Figure 1 is illustrated the input circuit and in Figure 2 the output circuit. All component measurement instruments were in the secondary standards classification and very carefully calibrated against primary standards. The tubes used in all amplifiers were of average transconductance and selected within very narrow limits. The temperature rise figures were as measured with the thermometer in contact with transformer case, the amplifier being in open non-circulating air and of four or more hours duration. Amplifiers were warmed up under full voltage for a period of three hours before measurements were made. Overall gain as given in decibels is as measured at the given a.c. line voltage. This should be noted as in some amplifiers the plate voltage will change with slight changes in line voltage and in some cases a material change in gain will occur.

* * *

Amer-Tran Model 86



Amer-Tran model 86. Method of measurement: Constant input, variable output.

Output impedance load	500	ohms
Input impedance load	500	ohms
Line voltage	115	volts
Line current	1.5	amps
Max. temperature rise	17.5	deg. F.

Following values are as measured at 400 cycles per second:

Output power level	4.65	watts

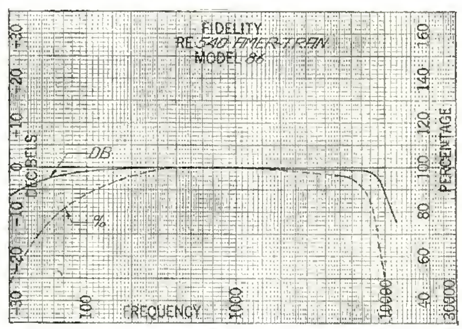
Hum level: More than 46 Db. below the reference level.

Gain	70.	Db.

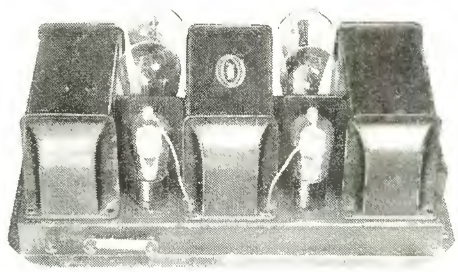
Tubes Used

1 a.f.	UY 227
2 a.f.	UY 227
P. P.	UX 250
P. P.	UX 250
Rectifier	UX 281
Rectifier	UX 281

Amer-Tran Response Curve



Samson PAM 39



Samson PAM 39. Method of measurement: Constant input, variable output.

Output impedance load	500	ohms
Input impedance load	5000	ohms
Line voltage	113.5	volts
Line current	1.2	amps
Max. temperature rise	19.5	deg. F.

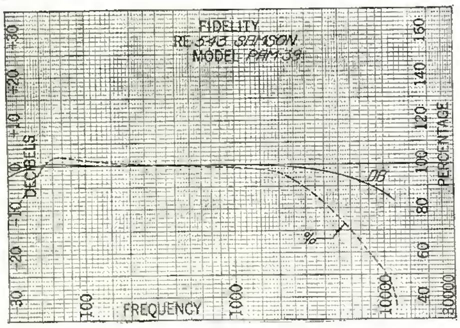
The following values are as measured at 400 cycles per second:

Output power level	4.65	watts
Hum level, 4.7 per cent	26.3	Db.
Gain	57.12	Db.

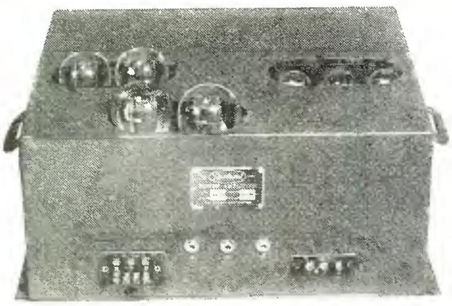
Tubes Used

1 a.f.	UY 224
2 a.f.	UY 224
P. P.	UX 250
P. P.	UX 250
Rectifier	UX 281
Rectifier	UX 281

Samson Response Curve



Rauland Model 53-A



Rauland model 53-A. Method of measurement: Constant input, variable output.

Output impedance load	8000	ohms
Input impedance load	4000	ohms
Line voltage	112	volts
Line current	1.5	amps
Max. temperature rise	11.	deg. F.

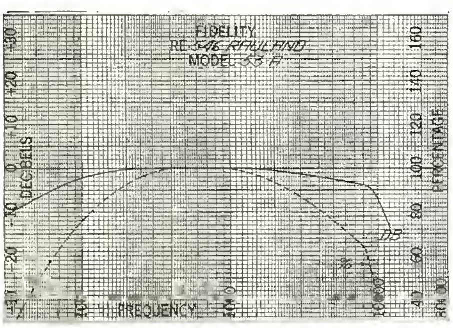
The following values are as measured at 400 cycles per second:

Output power level	4.65	watts
Hum level, 2.98 per cent	30.5	Db.
Gain	68.13	Db.

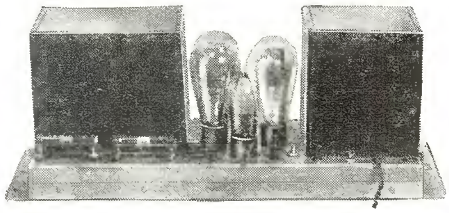
Tubes Used

1 a.f.	UY 227
1 P. P.	UX 112-A
1 P. P.	UX 112-A
2 P. P.	UX 250
2 P. P.	UX 250
Rectifier	UX 281
Rectifier	UX 281

Rauland Response Curve



Electrad Model C-250



Electrad model C-250. Method of measurement: Constant input, variable output.

Output impedance load	4000	ohms
Input impedance load	8000	ohms
Line voltage	114	volts
Line current	1.63	amps
Max. temperature rise	19.	deg. F.

Following values are as measured at 400 cycles per second:

Output power level	4.65	watts

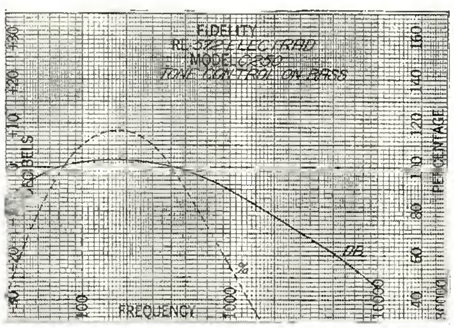
With tone control set at treble: Hum level, more than 46 Db. below the reference level.

Gain	53.53	Db.

Tubes Used

1 a.f.	UY 224
P. P.	UX 250
P. P.	UX 250
Rectifier	UX 281
Rectifier	UX 281

Electrad Response, Treble



Electrad model C-250. Method of measurement: Constant input, variable output.

Output impedance load	4000	ohms
Input impedance load	8000	ohms
Line voltage	114	volts
Line current	1.63	amps
Max. temperature rise	19.	deg. F.

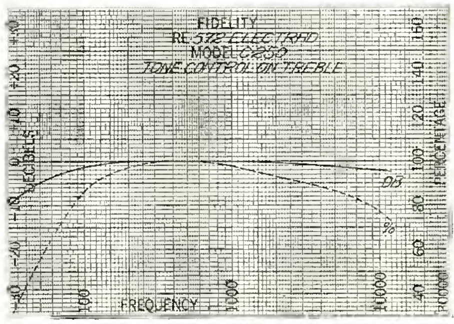
Following values measured at 400 cycles per second:

Output power level	4.65	watts

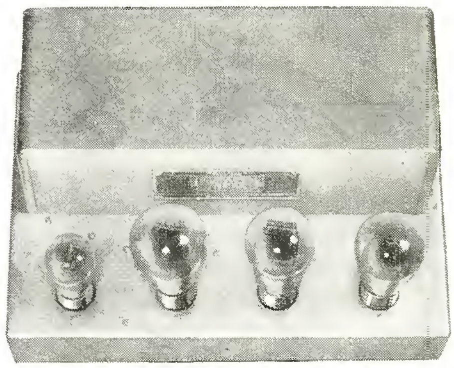
Hum level, more than 46 Db. below the reference level.

Gain	50.64	Db.

Electrad Response, Bass



Thordarson Model 3715



Thordarson model 3715. Method of measurement: Constant input, variable output.

Output impedance load	1800	ohms
Input impedance load	8000	ohms
Line voltage	115	volts
Line current	.77	amps.
Max. temperature rise	17.	deg. F.

The following values are as measured at 400 cycles per second:

Output power level	1.55	watts

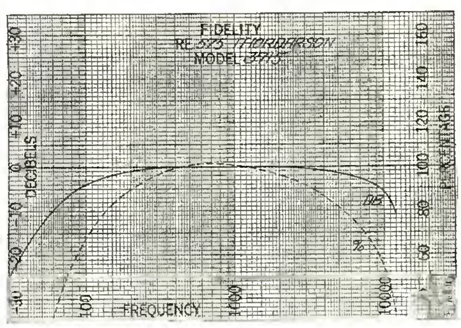
Hum level, more than 46 Db. below the reference level.

Gain	42.29	Db.

Tubes Used

1 a.f.	UY 227
2 a.f.	UX 250
Rectifier	UX 281

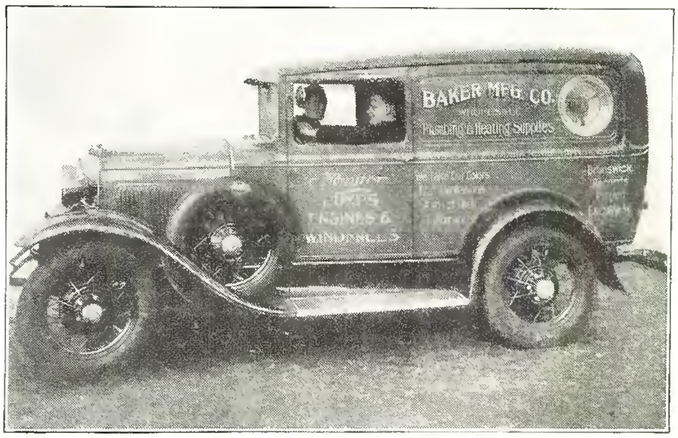
Thordarson Response Curve



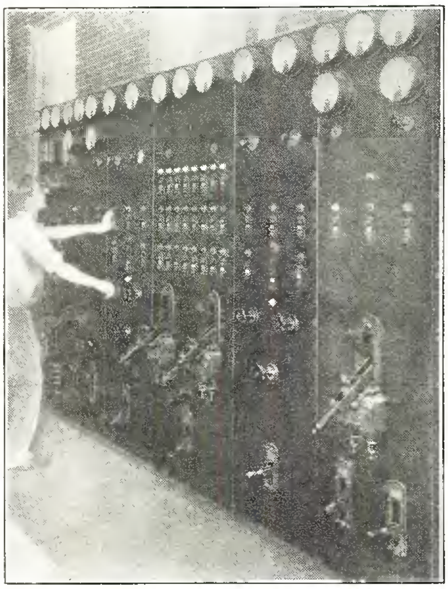
A Page of Interesting Pictures

This is the new home of KDKA at Saxonburg, Pa., the transmitter being housed in the attractive building shown here

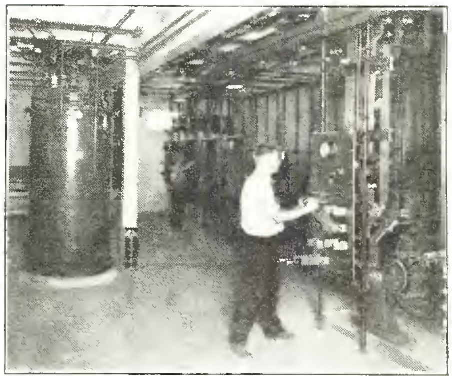
The Baker Mfg. Co., wholesale plumbing and heating supplies, covers the Oklahoma oil fields and finds that musical entertainment comes in handy not only on the trips but while the car is parked at the leases. The Radio Laboratories, 1511 Walnut St., Kansas City, Mo., made the installation and supplied the photograph at the right



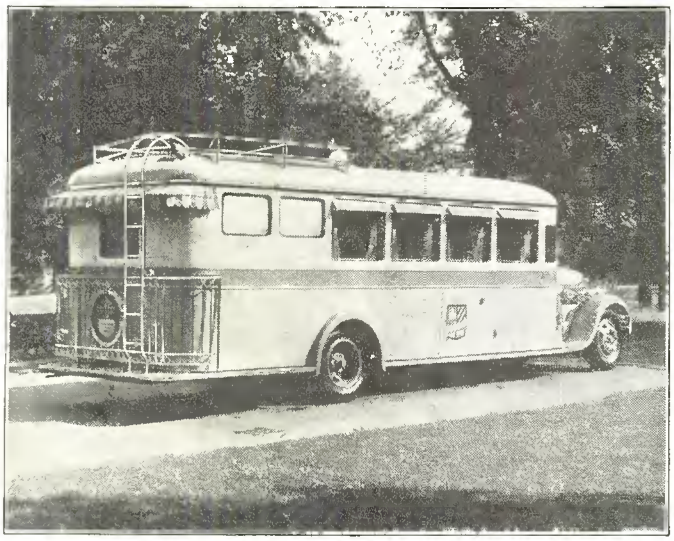
Painted yellow and black to reduce flying hazards these poles are used for the antenna installation at KDKA. The transmitter house shown in the preceeding photograph may be seen in the background of this picture



This photograph shows one of the power panels at the New KDKA transmitting station. Another section of the power equipment installed in the basement may be seen in the photograph at the right



In this photograph is shown part of the power equipment used in the KDKA transmitter, this installation being made in the basement of the transmitter house. This sub-station generates sufficient power to meet the lighting requirements of a city of 25,000 inhabitants. The present power of the new transmitter is 50,000 watts



To provide entertainment on long trips a Delco automotive radio has been installed in the de luxe motor coach, Bonne Entente II, owned by General Motors of Canada, Ltd., and used by company officials for making business tours

Installed in locker compartments above the seats the Delco standard set is easily accessible for tuning. This photo shows the interior view of the Bonne Entente II used by GM executives while travelling in Canada. The receiver has automatic volume control to compensate for variations in signal strength

Scott 1931 All-Wave Superheterodyne

DESCRIBED on this page is the Scott 1931 All-wave receiver using the superheterodyne circuits, and covering both the broadcast and short wave bands. The front view of the chassis is found in Figure 1; a close-up of the rear chassis in Figure 2; the separate power supply in Figure 3 and the schematic for the power supply in Figure 4. Response curves covering sensitivity, selectivity and fidelity as recently taken in our laboratory, are shown in Figures 5, 6 and 7, respectively, while the electrical connections of the super are shown in the drawing in Figure 8.

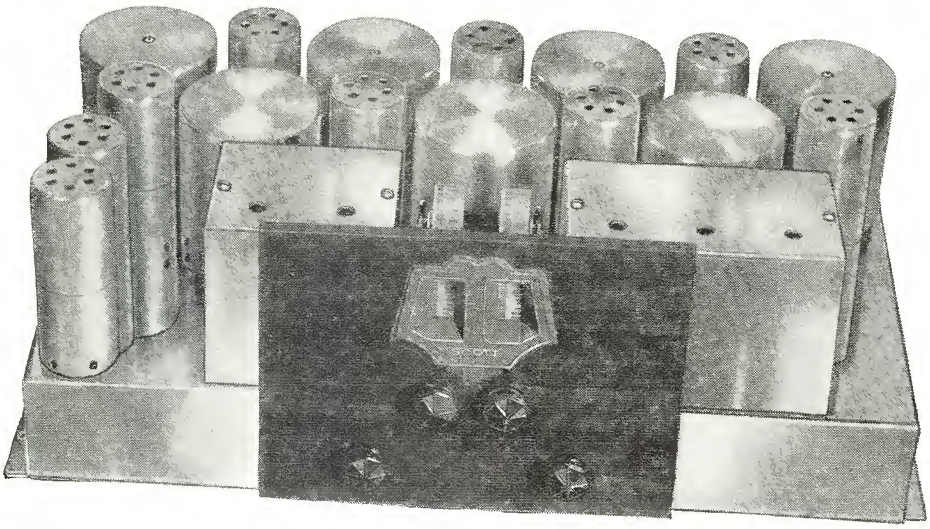


Fig. 1. Here is shown the front view of the chassis of the Scott 1931 All-Wave super recently measured in our laboratory

From 15 to 545 Meters

The receiver covers a frequency range of from 20,000 kc. to 550 kc. Six sets of coils are required to cover this range, there being two coils to each set. Coil ranges are as indicated: 15-21 meters; 21-31 meters; 31-51 meters; 51-105 meters, and 105-200 meters. The broadcast set is from 200 to 545 meters. Each set of coils overlaps so there are no dead spots between bands.

The antenna coil for the broadcast band is tapped at 2, 8 and 15 turns and coupled very loosely to the first r.f. stage. On short waves the antenna is connected to ground through a concentrated high inductance. This inductance is mounted on the three gang condenser cover and has a wire with a grid clip soldered to it. To tune on short waves, remove grid clip leading from first r.f. coil and place grid clip from concentrated inductance on first r.f. tube; then connect antenna to binding post on side of three gang condenser cover. The plug-in coils make the other changes that are necessary when they are plugged in their proper sockets.

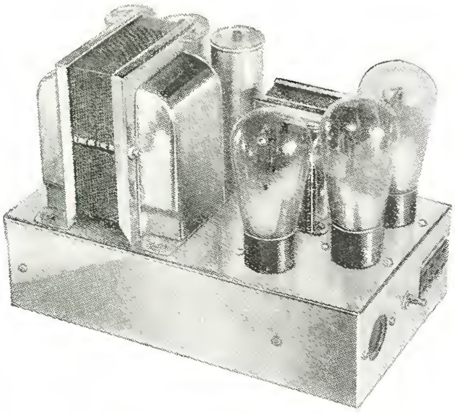


Fig. 3. The power supply used with the receiver described on this page is illustrated in this photograph

Oscillator Coupling

Examination of the circuit will show the oscillator is coupled to the lower end of the grid coil of the first detector, or mixing tube. These circuits are coupled inductively for the broadcast band, and capacitatively coupled on the short wave band. Grid circuit tuning is used, a 227 being employed. There are no other connections to make in the oscillator circuit other than plug in the proper oscillator coil (the one with four prongs) when changing to short wave operation, as all the short wave condensers are changed when coils are plugged into socket.

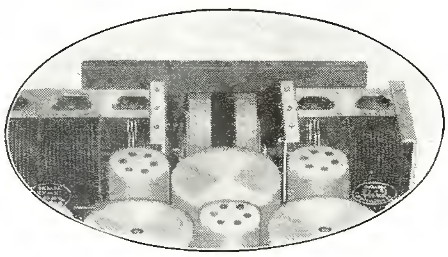


Fig. 2. A close-up view of the rear of the chassis, showing plug-in coils to the left and right of the two tube shields, and also special condenser sections for covering the higher frequencies

The first detector, or mixer, is tuned by one of the three gang sections to the incoming signal frequency. The grid circuit of this stage also has the oscillator signal, this latter being at a 470 kc. difference from incoming frequency. The mixer is biased to operate as a plate rectification detector, the stage using a 224 screen grid.

Intermediate Stage

Three stages of intermediate frequency, tuned to 470 kc., and inductively coupled make use of the 224 tubes. Coupling from stage to stage is by a very small number of turns of wire, to hold a sharp peak on all the intermediate frequency grid circuits which are tuned by a fixed and a very small variable condenser. The amount of gain per stage can be varied by moving the plate coupling coils up or down the grid coil. It is not recommended that changes be made in this coupling since it was originally set in the laboratory for best operation.

The second detector, using a 227, is a power detector, used to prevent overloading on strong signals. Instead of the single 227 first audio this job has two of these tubes arranged in push-pull, also to prevent overload and feeding through transformer coupling to the grids of the 245 tubes in push-pull, these tubes being located in the power supply unit.

Connected to the receiver chassis by a cable is the power supply unit whose schematic diagram is shown in Figure 4. A fuse is provided inside the amplifier base to protect the apparatus from damage due to a shorted circuit or tubes. A five prong socket in the front of the power supply is furnished to supply energy for the speaker field and

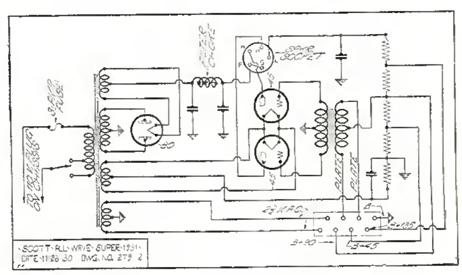


Fig. 4. Schematic diagram of the power supply of the Scott 1931 receiver

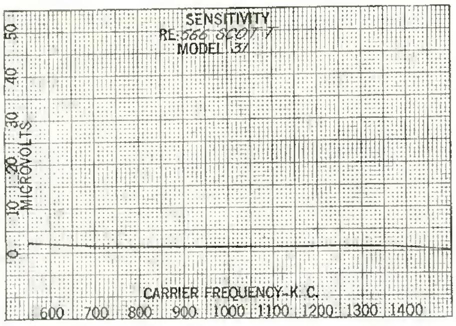


Fig. 5. Sensitivity curve

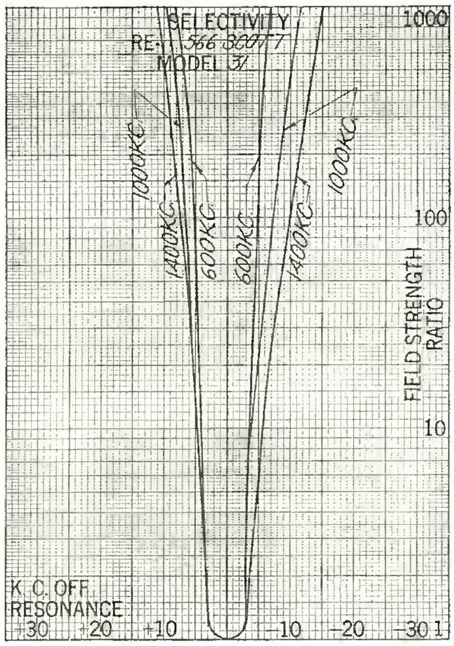


Fig. 6. Selectivity curve

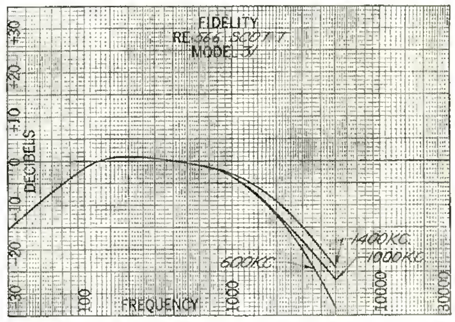


Fig. 7. Fidelity curve

output transformer which is located in the speaker base. The speaker has a five prong socket plug to fit this socket. The speaker field winding acts as the filter choke in the power unit. The rectifier used in the power supply is the conventional 280.

A comprehensive set of instructions for operating and servicing the receiver has been prepared for the Scott receiver by the engineers of the maker, from which excerpts will be made later in this article.

Two Dial Control

Two dials are used in tuning the present model, this being particularly desirable on the higher frequencies. Dials are marked in kilocycles for the broadcast band, and in numbers for the logging on the short wave bands. The dial to the left (see Figure 1) tunes the oscillator circuit and the right one the antenna input stage and the first detector. The oscillator dial will be at the frequency of the incoming signal, although the r.f. dial at the right may be as much as 10 kc. off. In tuning, harmonics may occur if the two dials are not kept together.

At the left in Figure 1 is a knob that switches from local to distant input conditions. It has three positions, low, medium and loud signal; all the way to the left is low, center is medium, and all the way to the right for loudest reception. On the right of the panel is the volume control knob operating a combined on-off switch and variable resistor. Turn the knob to the right to start up the set.

Instructions for operating the receiver on short waves state: remove the oscillator can (the one to the left, facing the front of the set, in the row nearest the panel). Remove the r.f. can (the one to the right, facing the set, in the row nearest the panel). Pull out the r.f. and oscillator coils and plug in the r.f. and oscillator coils to cover the short wave band desired. Be sure both coils have the same markings on top.

Now remove the cap from the screen grid tube in the r.f. stage, which is the second tube on the right hand side closest to the front panel, and place the screen grid cap coming from the choke coil on the large condenser shield on the screen grid tube. Remove the antenna from the antenna post on the rear of the chassis, and connect it into the antenna post on the large condenser shield.

The cans are left off when using the receiver for tuning in short waves. The receiver is tuned in the same manner as when tuning on the broadcast band, except that the kilocycle markings on the dials are ignored and the numbers used instead. Dials will track together pretty well except in a few places, but even there the two will only be a few numbers apart.

The three binding posts in the rear of the chassis are for the use of a magnetic pickup. Terminal 1 is connected to the cathode of the second detector, terminal 2 is connected to the C bias resistor and condenser, while the third terminal is connected to ground.

Each receiver is carefully balanced at the factory and it should not be necessary to immediately rebalance it. When necessary it may be rebalanced as follows: Carefully tune in a station about 700 kc. Starting with the first i.f. stage turn the small balancing condenser to the right and left until maximum signal strength is obtained. Do this with each stage in turn. To balance the r.f. start with the balancing condenser next to the dial in the large condenser can. This is the antenna stage. Turn the condenser to right and left until maximum signal is obtained. Next to this stage is the r.f. where the same procedure is followed. The last condenser is for the short wave and will not have to be balanced. If the oscillator does not line up to kilocycle markings, turn the small condenser (to the left of the small condenser can) down to lower dial readings, and up to raise the dial reading. To change the reading on the r.f. follow the same procedure.

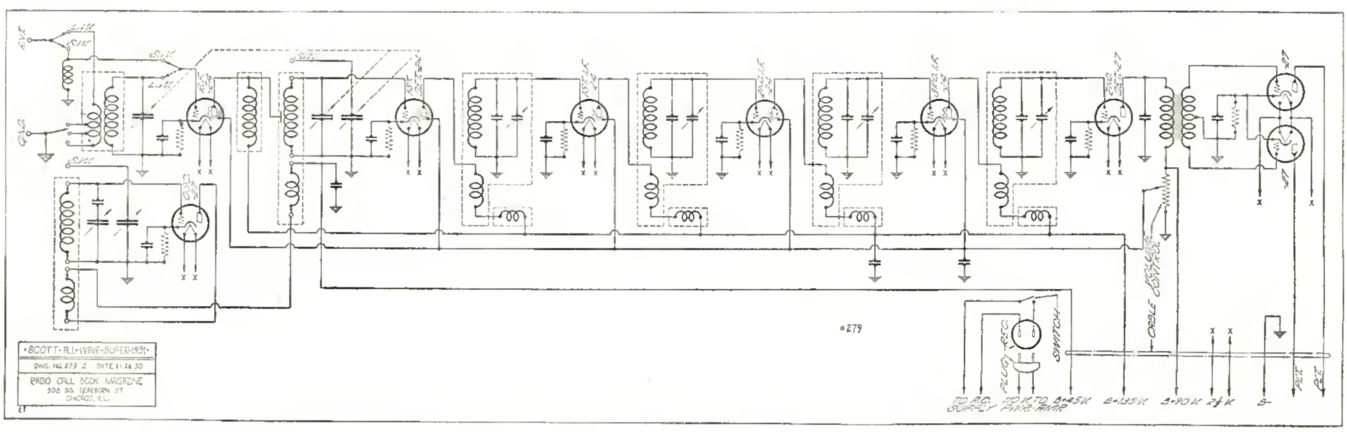


Fig. 8. In this diagram will be found the electrical connections for the Scott 1931 All-Wave receiver

Field Strength Effect on Receivers

SINCE the use of field intensity measurements has become the accepted index to the performance of a broadcasting station, it should be of interest to the listener and station owner alike to be familiar with the method by which such measurements are taken and the interpretation of such measurements in terms of their effect on receiver performance.

Fig. 2 shows a map made from field intensity measurements made with apparatus such as shown in Fig. 3. Fig. 3 is the circuit diagram of a typical field intensity measurement set, which consists essentially of a superheterodyne receiver of a more or less conventional type, with a beat oscillator, operating about 500 cycles from the peak frequency of the intermediate amplifier of the receiver, added. This receiver uses a loop antenna with the midpoint grounded and a known resistance added in the center of the loop. A carefully shielded local oscillator is also used, and can be tuned to frequencies in the broadcast band by means of a condenser. A sensitive volume indicator is coupled to the output of the receiver so that the intensity of the beat note, resulting from a received signal, and the beat note resulting from the local oscillator can be compared for relative intensity.

We are indebted to Messrs. Doolittle and Falknor, Chicago, for the preparation of the maps accompanying this article, since the field strength plotting shown thereon represents recent measurements taken covering one of the broadcasting stations in the Middle West.—Editor.

How It's Done

Signals are measured by tuning in the desired station and swinging the loop to a point where maximum deflection is secured, on the volume indicator. With the loop again swung to a position where the received signal falls to zero and the local oscillator put into operation, in zero beat with the signal of the station in operation, the attenuator is adjusted until the deflection on the volume indicator is the same for both the local oscillator and the received signal. If the current supplied to the attenuator is now read and the attenuator loss noted, the current flowing through the loop resistor can be easily calculated. Knowing this current and the resistance in series with the loop their product will give the voltage actually introduced into the loop from the radio station under observation. If this value is divided by the effective height of the loop antenna the signal intensity in

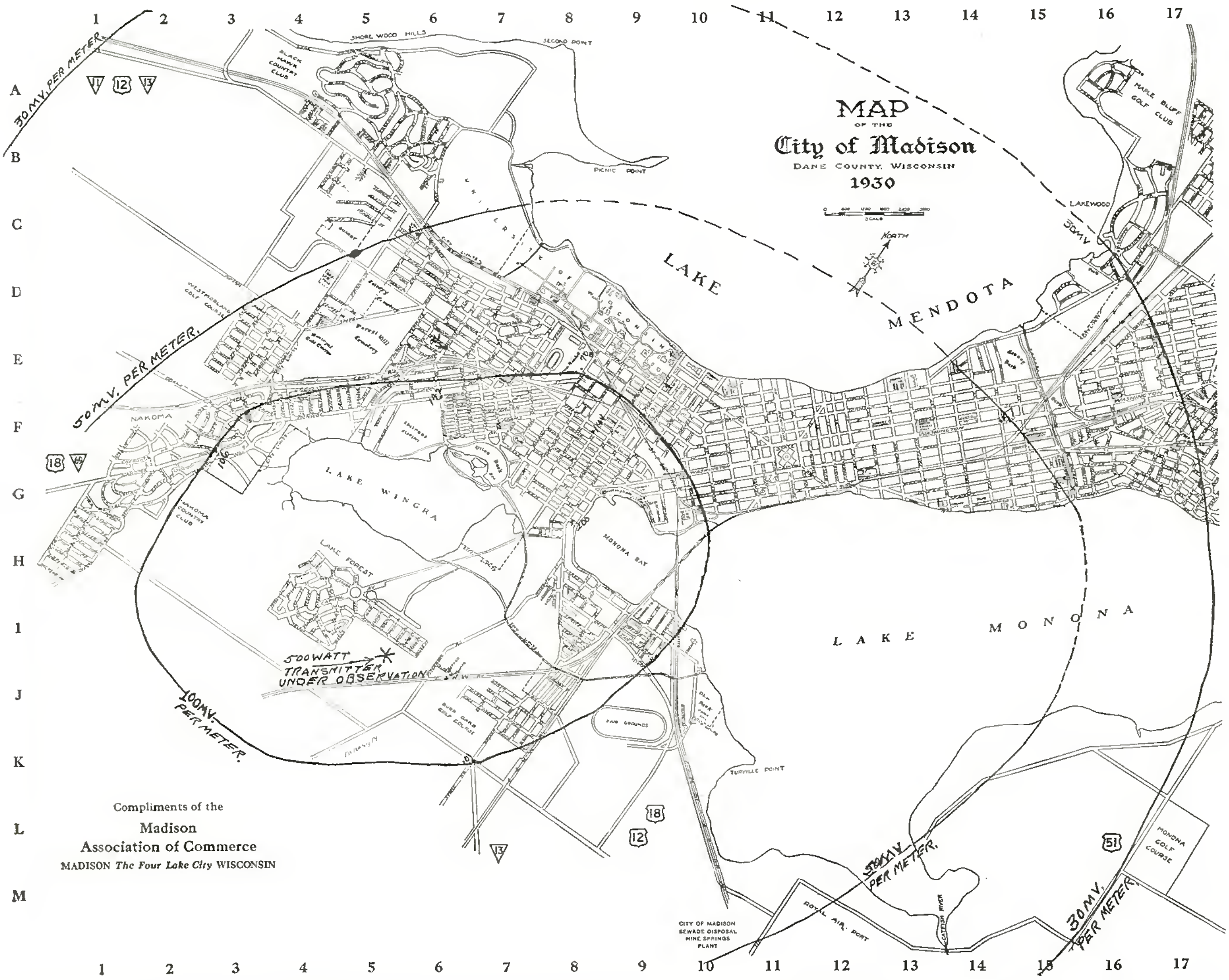


Fig. 1. This map shows the field strength of a local station, measurements being made to determine to what extent the thickly populated area would be affected by a strong field strength

terms of millivolts or microvolts per meter is the result.

Show Grades of Service

A map such as shown in Figs. 1 and 2 are prepared by connecting all points, having the same field intensity. Such lines show the relative grades of service to be expected, at various distances from a transmitter and also show the various degrees of interference that may be expected on signals from other stations due to the characteristics of the receiving set.

Fig. 2 shows that transmission from the station, from which these maps were made, is quite uniform in all directions, although some obstruction has caused a slight decrease in transmission to the South and Southeast. It further shows that for rural communities very good reception can be expected beyond the confines of the survey. for rural communities the lowest dependable signal being about 1 millivolt per meter. This map also shows that since the 30 millivolt circle falls in a thickly populated area, it is quite possible that a considerable territory will be covered with a signal intensity in excess of 50 millivolts per meter above which level considerable interference will be experienced on all receivers, when tuned to stations near the one under measurement, while on receivers of the older types modulating of the signals of all stations by the local station will be experienced.

Serious Effects

In order to determine to what extent the thickly populated area would be effected, the map of Fig. 1 was made. This map shows that the major portion of the town will be seriously effected by cross talk when a receiver is tuned to a station less than 20 kc. away from the local station, while few receivers will be able to receive signals separated by 10 kc. or less from the frequency of the local station.

Several types of interference may be expected from the local station in a case such as shown on Fig. 1. On very old receivers with little if any shielding of radio circuits, cross talk on all stations will occur due to the fact that sufficient voltage induced by the local station will always be present on the grid of the detector tube to cause the local station to be heard regardless of where the receiver is tuned.

On other types of receivers where shielding is satisfactory but the antenna system is poorly tuned or not tuned at all the local station will be heard only when the receiver is tuned to it or any other station. This is due to the fact that the signal applied to the grid of the first tube in the receiver by the local station is of such a high value that the first tube acts as a detector and all received signals are modulated by the local station.

On receivers having the antenna system sharply tuned it will be found that all but stations differing less than 15 or 20 kc. from the local station will be received satisfactorily. On receivers of this type the interference is due to the fact that the side bands from both the local station and the station that is desired to be received, overlap the resonance curve of the receiver.

In a territory where the field intensity of the local station is much in excess of 100 millivolts per meter bad cross talk can be expected on almost all types of receivers except where at least some pre-tuning is done before any signal reaches the grid of a tune. With this type of receiver it is possible to attenuate the local station sufficiently so that the voltage at the grid of the first tube will be too low to cause modulation of all other radio signals.

In cases where extreme local interference is experienced from causes indicated by the field intensity maps shown here, it is usually possible to reduce such interference by reducing the length of the antenna used on the re-

(*Continued on page* 83)

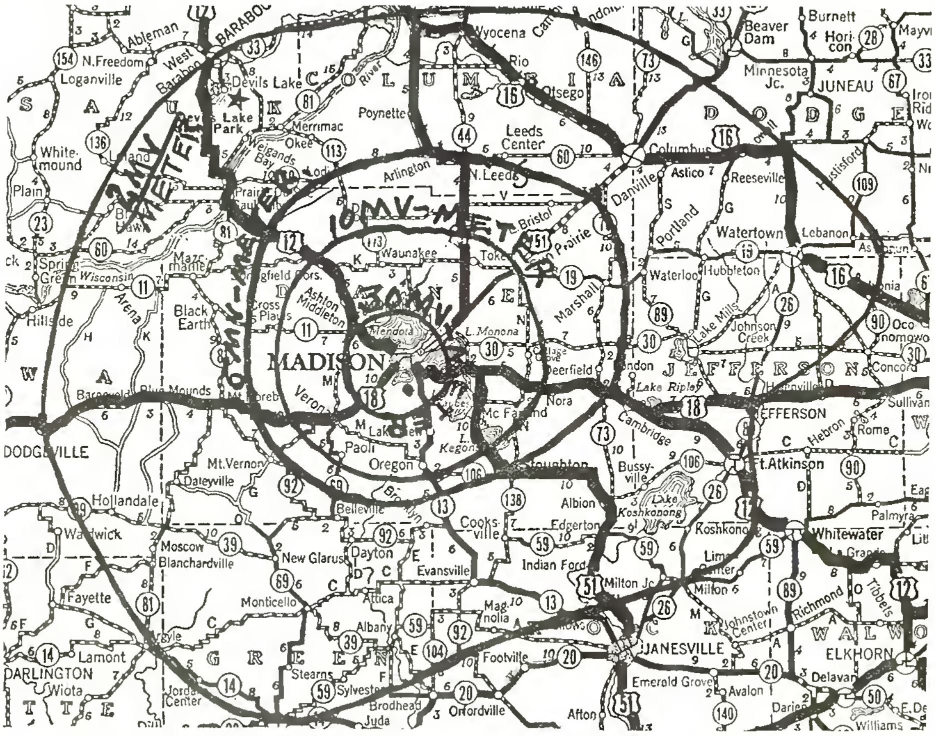


Fig. 2. The field strength map shown here was made from measurements taken with apparatus whose simplified schematic diagram is shown in Figure 3

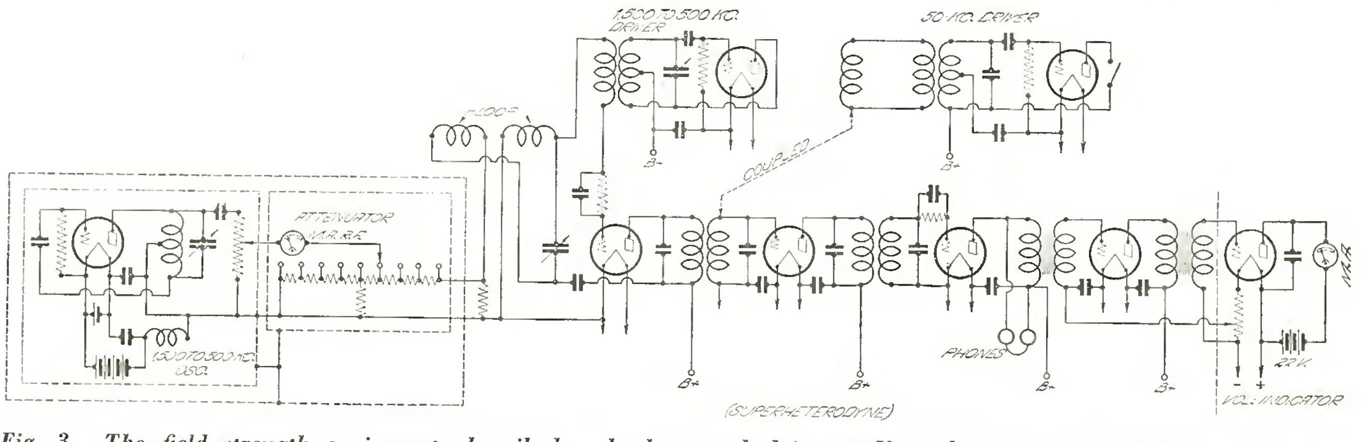
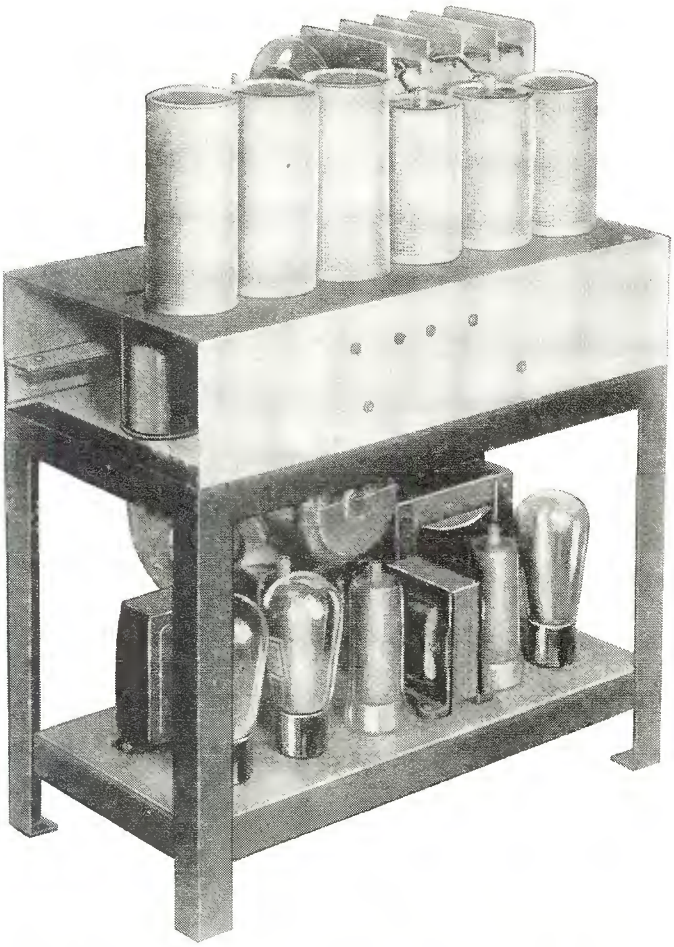


Fig. 3. The field strength equipment, described and photographed in our November issue, uses the simple schematic shown in the above drawing

Design Data on H. F. L's "Little Giant"

By E. K. OXNER*



This illustrates the rear chassis view of the "Little Giant" super made by the High Frequency Laboratories and described in the accompanying article

THE recent advent of numerous commercial superheterodynes as broadcast receivers has greatly increased the popular interest in receivers of this fundamental type. Great differences exist among the various adaptations of this familiar circuit and this article deals with the characteristics of some of the important components of a super which is about to appear on the market.

The great number of stations and the closeness of their allocation has made mandatory the use of at least three circuits at broadcast frequency ahead of the mixer or first detector tube to prevent carrier modulation and other undesired responses, particularly in view of the fact that the frequency 175 kc. has been almost universally adopted as the center of the intermediate amplifier transmission band.

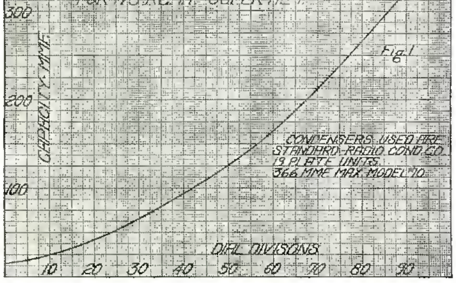
The 3 r.f. circuits, as they are familiarly called, are in themselves conventional in construction; care is taken that the r.f. amplification is substantially the same over the entire broadcast spectrum. Numerous methods of coupling the oscillator circuit to the third of these r.f. circuits are available, and offer little choice as to results; one of the most common methods (that of coupling through the mutual inductance of the two tuning coils when properly related physically) serves to minimize the difficulties of single dial operation or a close approach thereto.

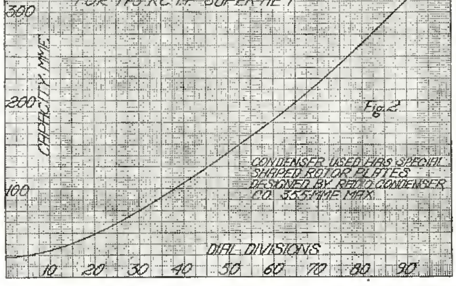
Many schemes, both mechanical and electrical, have been propounded, to provide a close approach to single dial tuning, with circuits differing by 175 kc. for maximum output and therefore operating over spectra of different widths. The mechanical methods have not been widely used commercially; a series condenser network has come into general use and is fairly satisfactory. Its main objectionable feature is that, theoretically, it offers only an "approach" to real single dial tuning, if the latter be defined as to require that the "difference" frequency of the two circuits be always, and exactly, the intermediate frequency.

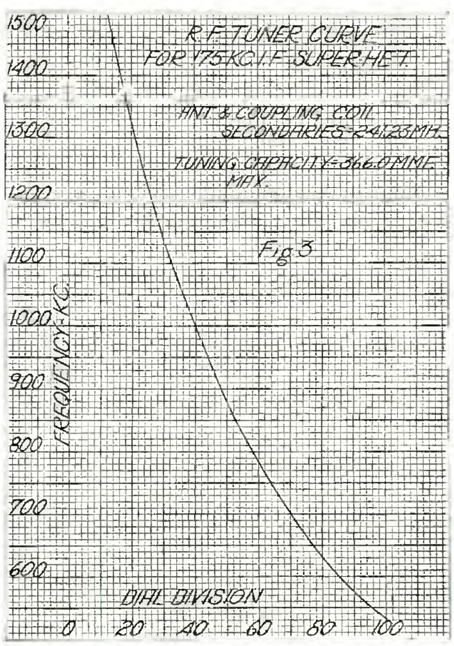
A method which provides this exact tuning required, and which further simplifies the construction of the receiver circuits as well as their adjustment in the field, is that involving the use of a special plate shape for the oscillator tuning condenser. Cost of testing has heretofore prevented its use, but gang condensers are now available with such special plates in one section. The necessity for holding correct inductance values for all tuning coils is of the same order as with the series condenser method.

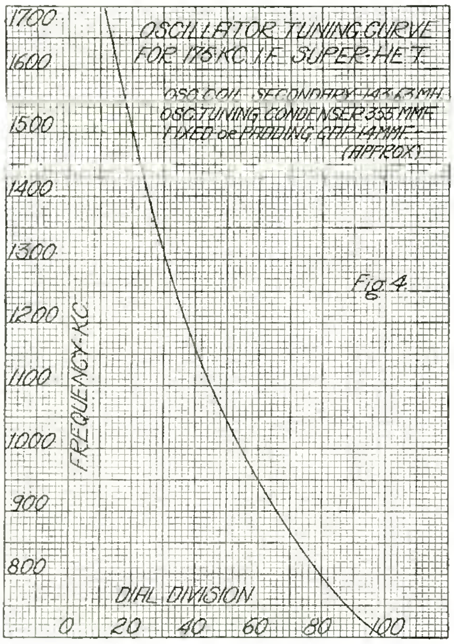
Fig. 1 indicates the capacity curve of the r.f. tuning condensers of such a gang unit. Fig. 3 shows the actual tuning curve of such units when associated with coils of the correct inductance and with proper allowance for minimum capacity, including trimmer, socket, coil, wiring and the tube, itself. To reproduce this curve exactly in the oscillator circuit requires that for any stated dial setting, the oscillator generate a frequency 175 kc. higher than that of the r.f. circuits. Thus the tuning curve of the oscillator circuit is obviously that of the r.f. circuits except that the frequency scale is shifted.

*Chief engineer, High Frequency Laboratories, Chicago.

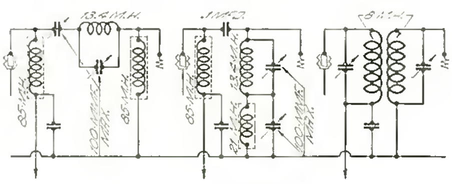






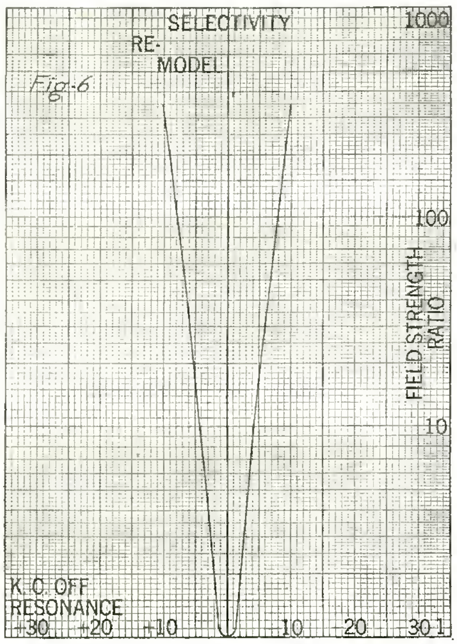


Numerous values of oscillator circuit inductance can be used, as well as any sufficient value of minimum circuit capacity which will be encountered in other parts of the circuit. For this work, an inductance value as indicated on Figure 4 was chosen, together with



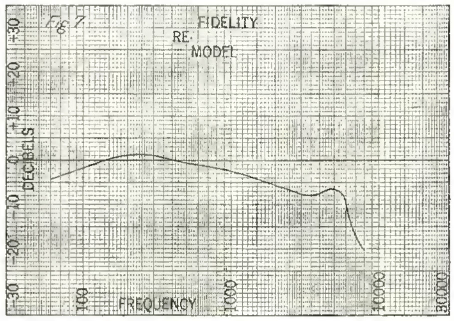
·FIG. 5·

a total minimum capacity of 50 mmf. of which varying amounts are to be inserted by means of the trimmer. This total reserve is sufficient to cover practically any arrangement of parts, etc., in any super. Figures 2 and 4 show the condenser and tuning curves, respectively, of the oscillator circuit used in this receiver. The mathematical treatment of this problem was performed by Dr. E. D. Koepping of the Radio Condenser Co., who supply the condensers used.

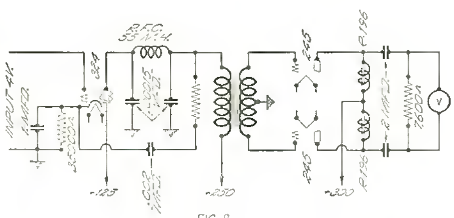


It should be noted that with such a tuning system, a check in the field, at any time, on the phasing of a receiver may be done in the same manner as with any multi stage r.f. set, merely by deflecting the slotted plates of the condensers at any dial setting, as compared to the extremely judicious balance between the values of *two* trimmers, which is required in the case of the series condenser system.

The intermediate amplifier, the "Heart of the Super," is again, in this



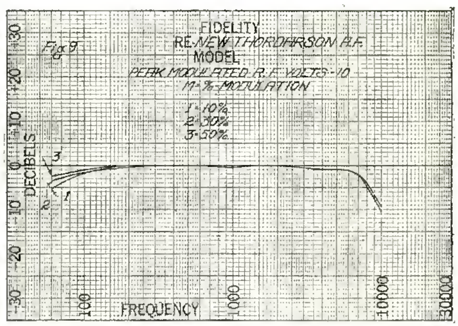
case, the Hopkins Band Rejector, with a considerable improvement in control of band shape and width. The performance curves of this system, which has been in use for nearly a year, have previously been published, as well as explanatory articles outlining the means of suppressing interfering signals. Figure 5 shows the diagram of the newest Hopkins circuit, with all constants given. Tubes are operated at the voltage ratings specified by the manufacturers. Among other improvements,



·FIG. 8·

this type amplifier contains adjustments which may be used to alter band width at the base of the curve (near the minimum input level) without affecting band width under the heavier input voltages. This is unique, and offers the great advantage that the amplifier as a whole does not "break down" or, in effect, widen its transmission band when confronted with an extremely high input signal voltage. Figure 6 is a typical result of an extreme adjustment, greatly favored by some fans who want the greatest possible selectivity. This curve is for the i.f. amplifier alone and does not include r.f. selection.

This receiver employs, for its audio



channel, an entirely new development in the well known dynamic speaker, as well as a remarkable improvement in the audio transformer used in its single audio stage, coupling a screen grid power detector directly to the output tubes. Figures 7 and 8 show, respectively, the operating conditions and the performance characteristic of the only such a.f. transformer available when development work was started on the components of this new super. This older system has been used extensively in a very large number of sets, whose output quality was accepted as par excellence. Comparison of Figure 9, showing the performance of the newly developed a.f. channel, will indicate immediately the remarkable improvement in response

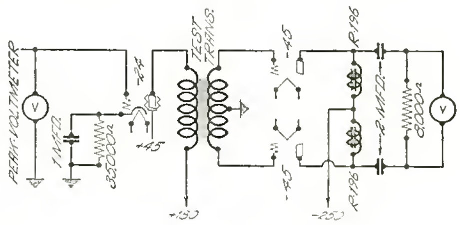
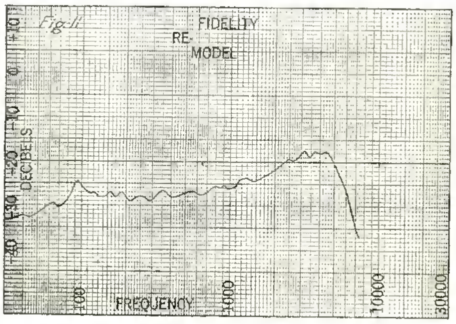


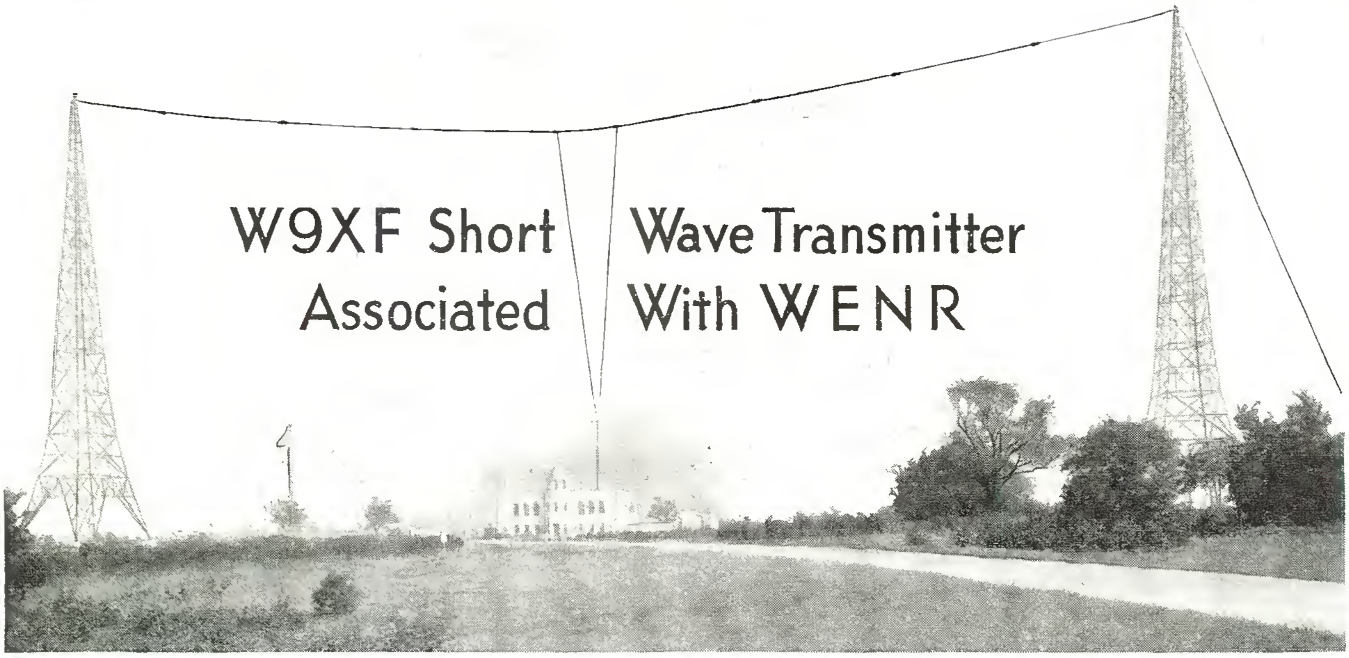
Fig. 10

which has been attained. Figure 10 shows the circuit conditions under which this new transformer was operated when the graph of Figure 9 was secured. The transformer curves and data are due to the Thordarson Electric Mfg. Co., of Chicago, whose laboratories investigated and developed the units used, at the request of the High Frequency Laboratories.

Figure 11 shows the performance curve of the new dynamic speaker used in this super. This graph represents actual sound pressure output, as measured in the laboratories of one of the foremost radio manufacturers. The response

(*Continued on page* 81)





W9XF Short Wave Transmitter Associated With WENR

By E. H. GAGER*

THE call letters W9XF were first used when the 50,000 watt transmitter for WENR was installed early in March, 1928. The preliminary test of this high powered transmitter made W9XF well known throughout the United States and many foreign countries. Therefore, when the Great Lakes Broadcasting Company was granted a license for a short wave transmitter, it was proper that the call letters W9XF should be assigned to this station.

For Delay Work

This station operates under an experimental license granted for the purpose of experimenting in the transmission of programs to foreign countries for rebroadcast in those countries. Its use for domestic broadcasting is not permitted. All of the programs of WENR are transmitted by W9XF. Reports have been received from every part of the civilized world, but the transmission seems to be particularly good toward the southwest. Japan, Australia and New Zealand are the countries best served by this transmitter. On one occasion, a two-hour program was successfully rebroadcast by 3YA, Christchurch, New Zealand. According to the reports of the New Zealand Broadcasting Company, not a word of the entire program was missed and the quality throughout the entire broadcast maintained a very high standard.

The transmitter has a rated power of 5,000 watts in the antenna, with approximately 85 per cent modulation. Two, UV-207 twenty kilowatt, water cooled tubes are used in the final stage. The frequency of the transmitter is controlled by a 1,505 kilocycle quartz crystal. The frequency is multiplied by two stages of multiplication to the operating frequency of 6,020 kilocycles. The antenna is located approximately 600 feet from the transmitter building and is fed by a two-wire transmission line mounted on fifteen-foot poles. This transmission line passes directly under the antenna of the 50,000-watt transmitter.

Mysterious Signals

Shortly after W9XF was put in service, we began to receive complaints

(*Continued on page* 82)

*Chief engineer, Great Lakes Broadcasting Co.—Stations WENR, W9XF, W9XR.

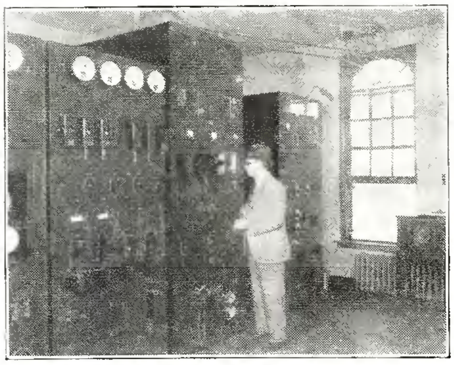


Fig. 2. Built by their own engineers, this photo shows the short wave relay equipment at WENR, where Mr. Gager is seen inspecting a part of the "works"

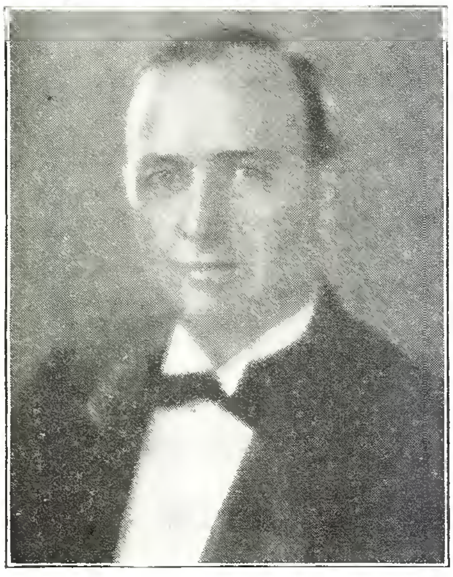


Fig. 1. E. H. Gager, chief engineer of the Great Lakes Broadcasting Co., operating stations WENR, W9XF and W9XR

Fig. 3. Here we have a high power tube, a peanut receiving tube, and a high power organist. Rating of the tube is 100 kw, that of the peanut tube probably in milliwatts, while the rating of Irma Glen, WENR's organist, is very high according to countless thousands of her listeners

Lincoln DC 8 Designed for Use With New Breather Battery

Latest Super Also Tunes Over 80-Meter Band Without Coil Change

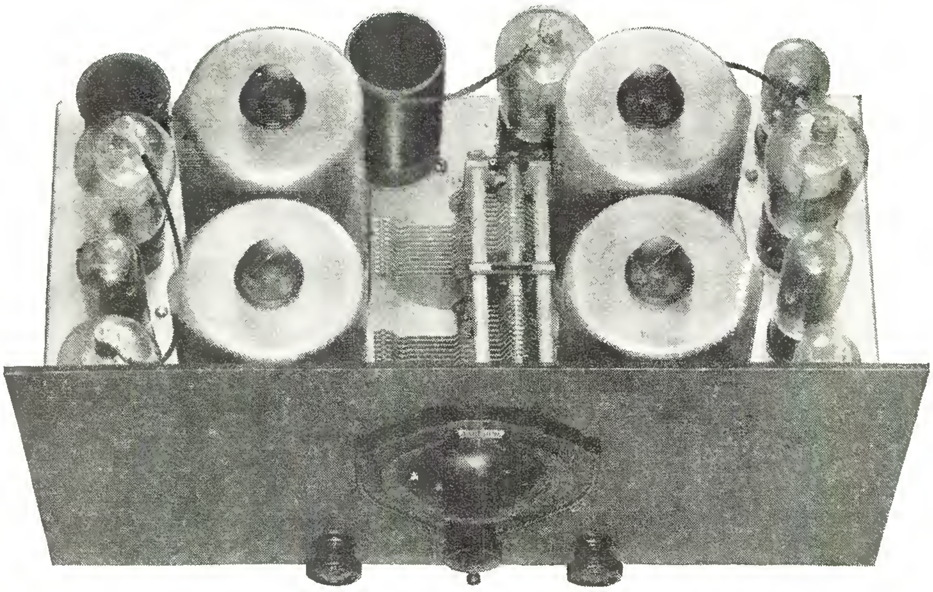


Fig. 1. From this photo may be seen the compactness of the Lincoln D-C 8 described in the accompanying text

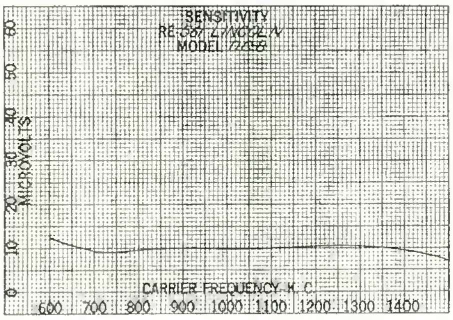
PRIOR to the development of the a.c. type receiver, radio equipment as a whole depended upon battery operation. The general outline of equipments required d.c. operated tubes, requiring a heavy drain on the filament supply, the power of which was furnished by a storage battery and the plate supply of a dry battery type or of the storage type. Due to the heavy drain on the plate supply, "B" batteries would not last long and the "A" supply, or, storage battery required constant charging; and, in the country districts where power lines are not available, batteries had to be carried miles back and forth at regular periods.

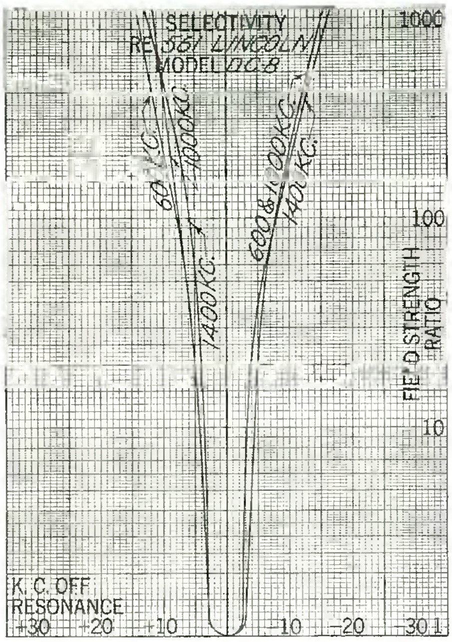
With the advent of the a.c. receiver, the storage battery type of receiver with all its inconvenience of charging and acid, went into the discard and manufacturers throughout the country concentrated on the design of equipment to be powered by the 110 volt a.c. line current. By this program, thousands of homes in the outlying farm districts, were forced to use the antiquated storage battery equipment, due to the fact they could not purchase the more up-to-date radio receiver.

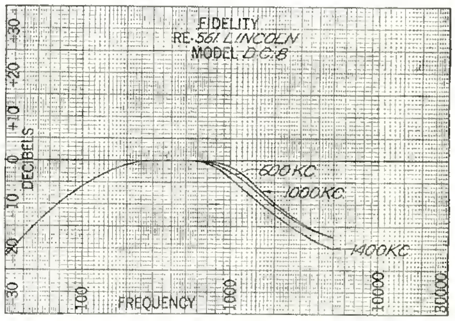
This created a great hardship on thousands of homes in view of the fact that the outlying districts must depend more or less upon reception from stations some distance away, and they, of all people, should have equipment capable of high amplification and modern design which radio has given the masses of people in the congested districts.

Due to recent developments in the last year, all of the detrimental features of the previous battery type receiver have been wiped out. In the design of the Lincoln DC-8 receiver, it is now possible to have consistent operation for a period of a year without any attention whatever to power equipment—

(*Continued on page* 81)







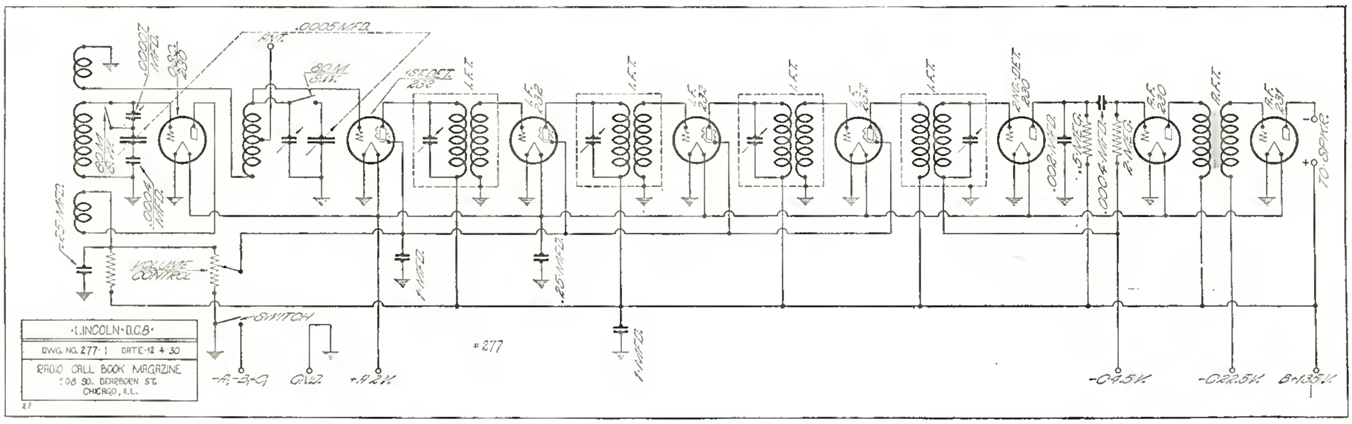


Fig. 2. Electrical details of the Lincoln D-C 8 may be learned by consulting the above schematic

Distortion and Cross-Talk Reduced

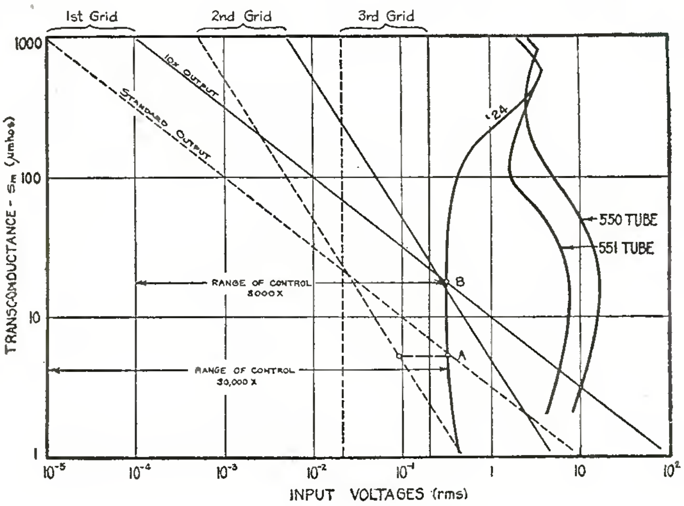


Fig. 2. Control analysis for graduated bias control; stage 3 uncontrolled; stages 1 and 2 controlled by common bias. Other conditions identical with Fig. 1

DESIGNED to reduce distortion due to: (1) non-linearity between input and output voltages in an r.f. amplifier, (2) cross-talk effects, and (3) hum in a.c. receivers due to low frequency modulation of the carrier, in control and screen grid circuits, two new screen grid tubes, the 550 and 551 were described by Stuart Ballantine, of the Boonton Research Corporation at the November meeting of the Rochester section of the Institute of Radio Engineers. Numbers of these tubes have been produced by Arcturus, Raytheon and Grigsby-Grunow companies who co-operated with the Boonton Research Corporation in manufacturing studies. Receiver tests in the field were made through the co-operation of the engineers of the Radio Frequency Laboratories.

Basis for the above is found in Contributions from the Radio Frequency Laboratories, No. 22, "Reduction of distortion and cross-talk in radio receivers by means of variable-mu tetrodes," by Stuart Ballantine and H. A. Snow, Boonton Research Corporation, Boonton, N. J., dated October, 1930.

From this paper we learn the cause of the first and second effects enumerated above is the increase in the high order curvature of the tube characteristic in relation to the effects of the first order, which increases as the applied r.f. voltages are increased. Reduction of these effects has been achieved in the new tubes by shaping the plate current-grid voltage characteristic so as to minimize the higher order curvature over an extended range of control grid voltage.

An abbreviated digest of interesting portions of the paper is given here:

Common Bias Control

A graphical method of applying the data for a unit stage to the prediction of the performance, control characteristics, overload and selection of control grid graduation in an amplifier comprising several stages is shown in Figure 1, where grid bias values do not appear explicitly but are represented by corresponding values of transconductance of the tube plotted as ordinates. This figure represents the case of common bias control in three stages. Voltages at the grids of the various stages are obtained by the conventional methods of receiver measurement using a standard signal generator. These constitute starting points at the upper edge of the diagram.

> ***Due to a shortage of space it has been necessary to considerably abridge the material in the paper by Messrs. Ballantine and Snow. However, we trust all the salient features have been retained. Engineers desiring the full paper will no doubt be supplied with copies upon application to the Boonton Research Corporation at Boonton, N. J. —Editor.***

At the grid of the third stage, for example, when the bias has been adjusted so the transconductance has been decreased from 1000 to 100 micromhos the voltage will have been increased ten times to preserve constant input to the detector; in the second stage the voltage will have been increased 100 times for standard output, and in the last stage to 1000 times, and so forth. It will be seen that overload occurs first in the third stage and limits the range of distortionless control. At standard output overload at the third stage occurs when transconductance equals 60 and input voltage is .05 volts, range of control being 5000 times. For ten times standard output, overload in the third stage occurs when transconductance is 250 and input voltage of 9×10^{-4} volts, a range of control of only 90 times. The unsuitability of this method of control (common grid bias) when high voltage detctors are to be operated with 224 tetrodes is thus apparent.

Graduated Bias Control

The advantage of a graduated bias control, in which the third stage is not controlled, and the first and second stages are controlled by a common bias is brought out in Figure 2, the other conditions here being identical with those in Figure 1.

In the case of standard output the first stage overloads first at point A for 6 micromhos and input voltage of .3 volt, a range of control of 30,000 times. At ten times output, overload is reached simultaneously in the first two stages at point B. Since the modulation-distortion curve is vertical in this region the maximum input voltage for 20 per cent distortion is about the same for ten times as for normal output. This is enormously greater than in the case of the common bias illustrated in Figure 1 where the range was only 90 times.

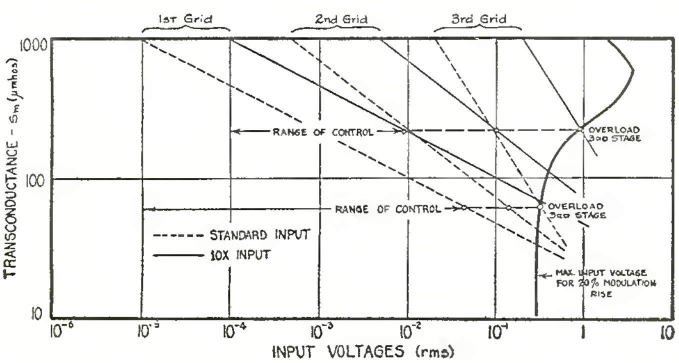


Fig. 1. Control analysis. Diagram of input voltages in 3 stage amplifier employing 24 tetrodes controlled by common grid bias in all stages

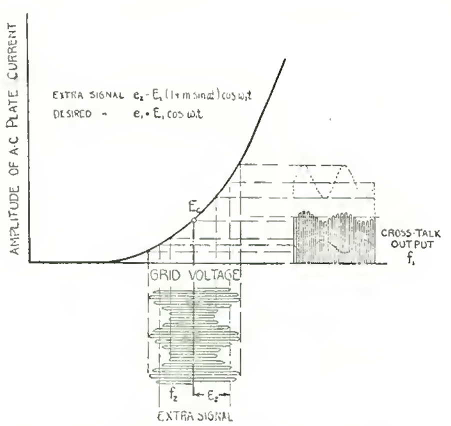


Fig. 3. Illustrating the production of Class B cross-talk. Heavy curve represents the relation between amplitude of plate current of desired signal frequency and grid bias with the desired signal impressed on the grid

It will be seen that the best graduation of bias depends in general upon the level of voltage at which the detector is to operate, and upon the distortion contour of the tube. A further graduation of bias between stages 1 and 2 generally results in additional improvement.

It should be noted the representation of the stage input voltages in the diagram by straight lines assumes the transconductance is independent of the voltage. In the range of voltages over which the input-output relations are non-linear this is not strictly true, and curved lines would be required in a perfectly accurate representation.

Cross-Talk

The term cross-talk is employed here to designate that species of interference which originates in r.f. amplifier tubes by modulation between two or more signals. These modulation effects depend upon the higher-order curvature parameters of the tube and are to that extent related to the problem of distortion. Any improvement effected in a tube to reduce distortion will also reduce a large part of the cross-talk.

For our present purposes we shall distinguish between two main classes of cross-talk.

In the first class (Class A) are included effects due to beating between two signals whose frequencies differ from each other and from that to which the receiver is tuned.

In the second class (Class B) is included cross-talk heard in circumstances of the following type: The receiver is tuned to a desired signal; a second signal, called the extra signal, of different frequency, is also present at the grid of the first tube. We shall also suppose the selectivity of the receiver and the frequency difference between the signals are such as to exclude the possibility of the extra signal being heard by simple interference in the absence of the desired signal. If the desired signal be modulated both signals are heard simultaneously, if unmodulated the extra signal is heard.

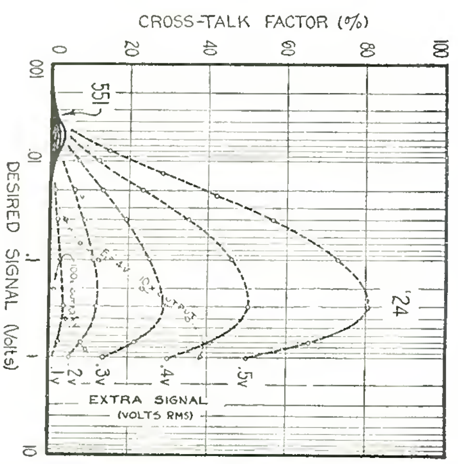


Fig. 4. Experimental curves showing cross-talk production in 24 and 551 tetrodes. Constant output maintained, corresponding to .001 volt desired signal at —3 volt bias

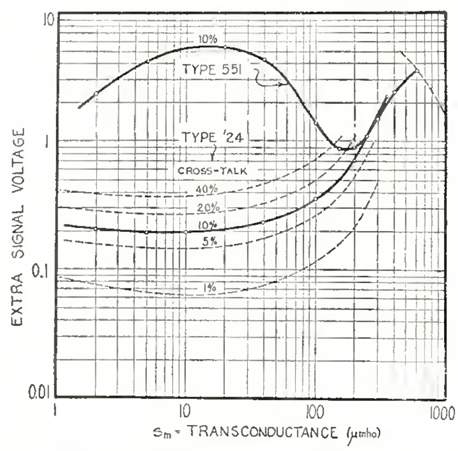


Fig. 5. Diagram showing relation between the transconductance produced by grid bias variation, and maximum voltage of interfering signal for various percentages of cross-talk

The mathematical theory can be developed along the lines of the following physical picture. Figure 3 represents the relation between the amplitude of the r.f. output current of the tube and the grid bias with the desired signal (Fig. 4) impressed on the grid. This relation is derivable from the input-output data and in general is non-linear. We shall now regard the extra signal (Fig. 5) as varying the grid voltage about the point E_c which represents the grid bias. In order that the output of the tube shall be audible after detection it should be of the modulated signal type.

Figure 4 shows the relation between the cross-talk factor for an average 224 tetrode (dotted curves) and the new type 551 tetrode (solid curves) and the input voltage at a fixed voltage output level, and for several fixed values of extra signal. The modulations of the two signals were the same, 30 per cent. The output level was such that 1000 microvolts were required at normal bias (—3v; S_m = 1000 micromhos) to produce it. A sufficient attenuation between this stage and the one following it was used to avoid any cross-talk effects in the second stage. The desired signal frequency was 1000 kc. and that of the extra signal was 900 kc. This frequency difference was not critical at the value employed, but was sufficient to preclude interference on the one hand and combination cross-talk of Class A on the other. Both desired and extra signals were applied directly to the grid of the tube.

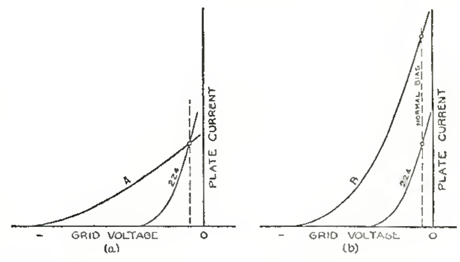


Fig. 6. Showing (a) decreasing transconductance and (b) increasing plate current accompanying attempts to decrease distortion by decreasing the mu-factor

Cross-Talk Analysis

For cross-talk analysis in a multistage amplifier we have employed a graphical method similar to that used for distortion and analysis which was shown in Figures 2 and 3. This is based on the fact that the cross-talk is approximately independent of the desired signal voltage. The basis of the method is a contour curve for the tube which shows the relation between the extra signal voltage which has to be applied to the grid to attain a given percentage of cross-talk and the operating point on the characteristic, as represented by the transconductance at the point. A typical set of such contours is shown in Figure 5.

The reduction of cross-talk at higher desired signal voltages which has been achieved in the 551 tube will be seen to be considerable. At S_m = 2.5 micromhos, for example, the ratio of extra signal voltage for 10 per cent cross-talk amounts to about 23 to 1. This means

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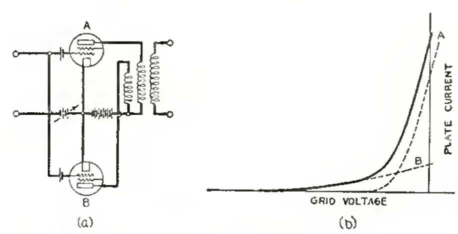

Fig. 7. Method of decreasing distortion and cross-talk

Silver 714 A. C. Superheterodyne

MEASUREMENT and schematic details of the Silver-Marshall 714 a.c. custom built superheterodyne will be found here. Electrical connections of the tuner will be found in the drawing at the bottom of this page, while the three response curves are also shown. The front view of the chassis is shown in Figure 1, while the power supply schematic is shown in Figure 3.

A band pass stage preceding the first 224 r.f. and another stage following it, feed into the first detector, these two stages using four of the five sections in the 5 gang condenser. The fifth section is used by the oscillator.

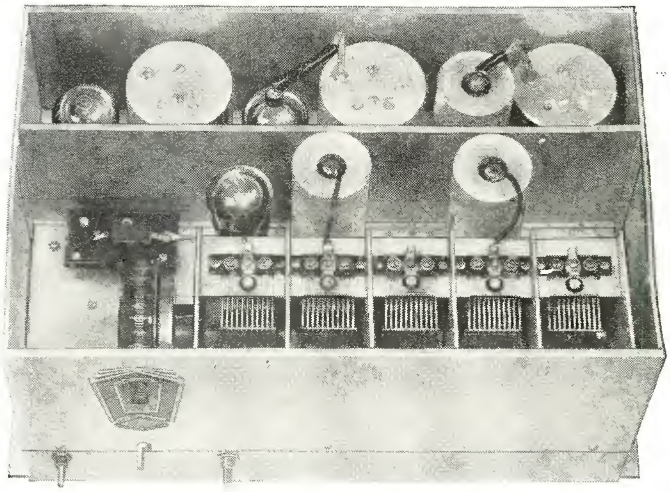

Fig. 1. This photograph shows the front top view of the Silver-Marshall 714 a.c. tuner, which, with its amplifier, was measured in the laboratory of this magazine. Curves are shown on this page

Sensitivity Very Good

Judging from the response curve measurement made on this receiver in the laboratory it is the most sensitive and selective that has yet been measured by our engineers. Those who have been following the curves appearing in each issue will be interested in these findings.

Measurements were made with the dummy antenna consisting of 20 uh, 200 mmf and 25 ohms. The output impedance load was adjusted to 4000 ohms and coupled capacitatively to the plates of the 245 output tubes. Receiver was phased at the factory value and the volume control turned on full. Line voltage 115, current .98 amperes.

Transconductance of the tubes was: 1 r.f. 1140; mixer 1120; detector 1030; 1 i.f. 1250; 2 i.f. 1200; 1 a.f. 1000; P.P| 1940; P.P. 1980 and oscillator 1000 micromhos.

In the following tables will be seen the interference ratios and the band width of the 714:

Interference Ratio

Resonance	*Kilocycles off resonance* Plus 10	Plus 20	Plus 30
600 kc.	-------	-------	-------
1000 kc.	-------	-------	-------
1400 kc.	-------	-------	-------
	Minus 10	Minus 20	Minus 30
600 kc.	-------	-------	-------
1000 kc.	-------	-------	-------
1400 kc.	-------	-------	-------

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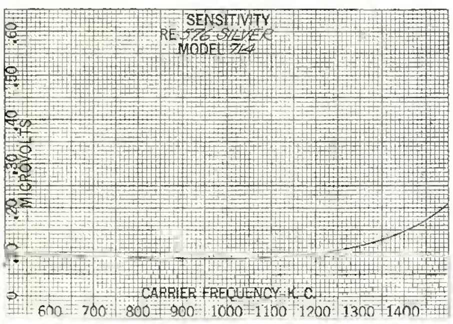
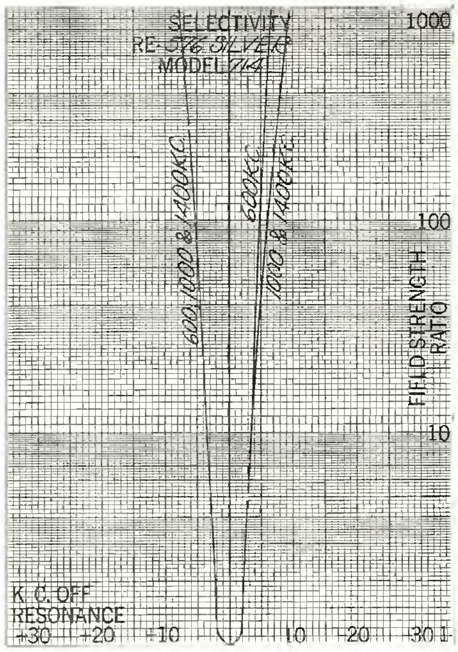
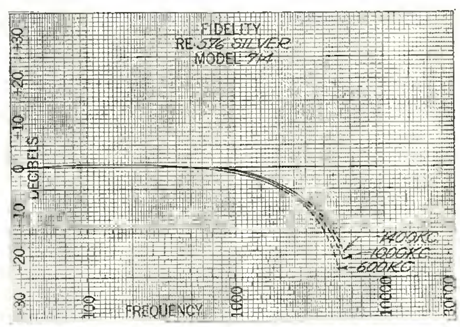
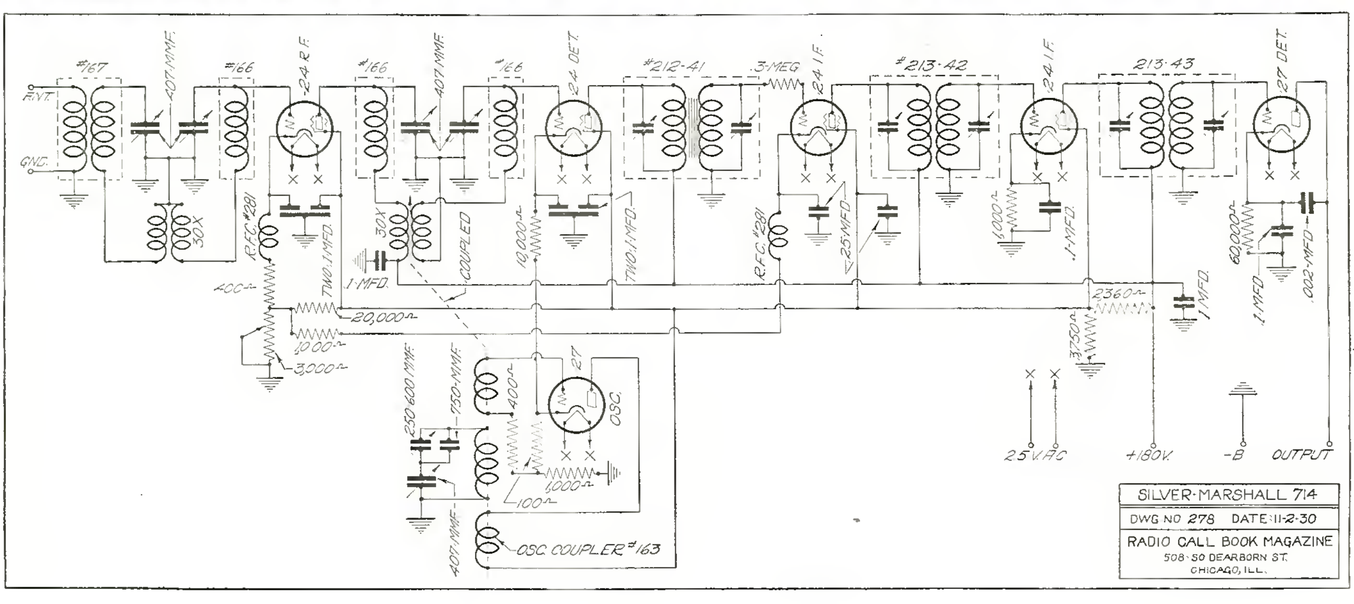








Westinghouse Remote Control Unit

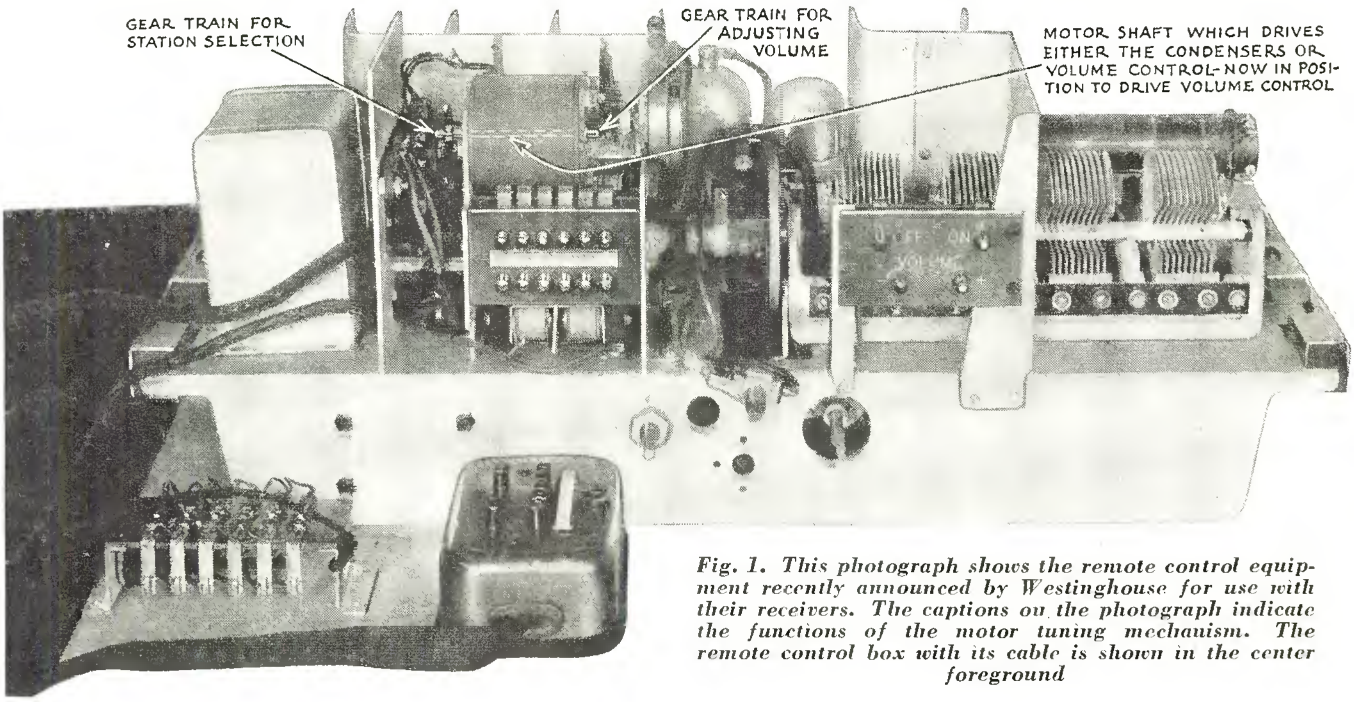


Fig. 1. This photograph shows the remote control equipment recently announced by Westinghouse for use with their receivers. The captions on the photograph indicate the functions of the motor tuning mechanism. The remote control box with its cable is shown in the center foreground

EMBODYING the most advanced engineering developments known to radio science, the new remote control equipment of the Westinghouse radio receiver brings increased pleasure into radio reception.

Motor Does Trick

An electric motor which automatically turns condensers to the right position makes it possible for listeners to tune in the desired stations simply by pressing a button.

The heart of the remote control is a row of buttons on the front of the cabinet to the left of the illuminated dial. The buttons are pressed in and the desired stations are tuned in, after which the set is ready to be operated from the remote control box.

Tune From Chair

The listener may retire to the comforts of any easy chair or to any other place where the remote control box has been located. Through the simple operation of corresponding press buttons the listener may tune in the desired stations just as accurately as though he were manually operating the receiver.

A feature of the Westinghouse remote control equipment is that a flat cord is used to connect the control box with the receiver. This flat cord has the advantages of being more flexible and durable than a round one and at the same time may be laid under a carpet out of sight.

Fractional Degree Accuracy

From a mechanical standpoint the station selector contacts which control the rotation of the motor are actuated by a series of cams. Accuracy within a fraction of a degree is obtained because when the condensers are rotated to the desired point the electrical contact is broken and the motor driven gear engaging the gear train which drives the condensers is disengaged.

The regular method of manual tuning is available as the remote control does not interfere with the ordinary operation of the receiver.

It will be observed by referring to the photograph in Figure 1, that the remote control box has a series of six buttons, by means of which as many stations may be automatically tuned in. Besides that by placing one finger on one of the two buttons at the left of the box in the photograph, and another finger on the other, it is possible to rock the tuning back and forth in search of any station that is not allocated to the six positions.

On the little panel at the right of the chassis in Figure 1 will be found four push buttons. The two at the top control the stopping and starting of the receiver itself, while the two buttons at the bottom control the volume.

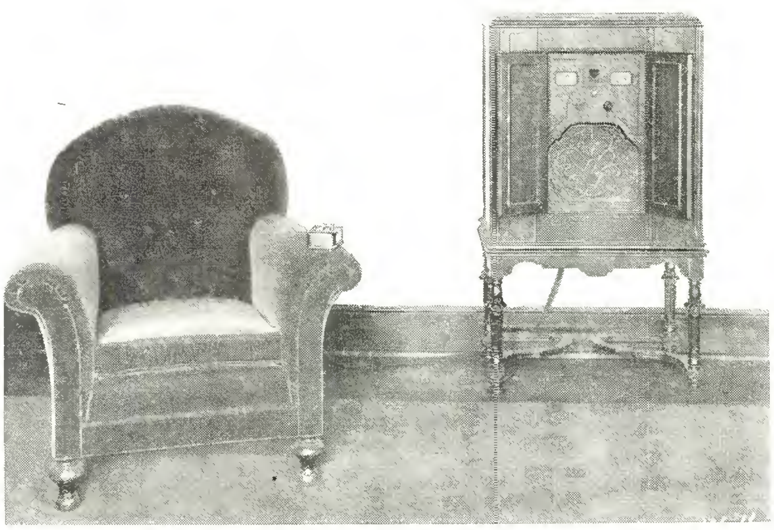


Fig. 2. This picture shows a view of one of the Westinghouse receivers with the remote control device placed in it, and the remote control box located at the arm of a chair, from where it may be operated by the user. Push buttons are also installed on the panel of the receiver so that tuning can be done from that position too. The new device does not in any way interfere with the normal manual tuning

S.W. and Broadcast on A.C. Conqueror

RECENTLY designed by engineers of the Insuline Corporation of America, the A. C. Conqueror, model 47, illustrated photographically on this page, covers both the short wave and broadcast bands from 17 to 600 meters, by the employment of six plug-in coils. Ranges of these coils will be found at the end of this article.

The schematic diagram of the receiver is shown in Figure 2, while the front top view of the A.C. Conqueror is found in Figure 1.

It will be observed the antenna input stage is of the tuned type, the primary coil being variable, this input feeding to a screen grid 224. The bias for this stage is derived from the voltage drop across the resistor between cathode and ground. The plate circuit of the 224 is not tuned, but the secondary circuit of the detector is tuned, and in addition has the regenerative coupling coil which is controlled by the throttle condenser, or regeneration condenser.

Careful Bypassing

One of the features worthy of mention is the care with which all the circuits are bypassed or choked, to eliminate common coupling. The screen voltage on the 224 passes through a resistor from the 180 volt feeder, and the plate supply for the 224 passes through another resistor in the 180 volt line, the latter being bypassed with a 2 mfd condenser. Thus the common coupling between screen and plate of the 224 is eliminated. It will also be seen that the plate circuit of the detector, where a 227 is used, is also fed through a separate resistor in the 180 line to further obviate common coupling. The same practice is employed in the first and second audio stages. Resistance coupling is used between the first and second audio stages, transformer coupling being used for the power output stage where a 245 tube is employed.

Double Tuning Control

Tuning of the first r.f. and the detector circuits is by double control, the left hand drum (in Figure 1) tuning the r.f. stage, and the right hand drum tuning the detector. The center knob connected to the condenser in the center is for the regeneration control. The knob at the extreme left is for variation of the coupling between the antenna coil and the secondary. An on-off switch is provided at the right. Good shielding is provided in each of the stages so that capacity effects are not to be expected. With a well filtered power supply the receiver functions without hum, regeneration control is smooth and the individual coil ranges generous as to coverage.

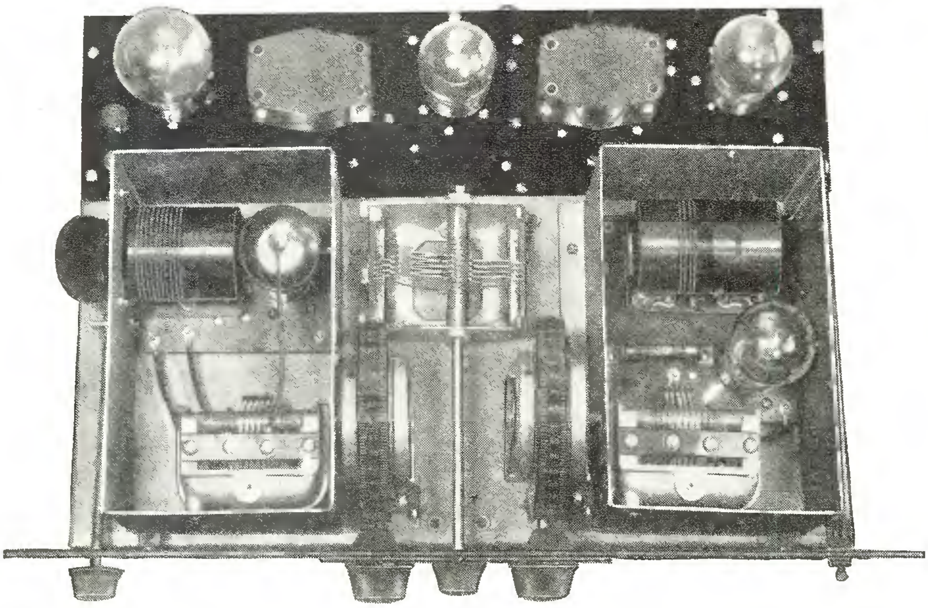


Fig. 1. This photograph shows the top of the new A.C. Conqueror, model 47, recently designed by the Insuline Corporation of America

Coil Range

The first of the plug-in coils covers from 17-28 meters; the second from 27-45 meters; the third from 40-80 meters; fourth from 75 to 150 meters; fifth from 145 to 300 meters (lower half of the broadcast band) and the last coil covering from 295 to 600 meters which is the upper half of the broadcast wavelength section.

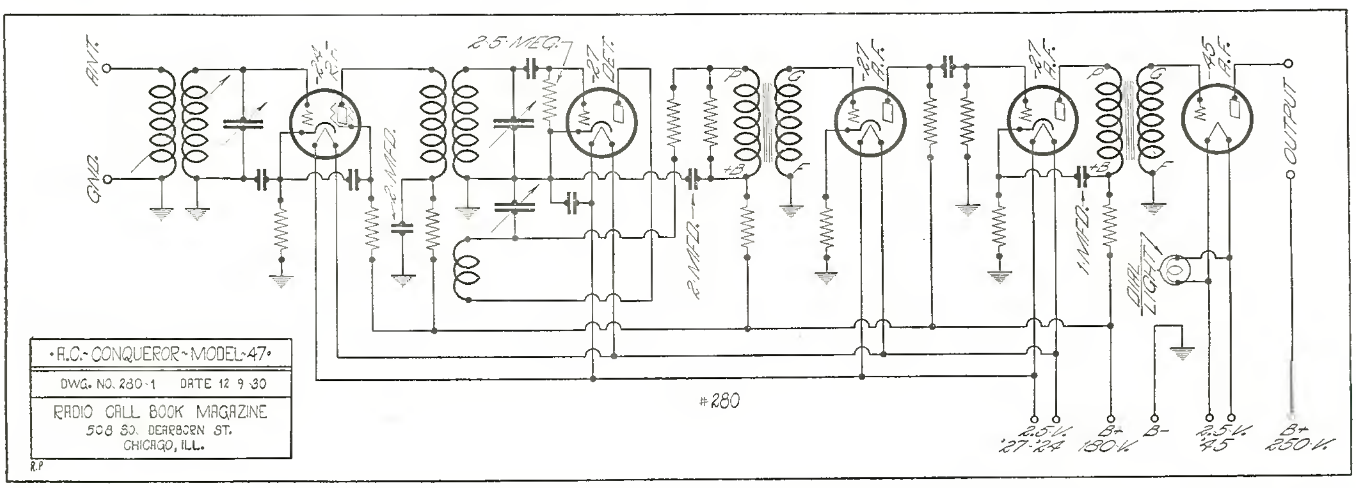


Fig. 2. In this illustration will be found the schematic diagram of the receiver described on this page. Any well filtered power supply with the voltages indicated may be used if desired

Aligning RF and IF in Radiola Supers

FACTORY SCHEMATIC INDEX

Name	Model	Vol.	No.	Month	Year	Page	SR. No.
A. C. Dayton	Navigator	10	4	Nov.	1929	94	24
Acme Mfg. Co.	AC7	10	2	March	1929	92	3
Acme Mfg. Co.	AC4	10	2	March	1929	93	4
All-American Mohawk	90	11	4	Nov.	1930	80	74
All-American Mohawk	6	10	2	March	1929	94	1
All-American Mohawk	8	10	2	March	1929	93	2
American Bosch	28-29	10	4	Nov.	1929	91	21
Amrad	70	10	4	Nov.	1929	92	22
Amrad	81	11	2	March	1930	81	44
Amrad	84	12	1	Jan.	1931	70	106
Apex	48	11	4	Nov.	1930	79	80
Apex (U. S. Radio)	31	12	1	Jan.	1931	68	108
Atwater Kent	38	11	1	Jan.	1930	72	28
Atwater-Kent (cap.)	55, 55-C	11	3	Sept.	1930	82	51
Atwater-Kent (Ind.)	55, 55-C	11	3	Sept.	1930	82	52
Audiola	31	11	4	Nov.	1930	79	79
Balkeit	A	10	3	Sept.	1929	85	12
Bosch	48	11	4	Nov.	1930	81	73
Bosch	58	12	1	Jan.	1931	67	109
Bosch Auto	80	11	4	Nov.	1930	82	94
Bremer-Tully	7-70	10	3	Sept.	1929	83	10
Bremer-Tully	81-82	11	4	Nov.	1930	80	75
Brunswick	3KRO	10	4	Nov.	1929	93	23
Brunswick	S15	11	4	Nov.	1930	76	86
Brunswick	S14	11	4	Nov.	1930	81	71
Colonial	31AC	11	1	Jan.	1930	73	29
Colonial	33 AC	11	4	Nov.	1930	74	95
Crosley	Roamio	11	3	Sept.	1930	71	67
Crosley	40S, 41S, 42S, 82S	11	3	Sept.	1930	79	57
Crosley	608 Gembox	10	2	March	1929	95	5
Crosley	705 Showbox	10	2	March	1929	96	6
Crosley	Jewelbox 704B	11	2	March	1930	78	41
Crosley	77	11	4	Nov.	1930	69	83
Crosley	53, 54, 57	12	1	Jan.	1931	66	103
DayFan	5080	10	3	Sept.	1929	84	11
Delco Auto. Radio		11	3	Sept.	1930	70	66
Edison	R4, R5, C4	11	3	Sept.	1930	69	49
Edison	R4, R5, C4	11	4	Nov.	1930	77	49
Edison	R6, R7	12	1	Jan.	1931	64	99
Erla	DuoConcerto	11	1	Jan.	1930	77	33
Fada	7AC	10	3	Sept.	1929	86	13
Fada	35-35Z	11	4	Nov.	1930	78	70
Federal	H	10	4	Nov.	1929	89	19
Freed-Eisemann	NR80	10	4	Nov.	1929	90	20
Freshman	2-N-12	10	3	Sept.	1929	87	14
General Motors		11	3	Sept.	1930	69	68
General Motors		11	4	Nov.	1930	82	68
Gilfillan Bros.	100	11	1	Jan.	1930	76	32
Graybar Electric Co.	600	11	2	March	1930	79	42
Grebe	7AC	10	4	Nov.	1929	87	17
Grebe	AH1	11	4	Nov.	1930	75	96
Gulbransen	Nine-in-Line	11	2	March	1930	77	40
Howard	S.G.A.	11	3	Sept.	1930	72	56
Howard	8	10	3	Sept.	1929	89	16
Kellogg	523-528	11	4	Nov.	1930	73	77
Kennedy, Colin B.	20	11	2	March	1930	75	48
Kennedy, Colin B.	26	11	4	Nov.	1930	71	81
Kennedy, Colin B.	10	12	1	Jan.	1931	73	38
King Mfg. Co.	J	11	1	Jan.	1930	75	31
Kolster	4	10	3	Sept.	1929	81	8
Kolster	21-23	11	2	March	1930	82	45
Kolster	K-43	11	4	Nov.	1930	70	72
Kylectron	70	11	4	Nov.	1930	78	65
Majestic	70	10	3	Sept.	1929	80	7
Majestic	90B	11	3	Sept.	1930	80	55
Majestic	130-A	11	4	Nov.	1930	68	84
Majestic	50	12	1	Jan.	1931	53	98
Philco	86-82	10	4	Nov.	1929	96	26
Philco	95	11	3	Sept.	1930	78	60
Radiette	F14	12	1	Jan.	1931	73	104
RCA	60	11	1	Jan.	1930	74	30
RCA	66	11	3	Sept.	1930	81	64
RCA	44	12	1	Jan.	1931	71	102
Silver	36A	12	1	Jan.	1931	69	105
Silver-Marshall	30B	11	3	Sept.	1930	73	53
Silver-Marshall	30	11	1	Jan.	1930	79	35
Silver-Marshall	35-A	11	4	Nov.	1930	72	82
Slagle	9	11	1	Jan.	1930	71	27
Slagle (Continental)	R-20	11	2	March	1930	83	46
Sonora	5R	10	4	Nov.	1929	95	25
Sparton	AC89	10	3	Sept.	1929	82	9
Sparton	589	11	3	Sept.	1930	76	63
Splitdorf	E175	11	1	Jan.	1930	80	36
Steinite	261	10	3	Sept.	1929	88	15
Steinite	70-80-95	11	4	Nov.	1930	81	76
Stewart-Warner	950	11	3	Sept.	1930	74	62
Stewart-Warner	Series 900	11	1	Jan.	1930	78	34
Stewart-Warner	R100	12	1	Jan.	1931	73	85
Stromberg-Carlson	846	11	3	Sept.	1930	75	54

SO much interest has been shown by service men in seeking data covering servicing of the recently announced superheterodynes under the Radiola, G. E., Westinghouse and Graybar banners, that it is felt desirable to quote here at length the alignment procedure covering the r.f. and i.f. stages of these 175 kc. superheterodynes.

All Super Chassis Alike

The following instructions are excerpts from the service manual on the Westinghouse WR-5, and as such will apply to all the Radiola, General Electric and Graybar superheterodynes. The General Radio type 360 oscillators mentioned in the instructions are those originally built to R. C. A. specifications for their service organizations.

"Five adjustable condensers are provided for the lining up of the r.f. circuits and shifting the oscillator frequency so it will be at a 175 kc. difference from the incoming r.f. signal throughout the tuning range of the set. Poor quality, insensitivity and possible inoperation of the receiver may be caused by these condensers being out of adjustment.

"If other adjustments have not been tampered with (the intermediate tuning and gang-condenser line-up condensers) the following procedure may be used for adjusting these condensers:

R. F. Alignment

"(a) Procure an r.f. oscillator giving a modulated signal at exactly 1400 kc. and 600 kc. The General Radio Co., types 320 or 360 after calibration by G. R. Co., will be suitable. A non-metallic screwdriver 1/4-in. in diameter is also necessary.

"(b) An output indicator is necessary. This may be a current squared galvanometer connected to the secondary of the output transformer instead of the cone coil of the reproducer

Stromberg-Carlson 635-636	10	4	Nov.	1929	88	18
Stromberg-Carlson 12-14	11	4	Nov.	1930	67	93
T. C. A. Clarion....50	11	4	Nov.	1930	79	78
Temple S-60	11	2	March	1930	74	37
Transitone Auto Radio....	11	4	Nov.	1930	80	69
U. S. Radio & Television....37	11	2	March	1930	76	39
Victor R32, RE45, R52	11	3	Sept.	1930	77	61
Victor R35, R39, RE57	12	1	Jan.	1931	65	101
Westinghouse WR-5	11	4	Nov.	1930	66	92
Westinghouse WR-4	12	1	Jan.	1931	72	107
Zenith 52	11	2	March	1930	80	43
Zenith 70	11	4	Nov.	1930	56	97

unit, an 0-5 milliammeter connected in series with the plate supply to the second detector (lead No. 1) or the output devices included in the General Radio oscillators. In the type 320 the meter leads should be connected in the second detector plate circuit and in the type 360 across the cone coil connections of the loudspeaker. The cone coil may remain in place or be disconnected, satisfactory results being obtained in either case.

"(c) Locate the 600 kc. trimming condenser, and turn the adjusting screw until it is about 3/4 of the way in. Set the "Local-Distant" switch at "Distant."

"(d) Set oscillator in operation at exactly 1400 kc. Place the set in operation and tune in the signal. Make sure the receiver is properly grounded and has an average antenna. Adjust the volume control until a reading is obtained in the output meter. While making adjustments regulate the volume control so that an excessive reading is not obtained. Then adjust the selector knob until the scale reads 1400 kc. Now adjust the oscillator, 1st detector r.f. and link circuit trimming condensers in the order given until maximum output is obtained.

"(e) Set the oscillator at exactly 600 kc. Tune in the signal on the set and adjust the 600 kc. oscillator trimming condenser, for maximum output while rocking the gang condenser back and forth. The dial scale should read exactly 600 kc. If it does not read 600 kc. loosen the screws that hold the scale and slip it until it reads 1/2 the error from 600 kc. on the opposite side of 600 kc. For example, if the scale reads 620 kc. at maximum output set the scale at 590 kc. Another example would be if the scale read 580 kc. to set it at 610 kc.

"(f) Shift the oscillator frequency to 1400 kc. and set the selector scale at exactly 1400 kc. Now adjust the four trimming condensers in the order given under (d) until maximum output is obtained.

"(g) Place the oscillator again in operation at 600 kc. and tune in the signal with the receiver. If adjustments have been properly made, the signal will be received at maximum output when the scale reads exactly 600 kc. If not, then the operations given under (e) and (f) must be again repeated.

"With this adjustment so that the scale is exactly at 600 and 1400 all other dial readings will be correct within very close limits.

Adjustment of I. F. Tuning Condensers

"Two screen-grid intermediate frequency amplifier stages are used in this set. Three transformers are necessary for coupling these two stages. Both the primary and secondary of each transformer is accurately tuned to 175 kc. and the correct functioning of the receiver is dependent on the proper alignment of the i.f. stages.

"The first i.f. transformer (the one in the copper container) has its two windings very loosely coupled, this condition being further accentuated by having copper shield placed between each winding, which makes possible very sharp tuning of this first i.f. stage

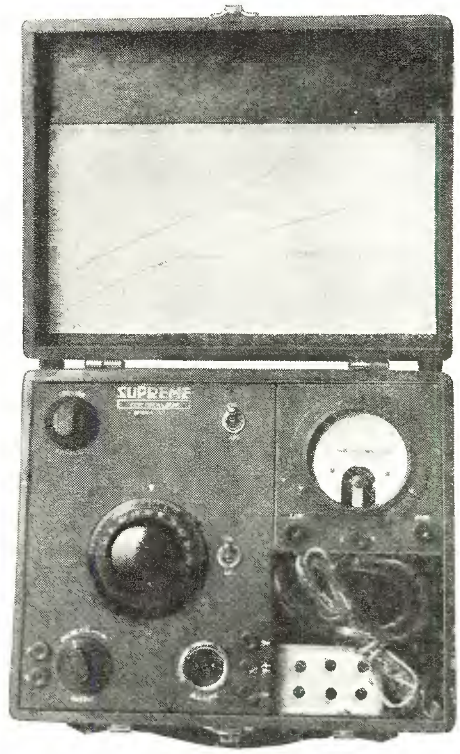


Fig. 2. Above is illustrated the recently announced model 70 made by the Supreme Instruments Corp., of Greenwood, Miss.

unless the "Local Distant" switch is in the local position and resistance is artificially added to the circuits. The other two transformers have their winding closely coupled (overcoupled) so that a broad top effect is obtained in the tuning curve. The reason for discussing the i.f. curve is that this type of coupling has a bearing on the method to be used for lining up the i.f. transformers. The second and third transformers being over-coupled, their tuning condensers are adjusted until a plus or minus equal frequency shift of the i.f. oscillator frequency will give the same output, and a flat top effect is obtained on the tuning curve. This is not the adjustment of the condensers that will give a maximum output and is a different procedure from that used in previous superheterodyne receivers. The first transformer being closely coupled the tuning condensers are adjusted for maximum output.

Detailed Procedure

"A detailed procedure for making these adjustments follows:

"A modulated r.f. oscillator giving a signal at 175 kc. and having a vernier condenser for shifting this frequency from 171 kc. to 179 kc. is necessary for aligning the i.f. stages of this set. The General Radio Co.'s type 360 oscillator gives this frequency variation, but calibration of these secondary points must be made on instruments purchased prior to June 1, 1930. On these earlier models and on the older General Radio type 320 oscillators to which the 175 kc. frequency has been added, the General

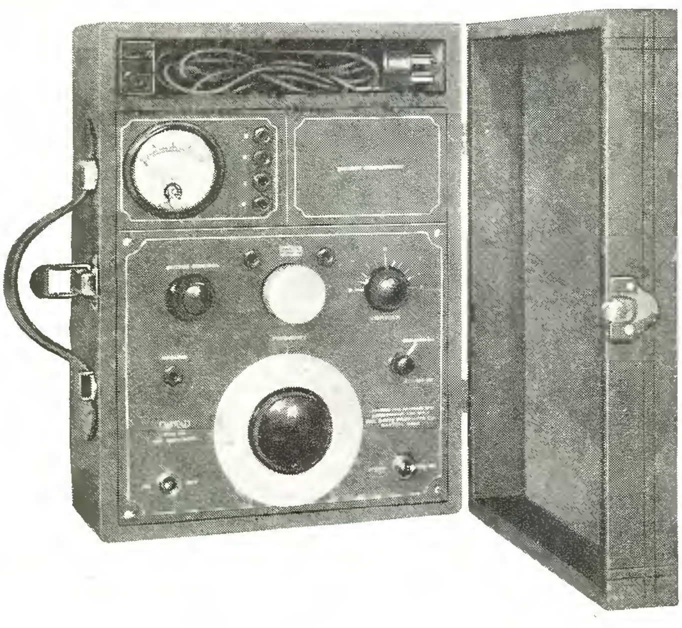


Fig. 1. This is one of the test oscillators designed by the Radio Products Co., of Dayton, Ohio, for use by service men in making alignment checks on receivers both t.r.f. and superheterodyne. It is known as the model 180

Radio Co. will add such calibrations, together with a 600 kc. and 1400 kc. calibration at a nominal cost.

"A nonmetallic screwdriver ¼ inch in diameter is also necessary for making these adjustments. With the necessary equipment at hand, proceed as follows:

"(a) Place the set in such a position that access to all mechanism is obtained.

"Place the receiver in normal operation with the volume control at minimum and then remove the oscillator tube. (Socket No. 2.) Make sure a good ground connection has been made.

"(b) Connect output meter in circuit. The meter leads of the type 320 oscillator should be connected in series with lead No. 1 of the s.p.u. terminal strip.

"The type 360 output meter should be substituted for the cone coil of the reproducer unit and the switch on the oscillator set at 'Dynamic.'

"(c) Place the oscillator in operation at 175 kc. and connect the coupling lead to the control grid connection of the second i.f. tube. (Socket No. 4.) If excessive output is obtained, disconnect the coupling lead from the oscillator and place it a short distance away, but in such a position that will cause an indication in the output meter without causing the needle to go beyond the scale.

"(d) Adjust the secondary and then the primary of the third i.f. transformer until a maximum reading is obtained in the output meter. After obtaining maximum output we know the two windings are closely adjusted to the same frequency. Now they must be readjusted until a flat top effect is obtained in the tuning curve. The flat portion should be at least 5 kc. in width. The method of doing this is to shift the oscillator frequency back and forth from 171 kc. to 179 kc. and noting, when the condensers are adjusted, that no appreciable change in output reading is obtained from 172.5 kc. to 177.5 kc. Also the drop in output should be the same at 171 kc. and 179 kc. This indicates that the flat top is centered at 175 kc. The usual method to obtain this characteristic is, after adjusting to maximum output to adjust the capacity of the secondary condenser until the flat top effect is obtained. It will probably not be centered at 175 kc. It is, however, easy to shift its center point by increasing each condenser slightly to shift it to a lower frequency or decreasing both condensers slightly to increase its frequency. To make this adjustment the first time will be somewhat difficult, but after a little experience it is equally as easy as other superheterodyne adjustments.

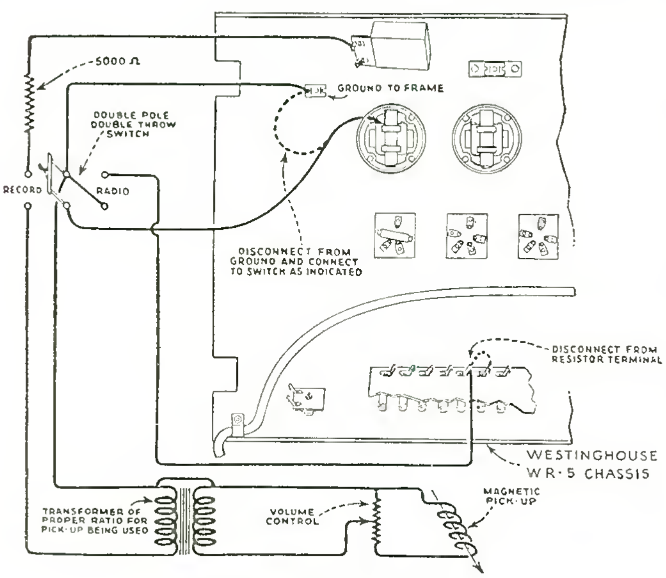
"(e) After adjusting the third i.f. transformer, shift the coupling lead to the control grid connection of the 1st i.f. tube and place it at a greater distance from the oscillator. Then advance the volume control to maximum. If necessary, reduce this coupling to an even greater extent so that too great an indication is not obtained in the output meter.

"(f) Now adjust the secondary and primary condensers until a maximum output is obtained. Then readjust in the same manner as with the third transformer until a flat top effect is obtained. This may not be quite as broad as the third transformer.

"(g) If the 'Local Distant' switch is not already so adjusted, place it in the 'Distant' position. Then shift the coupling lead to the control grid connection of the first detector. (Socket No. 3.) Now adjust the volume control until the meter reading is not excessive and then adjust the secondary and primary of the 1st i.f. transformer condensers until maximum output is obtained. This transformer tunes very sharply and no further adjustments are necessary.

"This completes the i.f. tuning adjustments and when so made, the set will perform at maximum efficiency."

Adding Pickup Unit to the WR5



WIRING NECESSARY FOR CONNECTING MAGNETIC PICK-UP TO WESTINGHOUSE WR-5 RECEIVER

Numerous requests have been made of our editorial department for data on the wiring changes necessary to provide for the employment of a magnetic type pickup on the Westinghouse WR-5 superheterodynes. This data has just been made available to us by the Westinghouse interests and the drawing at the left embodies the changes recommended by the makers of the receiver

Practical Testing Systems

A COMPREHENSIVE review of the practical testing systems available to the service men, and bearing the title given above, has recently been received by our editorial department. It is the work of John F. Rider, well known writer of radio textbooks, and is published by the Radio Treatise Co., Inc., 1440 Broadway, New York. The volume lists at one dollar.

A glance at the contents will readily show the scope of the book, which is well illustrated schematically throughout. Among the chapters are those devoted to the following: measuring instruments, resistance units, oscillators, tube testers, vacuum tube voltmeters, capacity tests, inductance tests, audio and output systems. The information given the service man is concise and complete; the volume well worth more than its price.

Mr. Rider will be remembered as the author of "Mathematics of Radio," "Radio Trouble Shooter's Manual," "Sound Pictures and Trouble Shooter's Manual," etc.

Stewart-Warner Service

HERE'S an interesting letter from David C. Dodge, of the Stewart-Warner Sales Co., 1344 Broadway, Denver, Colo., which covers service methods:

"Permit me to *brag* a little. Less than one-half of 1 per cent of the model 100 series Stewart-Warner radios sold in this territory have required service.

"Inasmuch as we are wholesalers only, we feel we would be taking business away from our dealers if we maintained an extensive service department. Therefore we work only on Stewart-Warner sets, and our testing equipment is of the usual type: tube tester, set tester for continuity also containing ohmmeter, oscillator, etc."

Increasing the Utility of D. C. Meters

By JESSE MARSTEN*

THE business of servicing a radio set or any speech equipment is a matter of determining the causes for a non-operative or poorly operative condition. Where the question is not a matter of fundamental design or construction, or an adjustment of a variable circuit element, such as a trimming condenser, the service problem resolves itself essentially into a determination of defective tubes or incorrect voltages.

A set delivering the proper voltages to the terminals for which they are intended would generally indicate continuity of circuits and satisfactory operating conditions—with a few exceptions, such as shorted variable condensers. Consequently a first determination of operating voltages at the tube terminals would give the major clues to the source of trouble. For example an open bias resistor or secondary of an r.f. or a.f. transformer will show up as absence of bias on the tube. An open primary would be evidenced by absence of voltage on the plates of tubes. Wrong values of bias resistor or voltage divider resistors would be shown by incorrect bias or plate voltages. Shorted filter condensers would result in no voltages being delivered from the power pack, and so on. By the same token current measurements may likewise be used as indices of satisfactory operating conditions, particularly so as regards the condition of the tubes. Thus plate current measurement under conditions recommended by the tube manufacturers will show the presence or absence of sufficient electron emission for satisfactory results.

Such a wide range of voltages and current are encountered in normal practice, that, in the absence of a multiplicity of meters or an elaborate test set, considerable difficulty would be experienced in making such tests. For example, the d.c. currents in an average receiver vary from less than 1 milliampere to over 100 milliamperes, and the voltages from 1½ volts to 400 volts. In special receivers and speech equipment this range is considerably greater, currents going as high as 250 milliamperes, and voltages to 1000 volts.

*Chief Engineer, International Resistance Company.

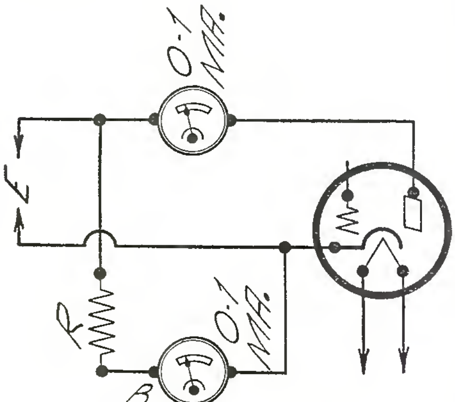


FIG: 1

A Universal Meter

A test meter which has come into almost universal use is the 0-1 milliammeter, or 0-1.5 milliammeter. By itself it has a limited degree of usefulness as a measuring instrument. But its sphere of utility may be considerably enlarged by the addition of suitable resistors of proper value, and the application of some elementary principles of electricity.

Its range as an ammeter can be increased to cover all ranges normally

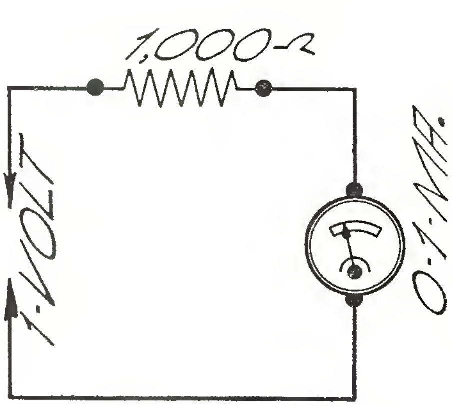
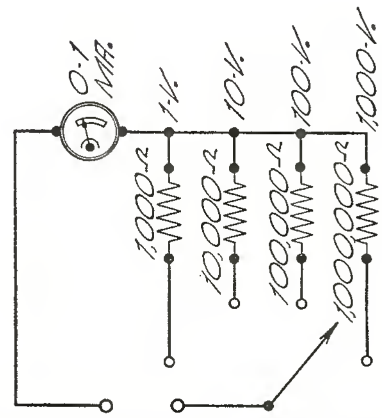


FIG: 2

met in practice, and it may also be used as a voltmeter up to 1000 volts or more if necessary. The reason for this is that direct current ammeters and voltmeters are essentially the same from the point of view of construction. A voltmeter is really an ammeter calibrated to read volts. The two instruments differ only in their manner of being connected in the circuit to be measured, ammeters being connected in series with the circuit in which current is to be measured, voltmeters being connected in parallel with the circuit to be measured.

Fig. 1 shows a milliammeter (A) connected in series with a line and a similar milliammeter in series with a resistor R connected across or in parallel with the line. Instrument A measures the total load current, for example, the plate current of a tube. Instrument B measures the current flowing through the resistor R and itself, the current



MULTI-RANGE VOLTMETER
FIG: 3

being supplied by the source of voltage E. According to Ohm's law

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

If R is kept constant, the current through ammeter B will be proportional to the voltage. Therefore, it is possible to calibrate the milliammeter B in volts.

To take a specific case, in Fig. 2 we have a 0-1 milliammeter with a resistance of 1,000 ohms in series. Assuming the resistance of the ammeter to be negligible, if a source of voltage is applied to the two terminals A B, sufficient to cause a current of 1 m.a. to flow through the system this voltage will be given by

$$E = I R = 1 \text{ ma.} \times \frac{1}{1000} \times 1000 = 1 \text{ volt}$$

With this external resistance of 1000 ohms, called a multiplier, the meter will measure a maximum voltage of 1 volt. Higher voltages may be measured by increasing the value of the multiplier resistance. To determine the value of multiplier resistance R required to convert a milliammeter having a maximum reading I, into a voltmeter to read a maximum voltage V, use the following formula:

$$R = \frac{1000 \times V}{I}$$

To illustrate: It is desired to convert a 0-1.5 milliammeter into a voltmeter to read up to 750 volts. V = 750 volts, I = 1.5.

$$R = \frac{1000 \times 750}{1.5} = 500{,}000 \text{ ohms}$$

A wide range of voltages can be covered by using a number of multipliers with a switching arrangement each cov-

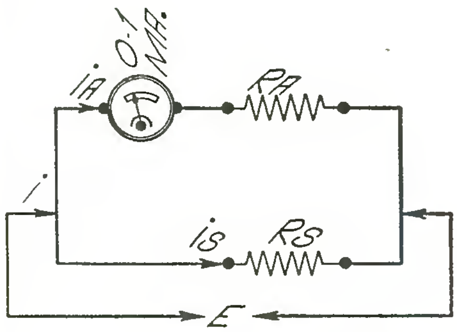


FIG: 4

ering a different range. Thus Fig. 3 shows a 0-1 milliammeter with suitable resistors for converting it into a multi-range voltmeter reading 0-1, 0-10, 0-100, 0-1000 volts.

Increasing Voltmeter Range

Where a voltmeter of a given range is available it is possible to increase the range by simple extension of the foregoing principles. It is necessary, however, to know the resistance of the voltmeter. This may be marked on the face of the meter or the resistance per volt may be marked on the meter. If the latter is the case the total resistance will be given by the product of the maximum reading of the voltmeter and the resistance per volt. Thus, if the resistance per volt is 1000 ohms and the voltmeter is a 0-100 meter, the total resistance is 100,000 ohms.

Suppose it is desired to increase the range of a voltmeter 0-V volts having a resistance R_v, by a factor n, i. e., we want the meter to read nV volts. The multiplier Rm required will be given by the formula:

$$R_m = (N-1)\ R_v$$

To illustrate: We have a voltmeter reading 0-100 volts, having a resistance of 1000 ohms per volt, and it is desired to increase its range to read 500 volts. The total resistance of the voltmeter R_v is $100 \times 1000 = 100{,}000$ volts. It is desired to increase its range 5 times $500 = 5 \times 100$; therefore $N = 5$. The multiplier resistance required is therefore—

$$R_m = (N-1)\ R_v = (5-1) \times 100{,}000 = 400{,}000 \text{ ohms}$$

Increasing Milliammeter Range

To enable a milliammeter to read higher currents than that for which it is designed it is necessary to use shunt resistors rather than series, as shown in Fig. 4. A measurable portion of the total current to be measured flows through the meter and the balance flows through the shunt. By properly choosing the shunt resistor R_s a simple proportionality factor may be obtained relating to the total current to the measured current.

In Fig. 4 let R_a = resistance of ammeter
let R_s = resistance of shunt
let E = voltage applied across meter and shunt
let i_a = current through ammeter
let i_s = current through shunt
let I = total current = $i_a + i_s$
let N = factor by which ammeter range is to be increased, i. e., $1 = Ni_a$

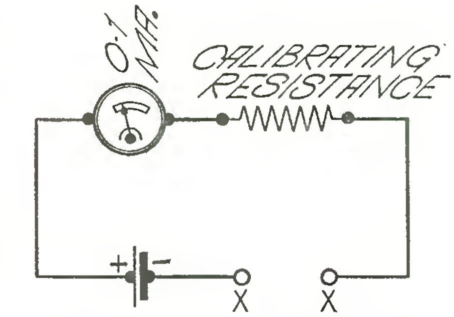
Then the following relations are true

$$i = i_a + i_s$$
$$i = Ni_a$$
$$e = iaRa$$
$$e = i_s r_a$$

From these four relations by simple arithmetic the following formula can be deduced:

$$R_s = \frac{Ra}{N-1}$$

which gives the value of the shunt resistor required to increase an ammeter range by a factor N.



FUNDAMENTAL CIRCUIT OF OHMMETER

FIG.-5

To illustrate: Suppose we have a 0-1 milliammeter whose resistance Ra is 30 ohms, and we desire to increase its range 10 times ($n = 10$); i. e., we want it to read up to 10 ma. The shunt resistor required will be given by

$$R_s = \frac{Ra}{n-1} = \frac{30}{10-1} = \frac{30}{9} = 3\tfrac{1}{3} \text{ ohms}$$

Converting Milliammeter Into Ohmmeter

The conversion of a milliammeter into an ohmmeter is a direct application of Ohm's law, which is

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

R is the circuit resistance
E is the voltage drop across the resistor
I is the current through the resistor

If this current is measured by an ammeter, and the voltage E is kept constant, the current i will be inversely proportional to the resistance in the circuit, and for given conditions it would therefore be possible to calibrate the ammeter in ohms.

The circuit commonly employed in this conversion is shown in Fig. 5. A battery of definite voltage is used in series with a resistance R, called a calibrating resistance, in series with a 0-1 milliammeter. The unknown resistor R_x is connected to the terminals X. This calibrating resistance R must be chosen with reference to the battery voltage E, so that when a short circuit is applied across X the meter reads maximum current, 1 milliampere. Thus suppose we use a 4½ volt battery as the source of voltage. With the terminals X short circuited, R must be 4,500 ohms in order that the maximum current 1 ma. be the current flowing

$$I = \frac{E}{R} = \frac{4.5}{4{,}500} = 1 \text{ ma.}$$

In other words whenever the current reads 1 ma. with this arrangement, we know that the circuit connected to terminals X has zero resistance, or is short circuited. Suppose a resistance of value 4,500 ohms is now connected across terminals X. The current registered by the milliammeter will be given by

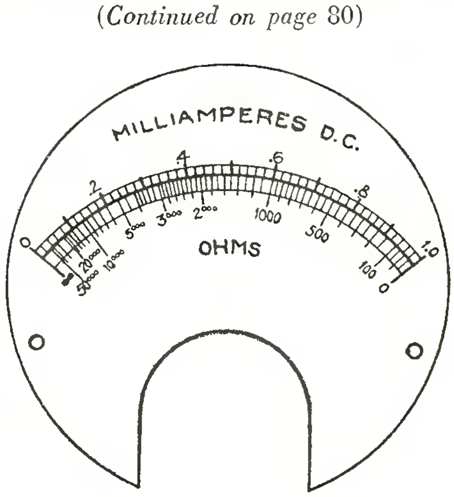
$$I = \frac{E}{R + R_x} = \frac{4.5}{4{,}500 + 4{,}500} = \frac{4.5}{9000} = 0.5 \text{ ma.}$$

and whenever this meter reads 0.5 ma. with this arrangement we know that the circuit or resistor connected across terminals X has a resistance of 4,500 ohms.

In the same way every reading on the milliammeter will correspond to some definite resistance, and for a given battery voltage and calibrating resistance the meter can be calibrated in ohms. The range and scale may be modified, by altering the values of battery voltage and calibrating resistance. Increasing the voltage and calibrating resistance increases the value of the maximum resistance that can be measured.

The last figure shows typical 0-1 ma. scales converted into direct reading ohmmeters. A single scale is made for a voltage of 1.5 and a calibrating

(*Continued on page* 80)



Service Data on the New

REPRESENTING as it does a departure from the circuits employed in previous receivers of that name, the Majestic chassis model 50 (used in model 52 receivers), photographed on this page, is a superheterodyne using 175 kc. intermediate frequency amplification. The diagram in Figure 4 gives all the electrical connections of the receiver and its power supply; Figure 1 shows the rear of the chassis, indicating position of the i.f. aligning condensers, and the aligning condenser for the oscillator tracking; Figure 2 is a bottom view of the chassis, showing position of the antenna alignment condenser, and the oscillator alignment screw. The table of average operating tube voltages is shown in Figure 3.

Perhaps the most important data on servicing this receiver is the information covering the alignment procedure. The model 50 chassis being a superheterodyne, employs a somewhat different procedure of alignment from previous Majestic models.

Oscillator alignment condenser is accessible from the bottom side of the chassis, and is located next to the end of the gang condenser on which the cable drive is mounted. See Fig. 2.

Second antenna alignment is accessible from the bottom side of the chassis and is located through the center hole of the chassis bottom. See Fig. 2.

First antenna alignment (compensating) condenser is accessible from the back side of the chassis, slightly upward and to the right of the antenna and ground binding posts. See Figure 1.

The oscillator tracking condenser is accessible from rear side of the chassis through a hole in the r.f. base assembly just to the right of the power transformer. See Fig. 1. The i.f. alignment positions are also indicated in this photograph.

Alignment Procedure

Tune in at approximately 1280 kc. and align oscillator and antenna circuits.

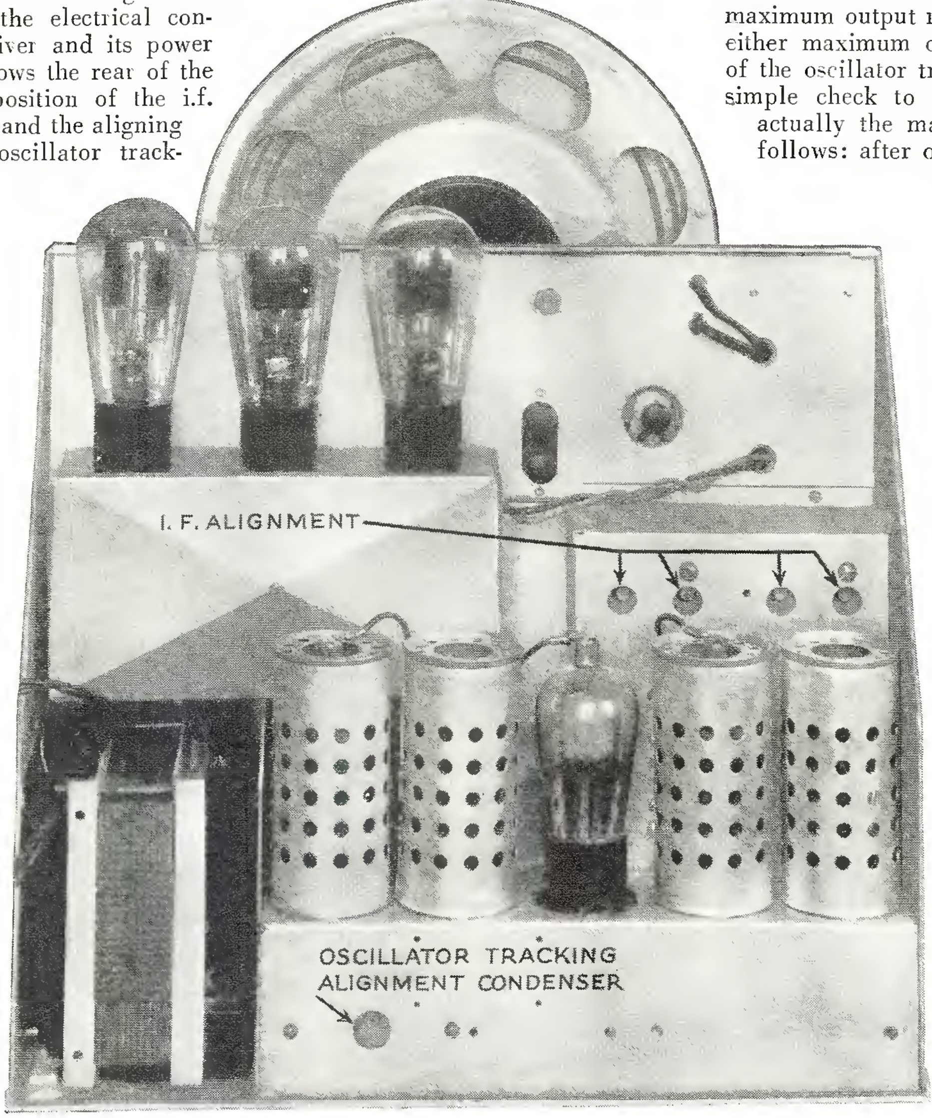


Fig. 1. This photograph of the new Majestic 50 chassis shows the position of the antenna compensating condenser, the four i.f. alignment positions and the oscillator tracking alignment condenser

Tune in at approximately 600 kc. and adjust the oscillator tracking condenser on chassis while rotating the tuning knob slightly back and forth until the maximum signal strength is noted on the output meter.

Next set main tuning dial to exactly 1500 kc. and tune in 1500 kc. signal with oscillator alignment condenser.

Retune antenna alignment condenser.

The dial setting should be checked by tuning in a broadcast station with a known frequency higher than 1000 kc. Slip the dial strip to the correct setting with respect to the index of the dial escutcheon.

Carefully test receiver for sensitivity and selectivity, and if necessary the entire operation outlined previously should be repeated until satisfactory results are obtained. In some cases maximum output may appear to fall at either maximum or minimum capacity of the oscillator tracking condenser. A simple check to determine if this is actually the maximum output is as follows: after obtaining the best setting of the tracking condenser, try a slight readjustment of the second antenna alignment condenser. If this readjustment results in only a slight improvement, the oscillator tracking condenser is satisfactorily adjusted.

I. F. Alignment

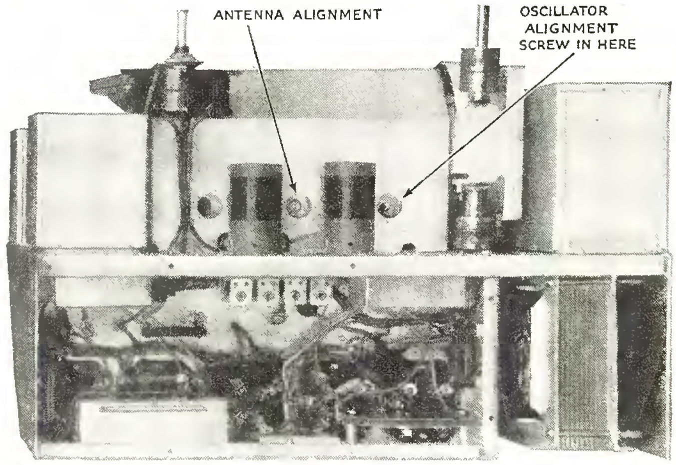
For intermediate frequency alignment, connect the output of the i.f. oscillator to the grid of the first detector. Tune oscillator at 175 kc. and align the first detector plate circuit, intermediate frequency grid circuit, intermediate frequency plate circuit and the second detector grid circuit to this frequency. This alignment should be done with great caution, inasmuch as it materially affects the entire selectivity of the receiver. If the intermediate frequency circuits are so far out of alignment that no signal can be heard, it may be necessary to put the oscillator output on the grid of the i.f tube and roughly align the second half of the i.f. stage first, and then proceed as above indicated. The four aligning condensers are located on the rear of the chassis about midway down on the right side (see Fig. 1). From left to right, facing the rear of the chassis, these positions are: first detector plate; i.f. grid; i.f. plate; second detector grid.

Majestic Model 50 Chassis

A small compensating condenser is provided to adjust the reflected capacity of the antenna. Adjustment of this condenser is possible through the hole in the rear of the chassis (to the right and above the antenna-ground binding posts in Figure 1). When the installation of the receiver is complete, a station between 1000 and 1400 kc. should be tuned in; volume control set for low volume, and the antenna compensator adjusted until maximum volume is secured. Further adjustment of this condenser is not necessary unless the length or position of the antenna is changed.

The volume control consists of two elements, a 645-ohm potentiometer and a 10,000-ohm rheostat; the latter connected from antenna to ground and varying the signal input from antenna; the former controlling the bias voltage for the r.f. and first detector tubes. Both controls are operated simultaneously by the same shaft.

Fig. 2. Here are shown the antenna alignment (second) position, and the position of the oscillator alignment screw, both of which are mentioned in the text covering the alignment procedure



Majestic Model 50 Chassis

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R.F.	2.35	180	3	3	90	3.		
227	Osc.	2.35	90	----	----	----	3.	----	----
224	1 Det.	2.35	180	8	8	90	.8	----	----
224	1 I.F.	2.35	256	3	3	90	4	----	----
227	2 Det.	2.35	225	20	20	----	.5	----	----
245	P.P.	2.35	250	1.75*	----	----	25	----	----
245	P.P.	2.35	250	1.75*		----	25	----	----
280	Rect.	4.8	358	----		----	40	----	----

Line voltage 115. Volume control maximum.

*On analyzer 245 grids may read 1.75 volts. If so, to get true reading measure with voltmeter from filaments to ground. This should be 37.5 volts.

Fig. 3. The tube operating voltages on the model 50 chassis of the Majestic are given in this table as abstracted from the service manual

According to the Majestic manual on this receiver, under no conditions should an attempt be made to use a ground connection on the antenna binding post. Be certain that the antenna and ground wires are connected to their respective binding posts and that they have been passed through hole in the back of the cabinet as indicated by label.

In territories where the a.c. line voltage is excessive, it is desirable that a voltage control be used. This may be secured from the Majestic distributor and should be used in every case where the line voltage exceeds 118 volts. This voltage regulator has three outlets marked 110, 120 and 130. The receiver plug should be inserted in the proper outlet, as determined by the service man's investigation of the line voltage. If the voltage regulator is not used where line voltage is excessive, rated normal tube life will be reduced.

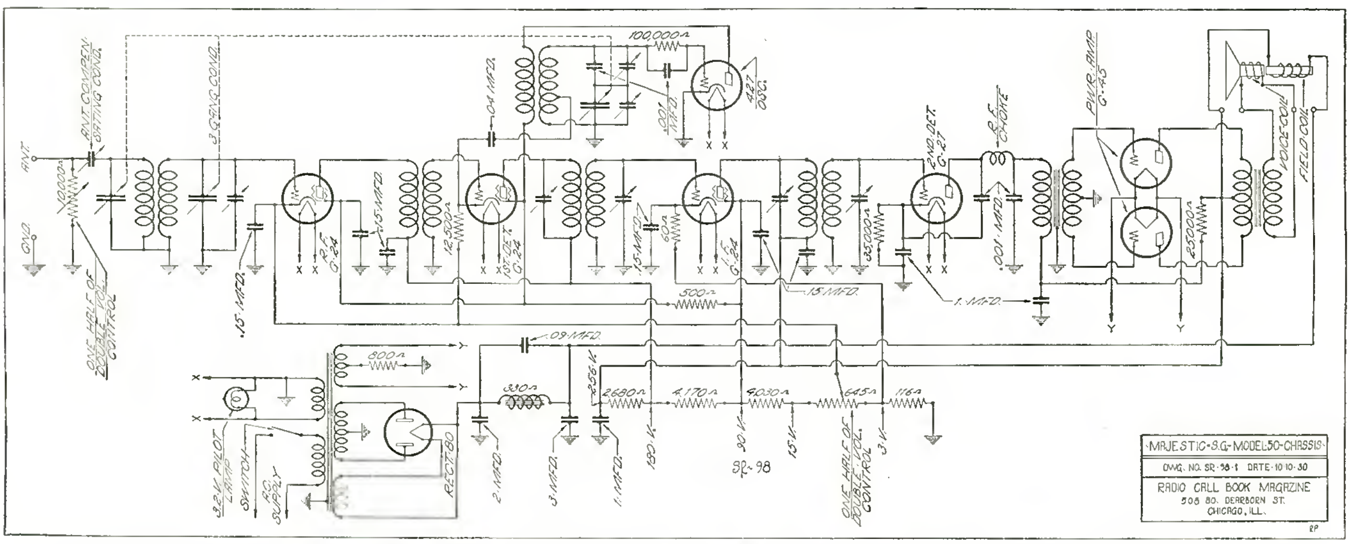


Fig. 4. The electrical details of the circuit employed in the Majestic model 50 chassis are given in this drawing

Locating Internal Noises in Receivers

By F. L. SPRAYBERRY*

The last word has not been written in servicing radio sets, nor is it likely to ever be written. With thousands upon thousands of service men in this country it is only natural that each man should develop his own method of servicing. However, here is an interesting and factful story, written by a man who is a radio service specialist. Perhaps in his article you will find short cuts that will save you time and money, or else lead the way to changes in your methods of servicing.
—Editor.

INTERNAL noise in a receiving set is a real problem to the average serviceman. Usually he can locate ordinary defects in a receiver such as grounded circuits, burnt out by-pass condensers and defective resistors. But it takes a real expert to locate and overcome the elusive internal noises that are often encountered.

The purpose of this article is to help the serviceman locate and overcome these difficult problems.

Radio receivers are very sensitive devices and once noise gets into the receiver it is amplified and passed on to the speaker in the same way speech and music are passed on. Some of these noises originate outside the receiver and some originate inside. All noises cannot be eliminated or reduced, but a great many can. The causes of noises arising in the receiver are so numerous that it would be futile to attempt to describe each one separately. These noises may be due to poor design, poor construction or defective parts. Fortunately, there are certain noises which can be classified into a few major groups.

Mechanical and Electrical Noises

Under these two broad general classifications of noise in a receiver, we have first a noise which reaches the ear by way of the loudspeaker which is the amplified impulse through the regular amplifying system. Second, there are noises which reach the ear directly without being transmitted electrically through the receiver. These latter noises are frequently as troublesome a source of disturbance as the former. As typical examples of the first class we have intermittent opening and closing of contacts in a circuit. This may be in the form of a defective connection or a defective condition of one or more of the parts used in the receiver.

As examples of the mechanical noises, we have noise due to vibration of the laminations in a power transformer or rattles in a cabinet door caused by vibration. Some mechanical noises are heard even though the speaker is disconnected or a resistance network substituted for the speaker. A simple check can be made to determine whether the disturbing noise comes from the speaker or not. Substitute a 4,000 to 8,000-ohm resistor for the speaker. While the resistor may not match the speaker output exactly it will place enough load on the apparatus under test to show whether or not the noises are of a mechanical nature. If the noise is still present it does not come from the speaker and must be traced in the set. This test, of course, is not applicable where the noise, although not coming through the speaker, is caused by speaker vibration affecting some part of the receiver, for example, rattling cabinet doors due to excessive output from the speaker. Here the serviceman must use his judgment in applying the tests.

Noises may further be classified according to the nature of the noise as follows:

Scratching noises, clicks, crashes, rattles and grating noises, generally due to poor construction or defective parts.

Whistling, generally due to regeneration, poor tubes and oscillation.

Ringing noises, gradually increasing in intensity. These are called microphonic noises—sometimes due to poor design—defective parts—defective tubes or too much volume.

Hum—generally due to poor construction—defective parts, faulty design or poor tubes.

In servicing a noisy receiver, the first thing to do is to determine whether the noise comes from outside or inside the receiver. In the case of a battery set this can generally be definitely determined by disconnecting the aerial from the set. If the noise disappears it shows that it comes from the outside and that the set is O. K. If the noise still persists, however, the indications are that it originates in the set and it becomes a matter of diagnosing the trouble in the manner outlined in this article.

In the case of electric sets this test is not conclusive. If disconnecting the antenna causes the noise to stop, its source is generally external to the receiver. If noise is still present, it may still come in from the outside through the power line and get into the receiver by way of the power pack.

Every serviceman should carry with him a line filter of simple design that can be quickly and easily connected to the line of the ordinary a.c. set to filter out line noises. Figure 1 shows an arrangement which has been used successfully for this purpose.

If the noise is appreciably reduced after connecting the filter between line and receiver, it indicates that the noise originates outside the set and comes in on the line. If the noise is still present it will be reasonable to assume that its source is in the receiver and it can be eliminated.

Irregular Noises

Under this heading come all sorts of crackles, scratchings, gratings, hissing and frying noises. The first three types are most frequently due to poor contacts. These arise from various causes. The most important are poor soldering and poor contact between tube prongs and socket spring contacts. Poor soldering may result in a loose and therefore intermittent contact which is readily detected and observed by moving the lead to see if it is loose. The presence of a large amount of resin around a soldered joint is always a sure indication of a poor joint. The continuity tester to be described later will help greatly in locating high resistance contacts. The presence of a green substance at a joint is a definite sign of corrosion and indicates a likely source of noise. The only thing to do in a case of this sort is to re-solder the joints properly. A poorly soldered joint is a source of noise in any circuit, power pack, audio or radio, since it causes irregular variations of current.

In battery sets such irregular noises arise due to poor contact at the battery terminals. To avoid corrosion in storage battery terminals, it is best to use vaseline on the terminals. Weak batteries are also frequent sources of sputtering and crackling noises. The storage battery should be kept in condition by

*Radio Service Specialist, National Radio Institute.

keeping it filled with distilled water and not allowing the voltage to fall below 1.8 volts. Frequently, it is a single cell in a battery that is the source of trouble, shown by a drop in voltage of the battery when it is operating under load. This is especially true of the storage battery. A hydrometer test may show correct gravity but a voltage test will show up a defective cell even if it has correct gravity if the voltage test is made while the battery is under load.

Tube and Tube Contacts

Special attention should be paid to these because they are often a source of noise. A gassy tube indicated by a blue haze in the tube when working, causes irregular changes in plate current, thereby producing noise. The best remedy for this is to use a new tube even though the old tube may show correct operating characteristics. However, the abnormal condition causing the blue haze in the old tube has more than likely ruined it.

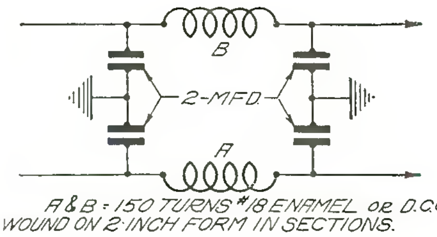


Fig. 1. This portable filter is suggested by the author to filter out line noises and should prove valuable to the service man

Loose elements in tubes will cause noise. Tapping the tube with your finger will sometimes show up a loose element. A slight ringing noise may be produced on tapping the tubes but this is normal. If tapping a particular tube results in crackling or sputtering, examine the tube socket contacts and examine the prongs of the tubes.

Defective socket springs are another source of noise. Socket spring contacts are made of phosphor, bronze or nickel silver. Such contacts are designed so that they exert pressure against the tube prongs. These springs may make good contact at the start and then later on develop poor contact for various reasons. Heat from a soldering iron may cause the spring to lose its "temper" and continual pushing and pulling the tube out of its socket may result in pushing the socket spring so far away that it does not make contact with tube prongs. Or the contact may be intermittent and we have another source of noise. Socket contacts and tube prongs should be cleaned if corrosion has formed or if they are dirty. Sand paper tube prongs and scrape socket prongs with a small pen knife. Bend the socket prong with a pair of small nose pliers so that it will make good contact with the tube-prong.

Volume Control

If a scratching noise is heard on any station as the volume control is rotated throughout its range, the noise is due to the volume control and may be in the form of a defective resistance winding or poor contact between the rotating arm and the resistance winding. There may be an oxidized contact. Poor mechanical contact may be made by the contact arm being bent away from the winding. It can be bent with a small pair of pliers so that it makes firm contact. A dirty winding or an oxidized winding should be cleaned. First use sandpaper lightly and then apply cigarette lighter fluid to the winding by means of a small tooth brush.

Defective Insulation

Sputtering, hissing and frying noises are frequently caused by poor insulation. If a breakdown occurs between two points, noise in the receiver results. Poor insulation in a power transformer may cause flash-overs and sparks. A frequent offender is the bakelite terminal strip which generally carries all the metal terminals. The presence of soldering flux and acid results in leakage between terminals and consequent noise. The terminal strip should be thoroughly cleaned and dried. If there is leakage due to the breakdown of the insulating material, parts of the strip have most likely been carbonized or charred. This may be scraped away with a knife. Dirt between posts at high potentials causes the same trouble and should be removed in a similar manner. Power transformers, choke coils, and filter condensers are the worst offenders in this respect since they are in the high voltage circuits. The rectifier tube socket should also be carefully examined for signs of leakage.

Failure of wire insulation may be caused mechanically. For example, if a high voltage wire is caught under a metal clamp or another wire which is tightened by a screw, the insulation may be broken though to such an extent that there will be mechanical strain and the wire may ground intermittently. Examination of the wiring will show up these causes of noise trouble.

Variable condensers are often a source of noise. The plates may touch as the rotor is rotated and produce a clicking noise. Fine particles of dust between condenser plates will also cause noise and it is often very hard definitely to trace noises to the variable condensers. One should always clean the condenser plates of noisy receivers carefully. This is accomplished by drawing ordinary smoking pipe cleaners between separate plates of both rotor stator plates.

Noise Due to Feed Back

Much has been written in regard to feed back oscillations. We do not intend to go into this subject too deeply here as most servicemen are familiar with the general procedure to be followed in correcting for undesirable regeneration.

When a set oscillates at radio frequencies, the characteristic squeal or whistle is heard. The pitch of this whistle, going up and down in scale as the variable condenser is rotated from one end of the dial to the other. In general, if we are servicing a neutrodyne set this means that the receiver must be reneutralized. This same condition may also be caused by an unbalanced condition of the main tuning condensers in tuned t. r. f. receivers.

Servicemen have their own particular methods for neutralizing. One solution is offered here. Carry in your service kit, drinking straws which you can obtain at most candy shops or drug stores. Place a portion of one of the straws on one of the tube's filament prongs then insert it in the socket in which the tube operates. It is the usual practice to begin at the tube preceding the detector and work back toward the antenna stage. A broadcast or modulated oscillator signal at about 1300 kilocycles is tuned in on the receiver. Due to the tube's filament being unlighted, it will not amplify and you can adjust the neutralizing capacity for that stage. A correct adjustment will be made when minimum signal is heard in the loud speaker or when a minimum deflection is obtained on an output meter.

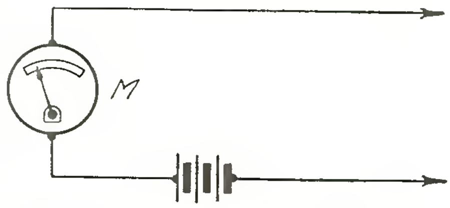


Fig. 2. A simple continuity tester is illustrated in this drawing. It consists of a voltmeter in series with a 4.5 volt C battery, and a set of test leads

The balancing condensers are adjusted in the same manner. An insulated screwdriver or hexagon wrench is used in balancing these condensers depending on the type of receiver in question. If the oscillation is in the radio frequency stages, the following may be the cause:

I. Absence of a good ground on a receiver or imperfect grounding which in most cases increases the tendency to regeneration and oscillation. This applies to the main ground connection and other various parts of the circuit which are supposed to be grounded.

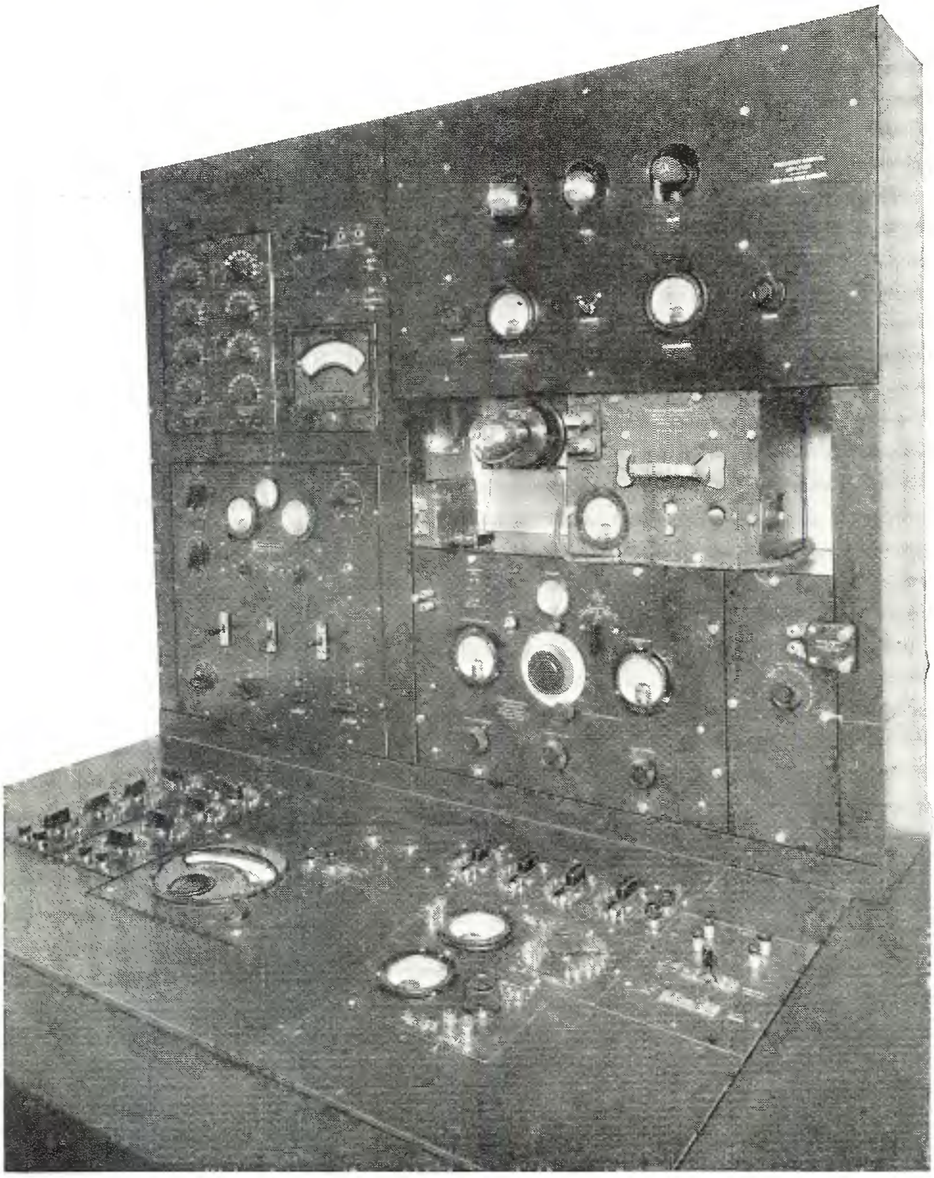
II. Too much gain or amplification

(*Continued on page* 77)

Receiver Response Curve Section

THOSE interested in the response curves appearing in this issue will find on this page a brief summary of the equipment, conditions of measurement, and a description of the meaning of sensitivity, selectivity and electrical fidelity.

The photograph shown here represents the apparatus used in making the measurements in our laboratory. As a rule only the latest models of receivers are measured for publication in this magazine.



Equipment Used

Equipment used in the response measurements conforms to specifications of the I. R. E. and the R. M. A. standardization committee. Such apparatus for the most part is manufactured by The General Radio Co. All test frequencies are determined by zero beat of a crystal controlled dynatron oscillator. Volt meters and microvoltmeters are periodically checked against calibrated standards for accuracy of adjustment.

Conditions of Measurement

All measurements are made in the manner outlined by the Institute of Radio Engineers Standardization Committee and published in detail in the 1929 Year Book of that organization. The individual conditions of measurements pertaining to each receiver will be found in the article accompanying each family of curves.

Sensitivity

Sensitivity curves show sensitivity in microvolts input plotted against carrier frequency in kilocycles.

Interpretation of this curve follows: A station will cause standard speaker output (.05 watts) when it has a local field strength equal to the microvolts divided by four indicated on the curve directly above the frequency of the station. To find the sensitivity of the receiver in microvolts per meter (based on a four-meter antenna), divide any point on the curve in microvolts by four. This sensitivity is measured at 30 per cent modulation.

Selectivity

Selectivity curves are plotted in field strength ratios vertically and frequency horizontally. Field strength ratios are determined by the input in microvolts required to obtain standard speaker output at the various frequencies off resonance, divided by the input required to give standard speaker output at resonance. The curves may be analized as follows: Resonance is the vertical zero line. A station on any frequency off resonance will cause equal volume interference when its vertical line intersects the curve of the station desired. The point of intersection indicates a field strength ratio greater than resonance which produces equal volume interference. For general purposes the selectivity of the receiver is the number of kilocycles between the sides of the curve at any specified carrier frequency and field strength ratio.

Electrical Fidelity

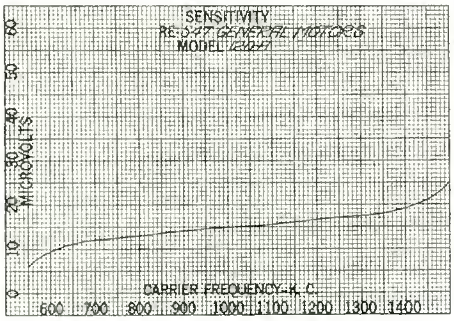
Electrical fidelity of a receiver is the loss or gain in faithfulness with which the audio component of the carrier frequency passes through the receiver. The measurements are made with a constant r.f. input voltage required to give standard speaker output when 400 cycles per second, 30 per cent modulation, is used. The r.f. input is maintained and the various test modulation frequencies varied. The ratio of the output at the modulation frequency of 400 cycles to the output at the other modulation frequencies (30 to 5000 cps) is calculated in decibels and plotted as loss or gain as the case may be from 400 cps. These measurements do not take into consideration the frequency response curves of the speaker used.

Since curves of all receivers are taken under the same conditions, it may be said that such curves serve as a yardstick by means of which various receivers of the same class may be compared. This means supers may be compared against supers, or tuned r.f. rated against tuned r.f. It is obvious that comparisons between the super and the tuned r.f. are hardly fair because of their circuit differences.

The General Motors Model 120-A

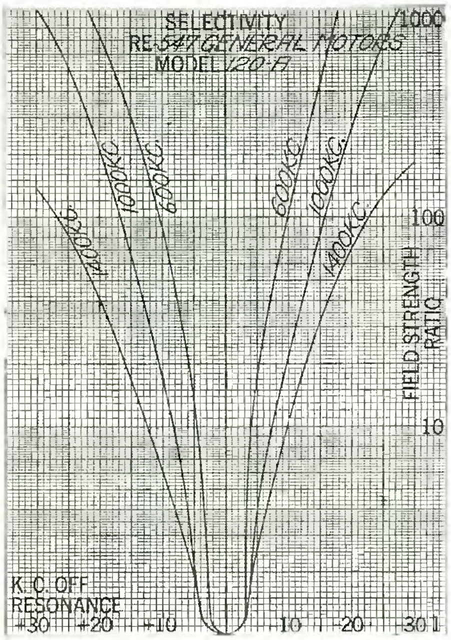
GENERAL MOTORS model 120-A measured in our laboratory on November 17, yielded the curves shown on this page. Serial number of the chassis 64637A. Output impedance was adjusted to 4000 ohms, coupled capacitatively to the plates of the 245 tubes. Standard output of .05 watts was maintained. The dummy antenna employed consisted of 20 uh, 200 mmf and 25 ohms. Phasing frequency at which alignment made was 1400 kc. Volume control turned on full. No oscillation indicated nor hum level measurable.

Mutual conductance of the tubes used in these measurements is shown as follows: 1 r.f. 1045; 2 r.f. 960; 3 r.f. 1030; detector 1050; 1 a.f. 940; p.p. 1730 and 1860 micromhos.



The dotted line in the fidelity chart was taken with the tone control turned to the bass position.

In the two tables below are shown:

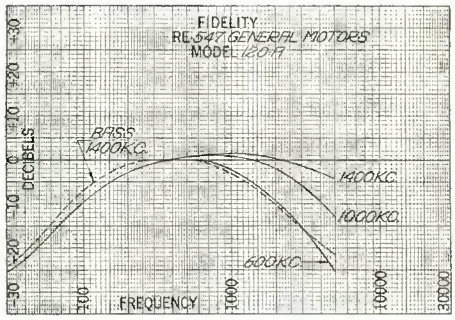


Interference Ratio

Resonance	Kilocycles off resonance Plus 10	Plus 20	Plus 30
600 kc.	80.7	608.0	1300
1000 kc.	17.05	205.0	977
1400 kc.	5.02	38.3	138.4
	Minus 10	Minus 20	Minus 30
600 kc.	103.0	14.5	....
1000 kc.	22.7	261.0	1317.0
1400 kc.	6.3	70.7	181.0

Band Widths

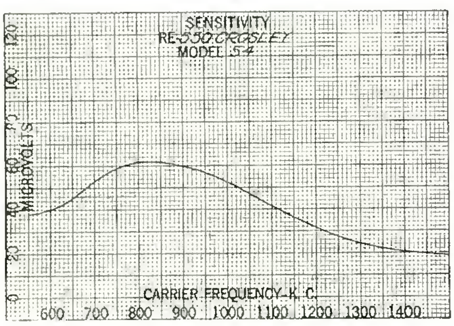
Times field strength	Kilocycles wide 600 kc.	1000 kc.	1400 kc.
10	8.5	16.0	18.0
100	20.5	32.7	49.7
1000	40.0	58.0	....



Crosley Radio Model No. 54

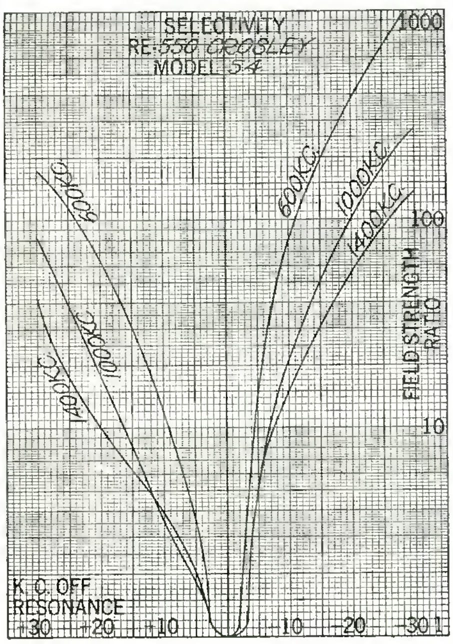
A FAMILY of curves taken on one of the midgets made by Crosley, the model 54 whose schematic diagram and service data appears elsewhere in this issue, is illustrated on this page, measurements having been taken November 11.

Output impedance was adjusted to 4000 ohms and coupled capacitatively to the plate of the single 245 output tube. The output was maintained at .05 watts. Input to the set was through a dummy consisting of 20 uh, 200 mmf and 25 ohms. The receiver was phased at a frequency of 1400 kc. The volume control was turned to maximum. No oscillation noted, nor hum level measurable.



The mutual conductance of the tubes used in this measurement is shown here: 1 r.f. 1140; 2 r.f. 1070; detector 1170 and output tube 1970 micromhos.

Interference ratios and the band widths are indicated in the tables shown:

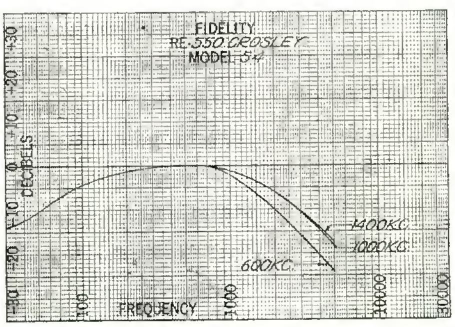


Interference Ratio

Resonance	Kilocycles off resonance Plus 10	Plus 20	Plus 30
600 kc.	9.62	64.2	172.0
1000 kc.	3.44	18.4	81.6
1400 kc.	4.18	9.83	42.2
	Minus 10	Minus 20	Minus 30
600 kc.	75.7	374.0	1205.0
1000 kc.	21.0	100.8	274.0
1400 kc.	15.1	55.2	136.0

Band Widths

Times field strength	Kilocycles wide 600 kc.	1000 kc.	1400 kc.
10	14.0	23.5	27.5
100	35.0	------	------
1000	------	------	------



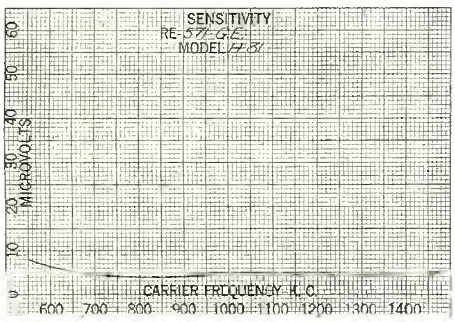
General Electric Model No. H-31

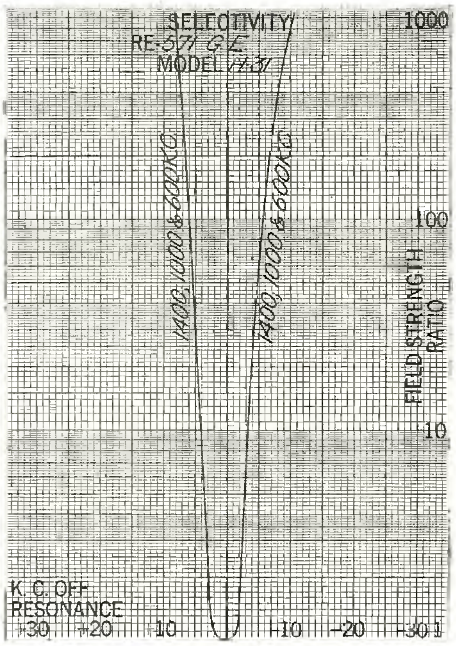
MEASUREMENTS on one of the superheterodynes marketed under the General Electric banner, the model H-31 have been recently completed and the three curves derived therefrom given at the bottom of this article.

An output impedance load of 4000 ohms was maintained, this being coupled capacitatively to the plates of the 245 output tubes. Standard output was .05 watts. The dummy antenna used was the standard having 20 uh, 200 mmf and 25 ohms. No change was made in the phasing frequency since this value was set in the factory. Volume control was turned full on. No measurements could be made covering either the hum level or oscillation.

Tubes have a mutual conductance as indicated in this paragraph were used on the measurements: 1 r.f. 940; 1 i.f. 1020; 2 i.f. 900; 1 detector 1000; 2 detector 1030; oscillator 1300; p.p. 1850 and p.p. 1850 micromhos.

In the two tables following may be found the interference ratios and the band widths as taken from the curves on selectivity.



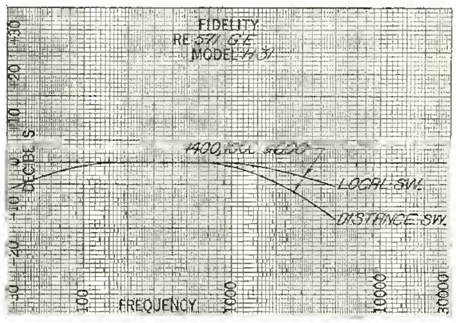


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
600 kc.	900	—	—
1000 kc.	900	—	—
1400 kc.	900	—	—
	Minus 10	Minus 20	Minus 30
600 kc.	—	—	—
1000 kc.	—	—	—
1400 kc.	—	—	—

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	7.9	7.9	7.9
100	12.4	12.5	12.4
1000	17.9	17.9	17.9

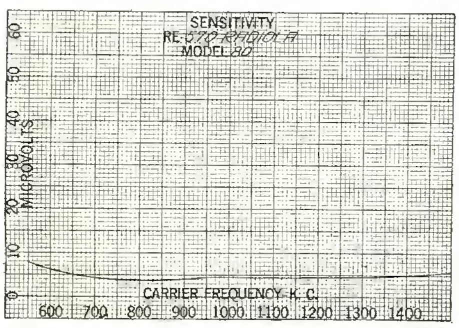


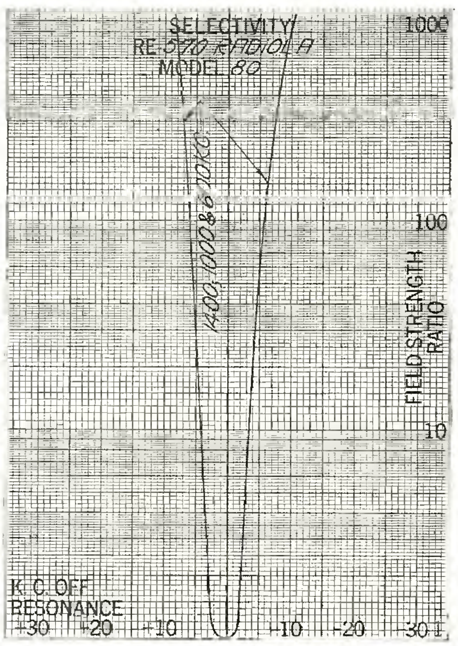
Radiola Superheterodyne Model 80

USING the 175 kilocycle intermediate frequency stages and known as the bell-wether of this type of superheterodyne in commercial production, the model 80 selling under the name of Radiola, has recently been measured in our laboratory, and the response curves of this model taken.

As customary the output impedence load was adjusted to 4000 ohms and coupled capacitatively to the plates of the 245 tubes. The standard output of .05 watts was maintained, the antenna input being from the standard dummy, consisting of 20 uh, 200 mmf and 25 ohms. The phasing frequency set in line production was maintained. Volume control turned on full. No hum or oscillation found.

Mutual conductance of the tubes used in this measurement is shown by the following values: 1 r.f. 940; 1 i.f. 1020; 2 i.f. 900; oscillator 1300; 1 detector 1000; 2 detector 1030; p.p 1850 and p.p 1850 micromhos.



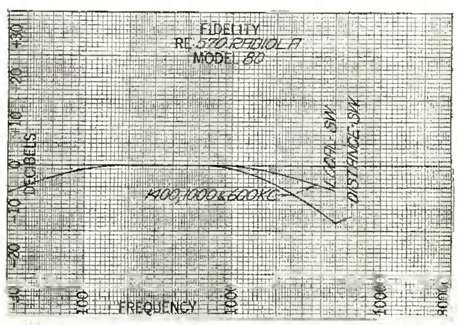


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
600 kc.	900	—	—
1000 kc.	900	—	—
1400 kc.	900	—	—
	Minus 10	Minus 20	Minus 30
1000 kc.	—	—	—
600 kc.	—	—	—
1400 kc.	—	—	—

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	8.0	8.0	8.0
100	12.5	12.5	12.5
1000	18.0	18.0	18.0



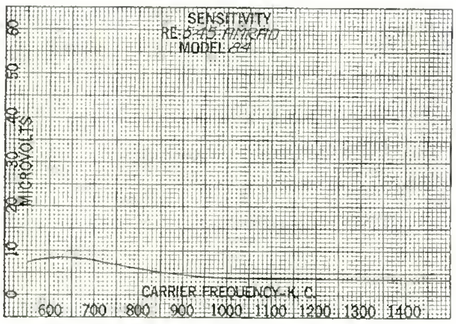
Amrad Receiver Model No. 84

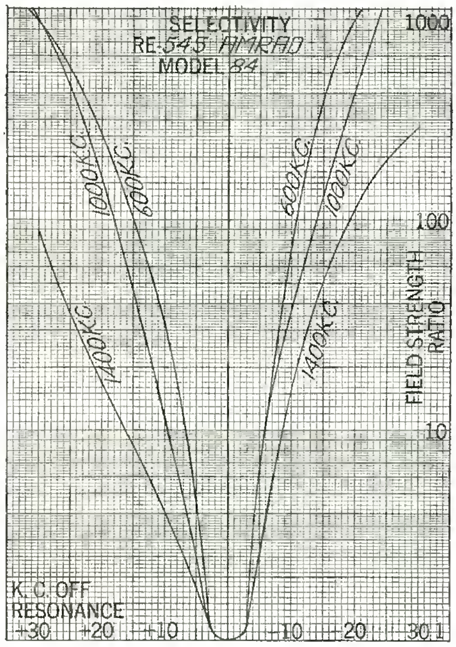
RECENT measurements made on one of the Amrad chassis, model 84, shows the curves resulting in the three graphs with this article.

The output impedance load was adjusted to 4000 ohms and coupled capacitatively to the plates of the 245 tubes. Standard output of .05 watts was maintained on all measurements. The dummy antenna was the standard containing 20 uh, 200 mmf and 25 ohms. The receiver was phased at 1400 kilocycles and the volume control turned on full. Neither hum nor oscillation was found.

The mutual conductance of the tubes used in this measurement follows: 1 r.f. 1140; 2 r.f. 1240; 3 r.f. 1170; detector 1120; 1 a.f. 1040; p.p. 1920 and 1970 micromhos.

Based on the curves of selectivity the interference ratios and the band widths are derived below:



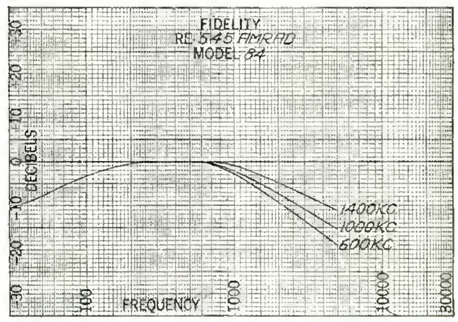


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
1000 kc.	11.5	160.0	330.0
600 kc.	33.0	250.0	330.0
1400 kc.	4.0	17.0	33.0
	Minus 10	Minus 20	Minus 30
600 kc.	6.5	900.0	......
1000 kc.	6.5	410.0	......
1400 kc.	2.6	112.0	270.0

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	12.5	15.5	25.0
100	25.7	32.0	......
1000	52.5	55.0	......



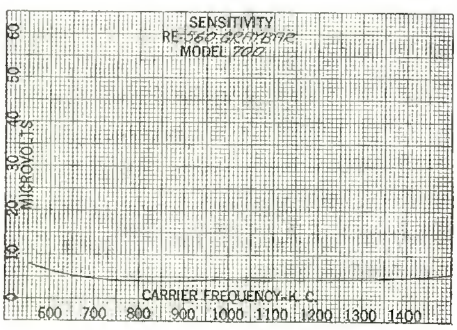
Graybar Superheterodyne, No. 700

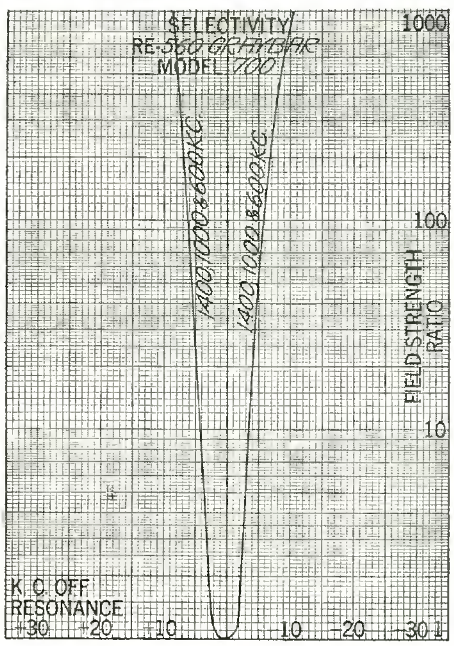
THREE of the response curves covering the superheterodyne marketed under the Graybar name and known as model 700 are shown here.

As usual the output impedance load was adjusted to 4000 ohms. Coupling to the plates of the 245 output tubes was capacitative. The standard output for receivers, .05 watts, was maintained on all measurements. Antenna input was through the dummy consisting of 20 uh, 200 mmf and 25 ohms. Phasing frequency was checked at the value set at the factory, and the volume control turned on maximum. No hum nor oscillation was present.

Mutual conductance of the tubes used in this set-up is indicated in the following values: 1 r.f. 940; 1 i.f. 1020; 2 i.f. 900; detector 1000; p.p. 1850; p.p 1850; 2 detector 1030 and oscillator 1300 micromhos.

In the two tables following will be found the interference ratios and the band widths as taken from the selectivity curves:



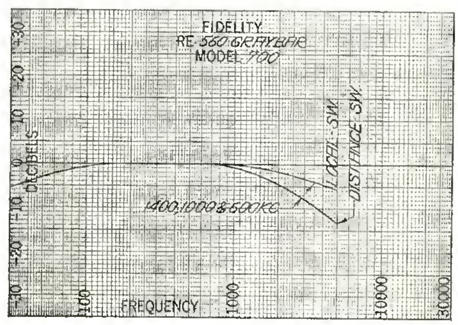


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
600 kc.	900	....	....
1000 kc.	900	....	....
1400 kc.	900	....	....
	Minus 10	Minus 20	Minus 30
600 kc.	....	....	....
1000 kc.	....	....	....
1400 kc.	....	....	....

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	8.1	8.1	8.1
100	12.6	12.6	12.6
1000	18.1	18.1	18.1



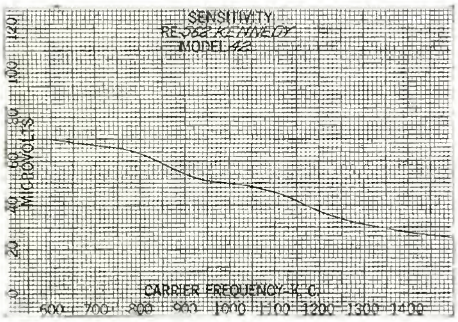
Kennedy Radio Model No. 42

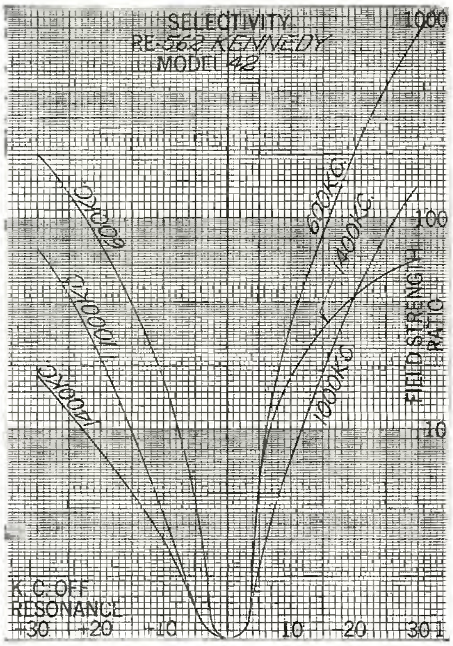
AMONG the midget receivers recently measured in our laboratory is the Colin B. Kennedy model 42 whose response curves are shown on this page.

Output impedance load was adjusted for 4000 ohms, coupled capacitatively to the output power stage plate. Standard output of .05 watts was maintained. Antenna input was through the dummy containing 20 uh, 200 mmf and 25 ohms. Phasing frequency set at the factory was maintained and the volume control turned on full. No oscillation and no hum level was found.

Mutual conductance of the tubes used in this measurement is indicated in the following values: 1 r.f. 980; 2 r.f. 1030; detector 1040; 1 a.f. 1020, and power output stage 1920 micromhos.

In the two tables following will be found the interference ratios and the band widths, this data being secured from the selectivity curves:



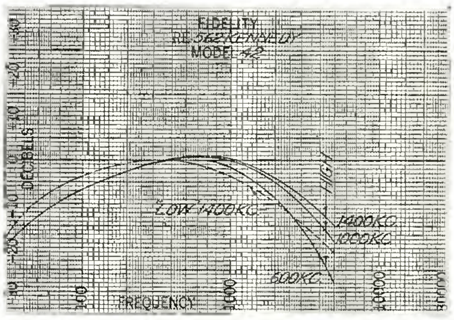


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
600 kc.	17.00	75.0	200.0
1000 kc.	3.90	22.0	71.0
1400 kc.	2.95	7.8	18.0
	Minus 10	Minus 20	Minus 30
600 kc.	30.0	205.0	750.0
1000 kc.	7.2	42.0	140.0
1400 kc.	17.5	42.0	63.0

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	13.7	27.0	30.0
100	38.5	-----	-----
1000	-----	-----	-----

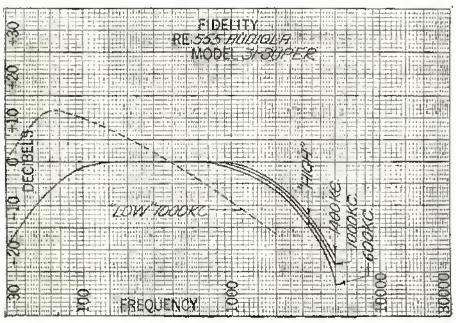


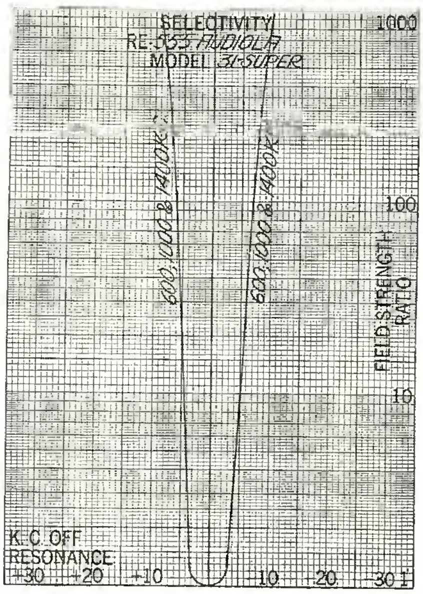
Audiola Super Model No. 31

MEASUREMENTS have been completed on the Audiola model 31 superheterodyne and its response curves are shown on this page. Input for the measurements was through the standard dummy antenna consisting of 20 uh, 200 mmf and 25 ohms. The output impedance was maintained at 4000 ohms and coupled capacitatively to the plates of the 245 output tubes. The receiver was phased at 1400 and 600 kilocycles and the volume control turned on full. Line voltage measured 110 volts and current .9 amperes.

Transconductance of the tubes used in the measurement on this model is indicated: 1 r.f. 1030; mixer 1080; detector 1100; 1 i.f. 1050; 2 i.f. 1020; P.P. 1940; P.P. 1970 and oscillator 1080 micromhos.

In the two tables will be found the interference ratios and the band widths:



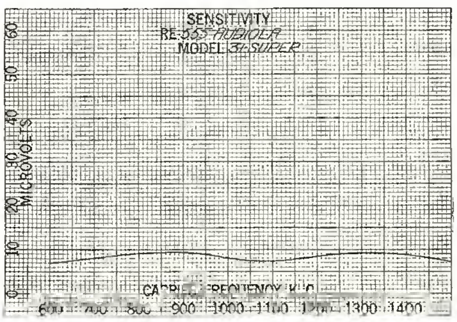


Interference Ratio

	Kilocycles off resonance		
	Plus 10	Plus 20	Plus 30
600 kc.	1300	-------	-------
1000 kc.	1300	-------	-------
1400 kc.	1300	-------	-------
	Minus 10	Minus 20	Minus 30
600 kc.	900.0	-------	-------
1000 kc.	900.0	-------	-------
1400 kc.	900.0	-------	-------

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	9.5	9.5	9.5
100	13.0	13.0	13.0
1000	19.5	19.5	19.5



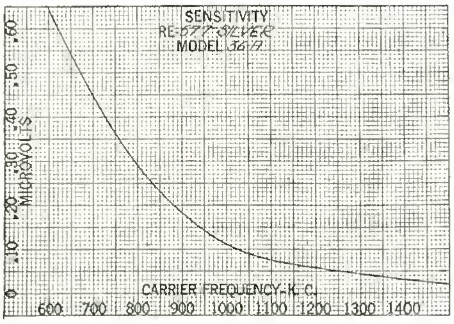
Silver Super Model No. 36-A

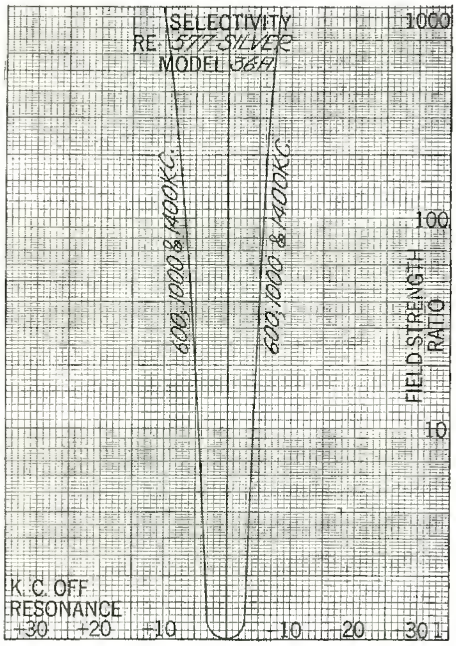
RESPONSE curves of the Silver superheterodyne model 36-A are shown on this page. Schematic circuit of the receiver and service data appears elsewhere in this section.

Dummy antenna used consisted of 20 uh, 200 mmf and 25 ohms. Output impedance was adjusted to 4000 ohms, coupled capacitatively to the plates of the 245 tubes in the output stage. The receiver was phased at the factory setting and the volume control turned to maximum. Line voltage 110 volts and current .95 amperes. Standard output of .05 watts was used in the measurements.

Transconductance of the tubes used indicated as follows: 1 r.f. 1120; mixer 1080; detector 1250; 1 i.f. 1140; 2 i.f. 1040; P.P. 1940; P.P. 1980; oscillator 1000 micromhos.

Interference ratios and band widths are shown in the two tables:



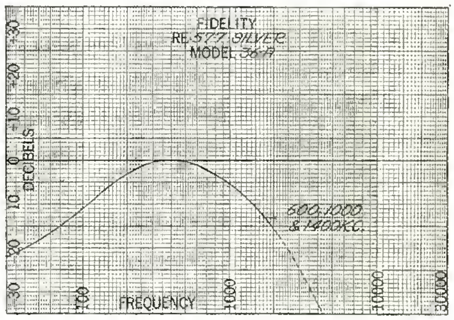


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
600 kc.	900	--------	--------
1000 kc.	900	--------	--------
1400 kc.	900	--------	--------
	Minus 10	Minus 20	Minus 30
600 kc.	--------	--------	--------
1000 kc.	--------	--------	--------
1400 kc.	--------	--------	--------

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	8.5	8.5	8.5
100	12.0	12.0	12.0
1000	18.5	18.5	18.5



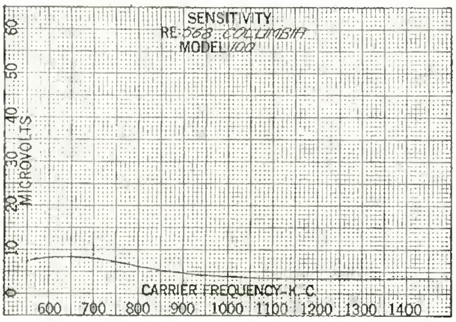
Columbia Radio Model No. 100

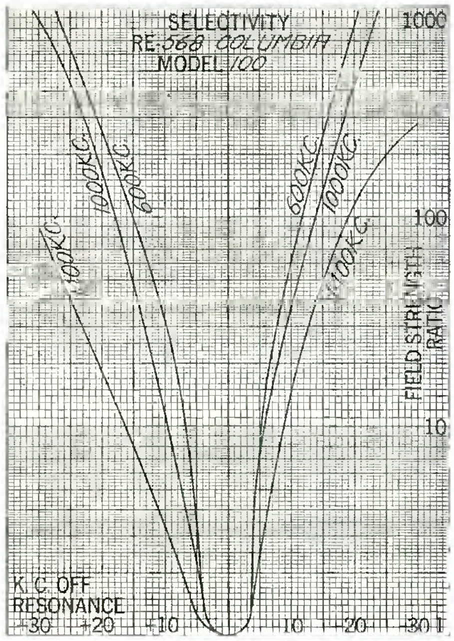
MODEL 100 Columbia, used by the Columbia Phonograph Co., is another chassis recently passing through our measurement laboratory. The response curves for this receiver are shown in this article.

Output impedance load was adjusted at 4000 ohms and coupled capacitatively to the plates of the 245 output tubes. Power output was maintained at the standard value of .05 watts. The customary antenna dummy was one with 20 uh, 200 mmf and 25 ohms. The receiver was phased at 1400 kc. and the volume control turned to maximum. Neither hum nor oscillation was encountered.

The tubes used in these measurements had the mutual conductance values indicated: 1 r.f. 1140; 2 r.f. 1240; 3 r.f. 1170; detector 1120; 1 a.f. 1040; p.p. 1920 and p.p. 1920 micromhos.

Interference ratios and band widths, taken from the selectivity curves, are set forth in the two tables following:



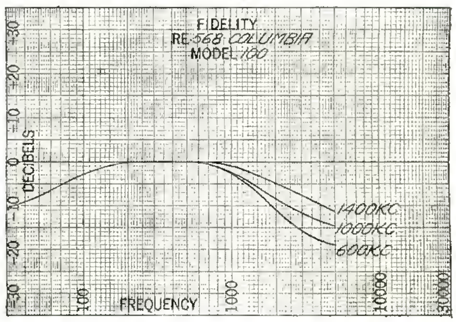


Interference Ratio

Resonance	*Kilocycles off resonance*		
	Plus 10	Plus 20	Plus 30
600 kc.	32.0	255.0	--------
1000 kc.	11.5	165.0	870.0
1400 kc.	3.3	18.0	83.0
	Minus 10	Minus 20	Minus 30
600 kc.	60.0	840.0	--------
1000 kc.	36.0	410.0	--------
1400 kc.	14.5	112.0	280.0

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	12.0	15.5	30.5
100	27.0	31.7	--------
1000	48.5	55.0	--------



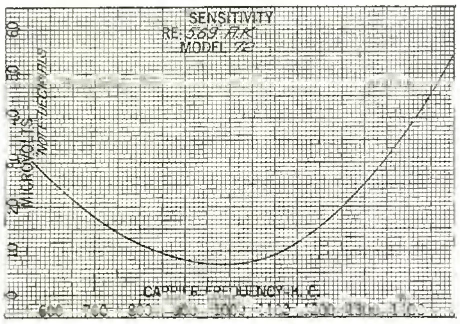
Atwater-Kent Model 72 Super

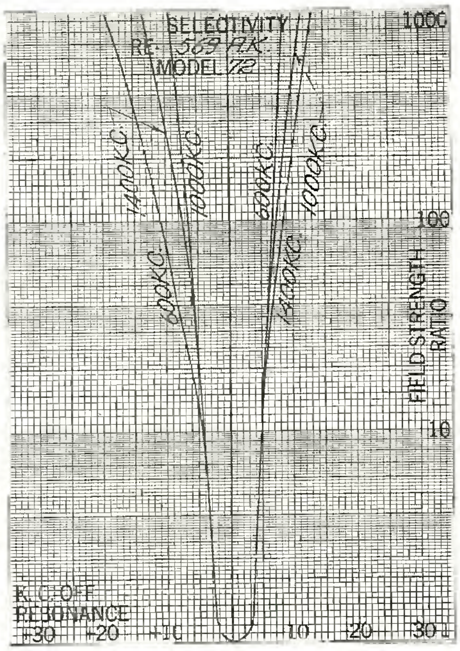
ATWATER-KENT'S superheterodyne, known as their model 72, has been recently measured in our laboratory and the curves derived are presented on this page. In reading the sensitivity curves, readers should note that microvolts are plotted from 0 to 6, a period being placed between the numeral and the cipher.

Dummy antenna used consisted of 20 uh, 200 mmf and 25 ohms. Output impedance was maintained at 4000 ohms, coupled capacitatively to the output plates. The factory phasing frequency was maintained and the volume control turned to maximum setting. Line voltage 115, current .82 amperes.

Transconductance of the tubes used: Mixer, 1140; detector, 1000; 1 i.f. 1080; 2 i.f. 1040; 1 a.f. 1000; P.P. 1940; P.P. 1980, and oscillator, 1030 micromhos.

Interference ratios and band widths are shown in these tables:



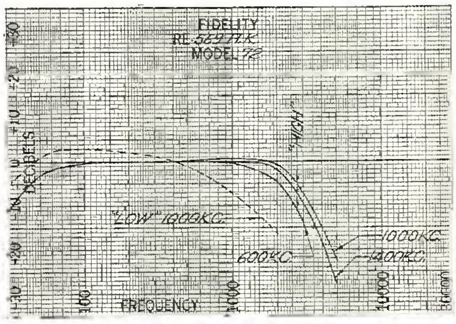


Interference Ratio

Resonance	Kilocycles off resonance Plus 10	Plus 20	Plus 30
600 kc.	75.0	-------	-------
1000 kc.	-------	-------	-------
1400 kc.	275.0	-------	-------
	Minus 10	**Minus 20**	**Minus 30**
600 kc.	-------	-------	-------
1000 kc.	450.0	-------	-------
1400 kc.	210.0	-------	-------

Band Widths

Times field strength	Kilocycles wide 600 kc.	1000 kc.	1400 kc.
10	9.5	9.2	9.2
100	17.7	14.0	14.5
1000	28.0	21.0	27.0

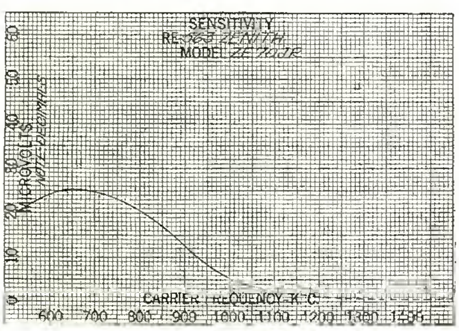


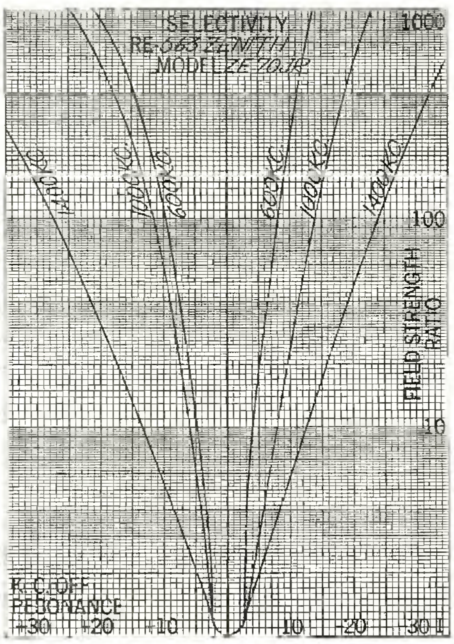
Zenith Radio Model ZE-70 Jr.

RESPONSE curves have been taken on the Zenith model ZE-70 Jr., and are illustrated on this page. R.f. input to the receiver was through the standard dummy consisting of 20 uh, 200 mmf and 25 ohms. Output impedance was kept at 4000 ohms, coupled capacitatively to the plates of the 245 output tubes. The receiver was phased at 1400 kc. and the volume control turned to maximum. Line voltage 115 volts, current .85 amperes.

Transconductance of the tubes used in the measurement are indicated: 1 r.f. 1080; 2 r.f. 1040; 3 r.f. 970; detector 970; 1 a.f. 950; P.P. 1980 and P.P. 1940 micromhos.

In the two tables below will be found the interference ratios and the band widths taken from the selectivity curves:



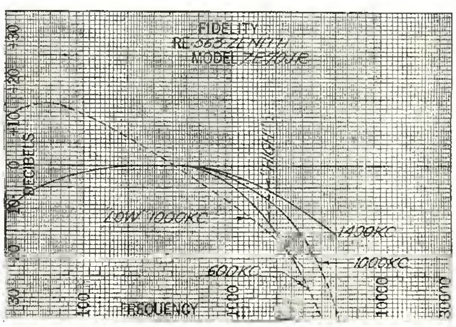


Interference Ratio

Resonance	Kilocycles off resonance Plus 10	Plus 20	Plus 30
600 kc.	112.0	900	-------
1000 kc.	58.0	550.0	-------
1400 kc.	5.3	31.0	142.0
	Minus 10	**Minus 20**	**Minus 30**
600 kc.	240.0	-------	-------
1000 kc.	24.0	550.0	-------
1400 kc.	5.9	46.0	285.0

Band Widths

Times field strength	Kilocycles wide 600 kc.	1000 kc.	1400 kc.
10	8.8	13.8	26.0
100	17.5	25.5	51.5
1000	34.5	47.5	-------

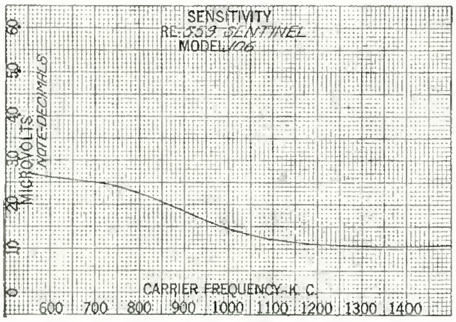


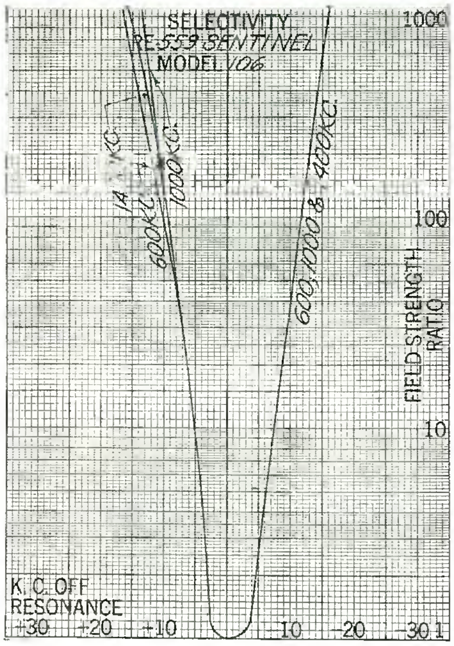
Sentinel Super Model 106

SENTINEL'S model 106 superheterodyne has recently passed through our measurement laboratory and its curves are shown on this page. The dummy antenna used consisted of 20 uh, 200 mmf and 25 ohms. Output impedance was maintained at 4000 ohms, coupled capacitatively to the plates of the 245 output tubes. Factory phasing frequency was maintained and the volume control turned on full. Line voltage 110 volts, current .72 amperes.

Transconductance of the tubes used in this measurement: 1 r.f. 980; mixer 1080; detector 950; 1 i-f. 1040; P.P. 1980; P.P. 1940 and oscillator 1180 micromhos.

In the two tables here shown will be found the interference ratios and the band widths:



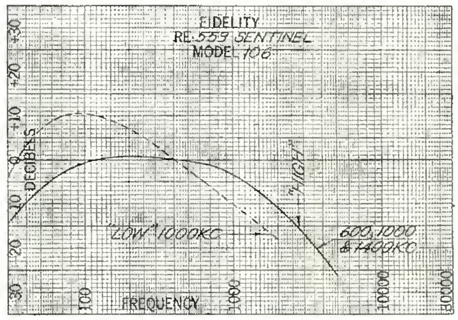


Interference Ratio

Resonance	Kilocycles off resonance		
	Plus 10	Plus 20	Plus 30
600 kc.	95.0	--------	--------
1000 kc.	140.0	--------	--------
1400 kc.	140.0	--------	--------
	Minus 10	Minus 20	Minus 30
600 kc.	37.0	--------	--------
1000 kc.	37.0	--------	--------
1400 kc.	37.0	--------	--------

Band Widths

Times field strength	Kilocycles wide 600 kc.	1000 kc.	1400 kc.
10	12.5	12.5	12.5
100	21.7	21.0	21.7
1000	32.0	29.5	32.5



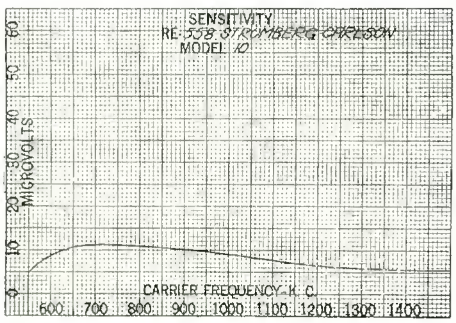
Stromberg-Carlson Model 10

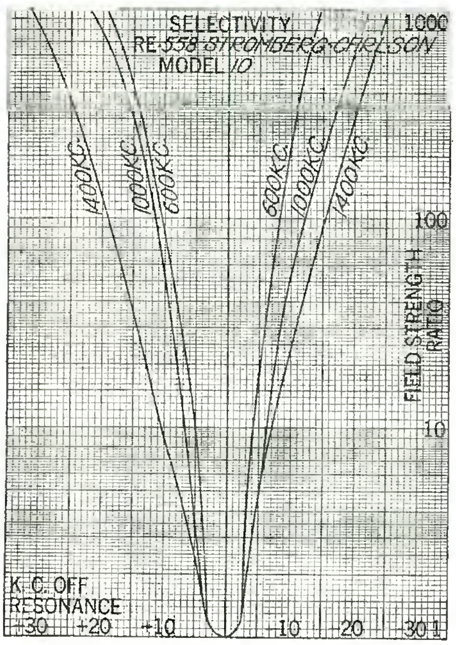
MEASUREMENTS of the sensitivity and fidelity of the Stromberg-Carlson model 10 receiver have been completed and the curves are shown on this page.

Input was through the standard dummy consisting of 20 uh, 200 mmf and 25 ohms. Output impedance was maintained at 4000 ohms coupled capacitatively to the plates of the 245 tubes. The receiver was phased at factory kc setting and the volume control turned to maximum. Line voltage 115 volts, current .9 amperes.

Transconductance of the tubes used in the measurements is indicated by the following values: 1 r.f. 1060; 2 r.f. 920; 3 r.f. 840; detector 990; p.p. 1620; p.p. 1660 micromhos.

In the two tables following will be found the interference ratios and the band widths:



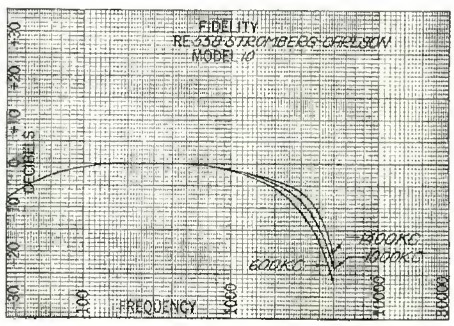


Interference Ratio

Resonance	Kilocycles off resonance		
	Plus 10	Plus 20	Plus 30
600 kc.	85.0	--------	--------
1000 kc.	52.0	730.0	--------
1400 kc.	9.0	125.0	--------
	Minus 10	Minus 20	Minus 30
600 kc.	230.0	--------	--------
1000 kc.	54.0	620	--------
1400 kc.	24.0	300	--------

Band Widths

Times field strength	Kilocycles wide 600 kc.	1000 kc.	1400 kc.
10	9.0	13.0	17.5
100	19.0	23.5	34.5
1000	34.0	44.0	56.0



Edison Models R-6 and R-7

RESPONSE curves of the Edison models R6, R7 have been published previously, appearing on page 64 of the November issue of this magazine. In that number it was stated the schematic would be found elsewhere in that issue. However, this was in error, since the schematic published on page 77 was that of the Edison models R4, R5, C4, in no way related to the schematic of the R6, R7 shown on this page.

As will be seen from the schematic in Figure 2 these models are the screen grid type as contrasted with the 227's in the previous models. Tube operating values are shown in the chart in Figure 1.

A socket reading analysis chart covering r.f., detector, a.f. and rectifier stages is included in the Edison service manual, from which some of the more interesting servicing aids are taken.

In the case of the first r.f. socket no reading on filament voltage which should be 2.2 volts with the fuse in the 115-volt position indicates: open filament lead to socket; open filament of secondary; shorted filament secondary; open circuit in either connecting cable or six-prong connector. Low reading of filament voltage indicates: low line voltage; incorrect location of primary fuse; shorted turns in filament secondary; shorted turns in primary of power transformer; short circuit in filament wiring. High filament reading indicates: high line voltage; incorrect location of primary fuse.

Normal plate voltage is 190 volts. No reading indicates open plate lead; open cathode lead; grounded first or second r.f. plate lead; open first and second r.f. plate isolating resistor; shorted first and second r.f. plate by-pass condenser; open low frequency or high frequency primary of 4th r.f. coil; "A" choke open or grounded; B choke field winding; B choke shorted; grounded high voltage secondary; one lead to 280 socket open; shorted turns in high voltage secondary; one side of high voltage secondary open; shorted grounded; open r.f. voltage divider, located in power unit; shorted filter condenser section; grounded rectifier filament winding; open radio-phono switch contacts; open or short circuit in either connecting cable or six-prong connector.

Low reading indicates: low line voltage; incorrect location primary fuse; low emission rectifier tube; grounded 3rd r.f. plate lead; shorted 3rd r.f. plate by-pass condenser; shorted speaker filter condenser section; short circuit between 3rd r.f. filter condenser and automatic volume control by-pass condenser; open 1 a.f. bias resistor; low potential end of screen grid voltage divider open (located in a.f. filter unit), shorted turns in primary of power transformer. High reading indicates: high line voltage; incorrect location primary fuse; shorted 1 r.f. screen grid by-pass condenser; shorted 2 a.f. plate by-pass condenser.

Edison Models R6 and R7

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R. F.	2.2	190	----	2.5	80	3.5	6.0	2.5
224	2 R. F.	2.2	190	----	2.5	80	3.5	6.0	2.5
224	3 R. F.	2.2	190	----	2.5	80	3.5	6.0	2.5
227	Det.	2.2	----	*	----	----	----	----	----
227	1 A. F.	2.2	40	.5-2.5	±3.0	----	1.1	1.4	.3
227	2 A. F.	2.2	115	.5	6.0	----	3.8	4.8	1.0
245	P. P.	2.48	260	46	----	----	31.0	36.0	5.0
245	P. P.	2.48	260	46	----	----	31.0	36.0	5.0
280	Rect.	4.85	----	----	----	----	48.0	----	----

Line voltage, on 115-volt tap. Volume control.

*Grid volts 8-10 on strong signal.

Fig. 1. In this table may be found the tube operating voltages for the Edison model illustrated schematically on this page

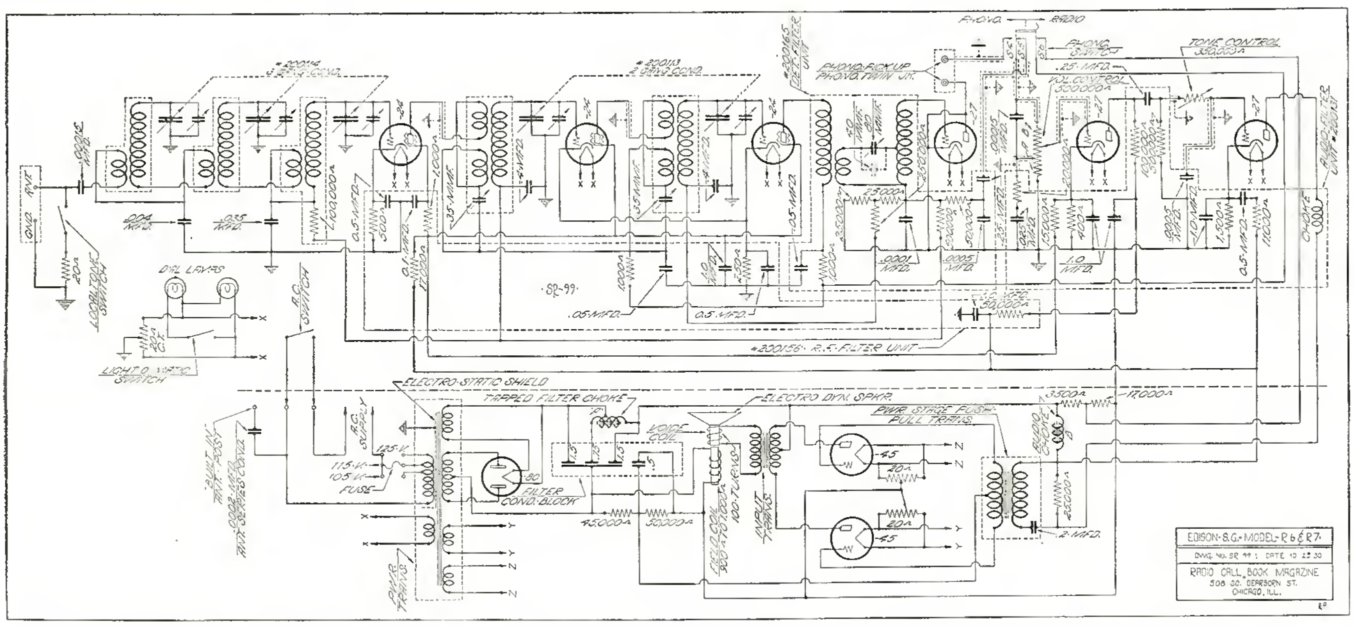


Fig. 2. The schematic diagram of the Edison models R6 and R7 including the power supply is shown in this diagram

Victor Models R 35, R 39, RE 57

KNOWN as the "micro-synchronous" model and using four stages of tuned r.f. with screen grid tubes, the Victor models R35, R39 and RE57 are illustrated schematically on this page in Fig. 2 with a table of tube operating values shown in the table in Fig. 1.

An interesting point in the Victor service manual covers installation of the receiver in a room so the receiver faces the length of the room rather than its breadth; also a space of at least four inches be allowed between the back of the cabinet and the wall. Best acoustic results will be obtained if these suggestions are followed.

Under general tests it is indicated that excessive hum may be caused by: faulty 224 in detector socket (at least one 224 out of the four will be found that will give minimum hum in the detector socket); faulty 280 or 227; unbalance in plate currents of the two 245's. (Try new 245 in one socket, then in another); wire or terminal grounded to chassis, or open circuit in any of the various ground connections to chassis; open or shorted center tap resistor in amplifier unit; short or partial short in one of the resistors mounted on the under side of the resistor board; shorted or open condenser in condenser bank or faulty connection to condenser bank; defective 280 socket, one plate not making contact; faulty connection to tapped section of filter reactor.

Microphonic howl may be caused by: defective tube in detector or first audio tube sockets; speaker not properly felt insulated from baffle on front of the cabinet. (Raise the amplifier-speaker unit to gain access to the felt and re-adjust the felt properly, making sure the rim of the speaker is tight against the felt); loose metal parts such as screws, shields, etc., or an improperly centered cone may set up a howl or coils or tubes, too much unshielded exposure of the green lead between the control grid of the 224 and coil; open circuit in any of the .1 mfd by-pass condensers, or poor ground (loose rivet) in any of these condensers; ungrounded shield on shielded lead of the radio chassis.

Victor Models R35, R39 and RE57

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R. F.	2.15	172	2.5	----	80	2.5	5.0	2.5
224	2 R. F.	2.15	172	2.5	----	80	2.5	5.0	2.5
224	3 R. F.	2.15	172	2.5	----	80	2.5	5.0	2.5
224	Det.	2.15	75	----	8	2.5	----	----	----
227	1 A. F.	2.15	55	0	----	----	1.5	1.8	.3
245	P. P.	2.25	185	36	----	----	19.0	22.0	3.0
245	P. P.	2.25	185	36	----	----	19.0	22.0	3.0
280	Rect.	4.8	----	----	----	----	36	----	----

Line voltage 112, on 120 tap. Volume control maximum.

Fig. 1. The tube operating values shown in this chart for the Victor R35, R39 and R57 are those taken with a Jewell analyzer, the manual indicating socket analysis together with possible causes of trouble

mechanical rattle, depending upon the nature of the fault; on the home recording model an open circuit in either of the resistors on the microphone reactor may cause a howl.

Oscillation in the set characterized by a generally unstable condition while tuning, may be caused by: Ungrounded or poorly grounded chassis; removal of shielding from any of the condensers,

Under excessive noise the following causes are listed: intermittent short or high resistance in any of the soldered joints, or in the power switch connections; loose or defective pilot lamp, or pilot lamp socket; shorted plates in one or more of the tuning condensers; faulty power or audio transformer; intermittent short on filter or by-pass condensers.

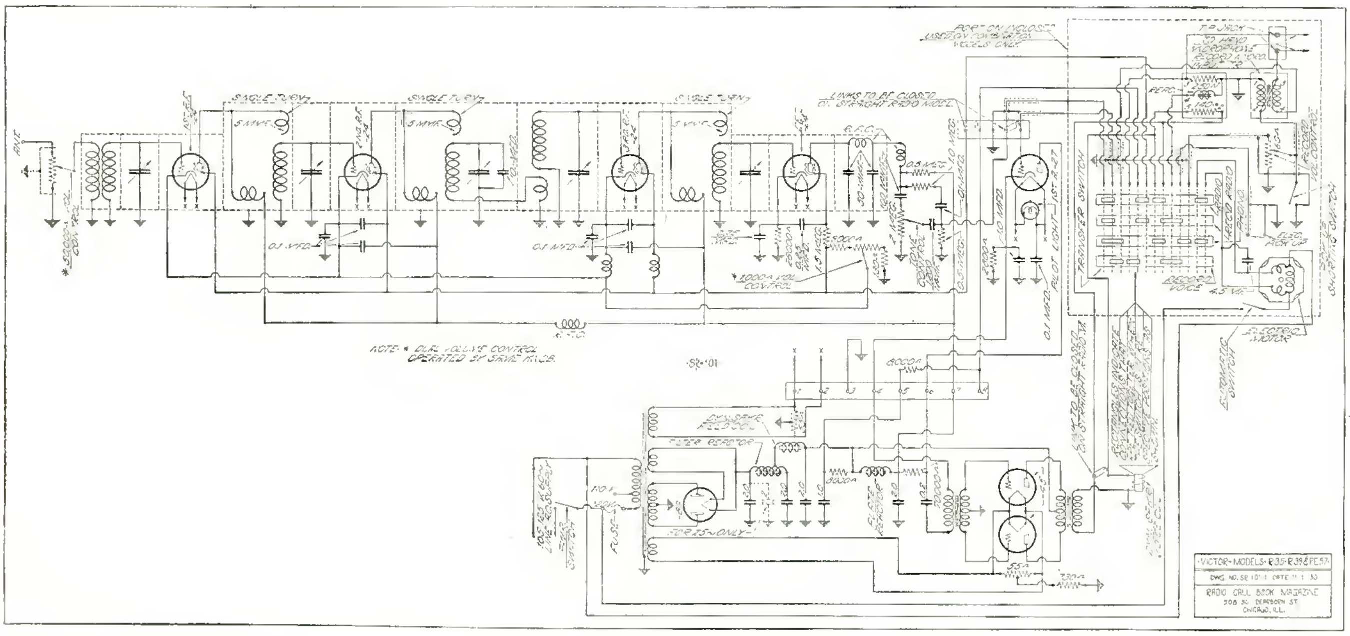


Fig. 2. The schematic diagram of the Victor models described on this page is shown in this illustration together with its power supply

Crosley Models Nos. 53, 54 and 57

ELSEWHERE in this issue appear the response curves on the Crosley 53, 54 models, whose schematic diagram and tube operating values will be found on this page. Each model incorporates five tubes, including the restifier: two 224 screen grids in the r.f. stages, one 224 screen grid used as a detector, a 245 power output tube and the 280 rectifier. The single stage audio is coupled directly to the screen grid detector, through the resistance-capacity connection indicated in the schematic diagram. The plate circuit of the output tube is connected directly to the voice coil of the speaker.

The high potential side of the plate circuit is connected to a filter system consisting of a choke coil and a Mershon condenser. Thence it branches into three circuits, one going through the speaker field to the plate of the output tube, one going through a 150,000 ohm resistor and a choke coil to the plate of the detector tube, and the third going through a 10,000 ohm resistor and the primaries of the respective radio frequency transformers to the plates of the radio frequency tubes. The resistors are of proper values to insure proper voltages between the plates and emitters of the tubes.

A branch from the r.f. plate supply circuit passes through a second 10,000 ohm resistor to the screen elements of the screen grid tubes, keeping them at the appropriate positive potential with regard to the emitters. A third 10,000 ohm resistor carries the necessary bleeder current from the second 10,000 ohm resistor to ground.

Biasing is accomplished by the resistors. The tube grids are connected through transformer secondaries or coupling resistors to the chassis and are at the chassis potential. Voltage drops in resistors keep the emitters at positive potentials with regard to the chassis. The combination of fixed resistors and variable volume control resistor in the emitter circuit at the extreme left of the circuit diagram accomplishes the biasing for the r.f. tubes. A 10,000 ohm biasing resistor is connected from the detector emitter to the chassis. Similarly a 1650 ohm biasing resistor is connected from the output filament to the chassis. This last resistor is connected to the middle of a 50 ohm potentiometer shunted across the output filament leads. Changes in resistor values may be made occasionally by the factory if reports from the field indicate such changes are desirable.

Recommended aerial length for outdoor installations is 50 feet or more; for indoor installations 25 feet or more.

Model Differences

Models 53 and 54, while practically identical in circuit and electrical characteristics, differ in mechanical construction. Model 54 is built on a more compact chassis for use in a mantle type cabinet. Model 57 corresponds to Model 53. It differs from Model 53 only in slight circuit changes, primarily those for enabling it to be adapted to an improved type of speaker.

Crosley Models 53, 54 and 57

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R.F.	2.1	160	3.1	......	85	3.	......	......
224	2 R.F.	2.1	160	3.1	......	85	3.	......	......
224	Det.	2.1	215	9.0	......	85	3.	......	......
245	Pwr.	2.2	230	45.0	......	....	33.	......	......
280	Rect.	4.1	340	......	......	....	45.	......	......

Line voltage 110. Volume control minimum.

Fig. 1. Tube operating values covering the Crosley models 53, 54 and 57 are shown in this chart, being transposed from a table of voltage limits shown in the Crosley service manual for these models

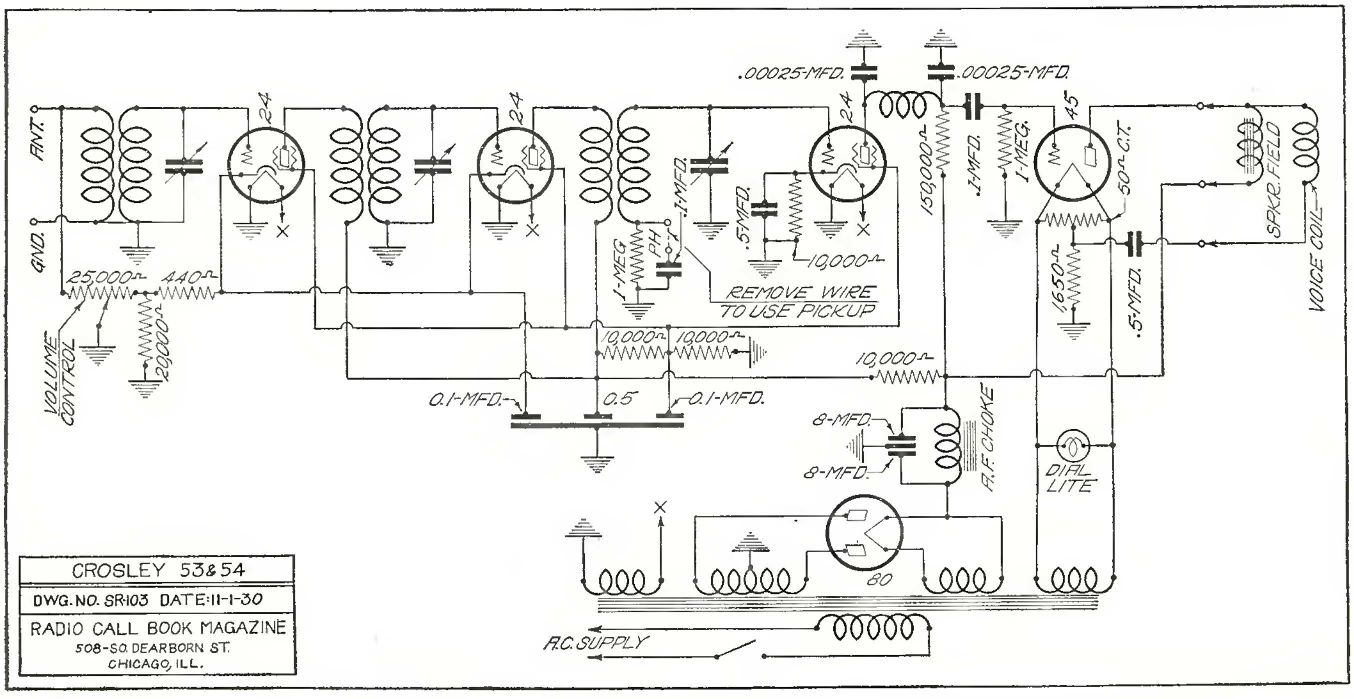


Fig. 2. The schematic diagram of the Crosley models described on this page is shown in this drawing with appropriate resistor and condenser values

Bosch Receiver Model No. 58

SERVICE data on the model 58, made by the American Bosch Magneto Corp., is shown on this page, the tube table in Figure 1 and the schematic of the receiver and power supply in Figure 2. The model 60 is practically the same as the 58 except it has an automatic volume control, a mute switch and a larger speaker.

Under service complaints in the Bosch manual are to be found a number of suggestions worth repeating since they cover the most common complaints. Weak or poor reception from distant stations might be caused by inefficient antenna, open or grounded antenna; poor or broken ground connection; defective tubes; condensers not aligned mechanically; condensers not aligned electrically; defective coil or connections; low or incorrect socket voltages; rectifier tube defective. Referring to the trimming condenser, if a peak or point of loudest reception cannot be secured by adjusting the trimmer condenser, look for an open antenna lead-in, grounded antenna, or shorted lightning arrester. A defect in the receiver or a wrongly connected local-distance cable may produce the same effect.

Poor tone quality might be caused by a defective power tube; unmatched power tubes; lack of C bias; incorrect voltages. Rattles and vibration may be caused by a speaker out of adjustment. Make sure the wires from the voice coil are not lying against the diaghragm. Also make sure the vibration is not caused by loose parts, such as the chassis holding bolts, etc.

Noise level is treated of in the manual since it covers a condition that is hard to explain to the lay user of a radio set. Noise level is the term applied to the amount of static and interference noise heard with the receiver turned on fully but not tuned to a station signal. If the noise level is high it is obvious that a weak or distant station will not be heard above the interference. The noise level is higher in summer, due to natural static, and is higher in congested districts or near trolley lines because of man-made interference. In some locations, therefore, reception of distant, or in some cases even semi-distant stations, may be impossible due to the high noise level.

A word or two about location seems proper. Local conditions have a decided effect upon reception. For this reason identical receivers will perform differently when installed in various different locations in the same town or city. Experience with receivers for automobile use has shown that a very considerable difference in reception may occur in a very short distance. In general, reception is better in thinly populated or suburban districts than in congested sections.

A loose connection anywhere in the receiver or accessories may produce noisy reception. Check the antenna and ground system, also the speaker cord.

The house lighting system should be checked for loose connections, defective switches or sockets. Jarring the cabinet will frequently indicate if the loose connection is in the receiver. Noise caused by turning the selector control is generally caused by condenser plates touching, or particles of metal between the plates.

Bosch Model 58

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R.F.	2.2	170	2.2	----	75.	3.0	----	----
224	2 R.F.	2.2	170	2.2	----	75.	3.0	----	----
224	3 R.F.	2.2	170	2.2	----	75.	3.0	----	----
224	Det.	2.2	30*	1.5	----	10.*	.1*	----	----
227	1 A.F.	2.2	150	8.0	----	----	5.0	----	----
245	P.P.	2.4	250	50	----	----	30.	----	----
245	P.P.	2.4	250	50	----	----	30.	----	----
280	Rect.	5.0	----	----	----	----	----	----	----

Line voltage 115. Volume control maximum.

*Approximate, since measured through high resistance.

Fig. 1. The table of tube characteristics as given in the Bosch manual covering model 58 may be seen above. Values marked with an asterisk are approximate since measurements are made through a high resistance

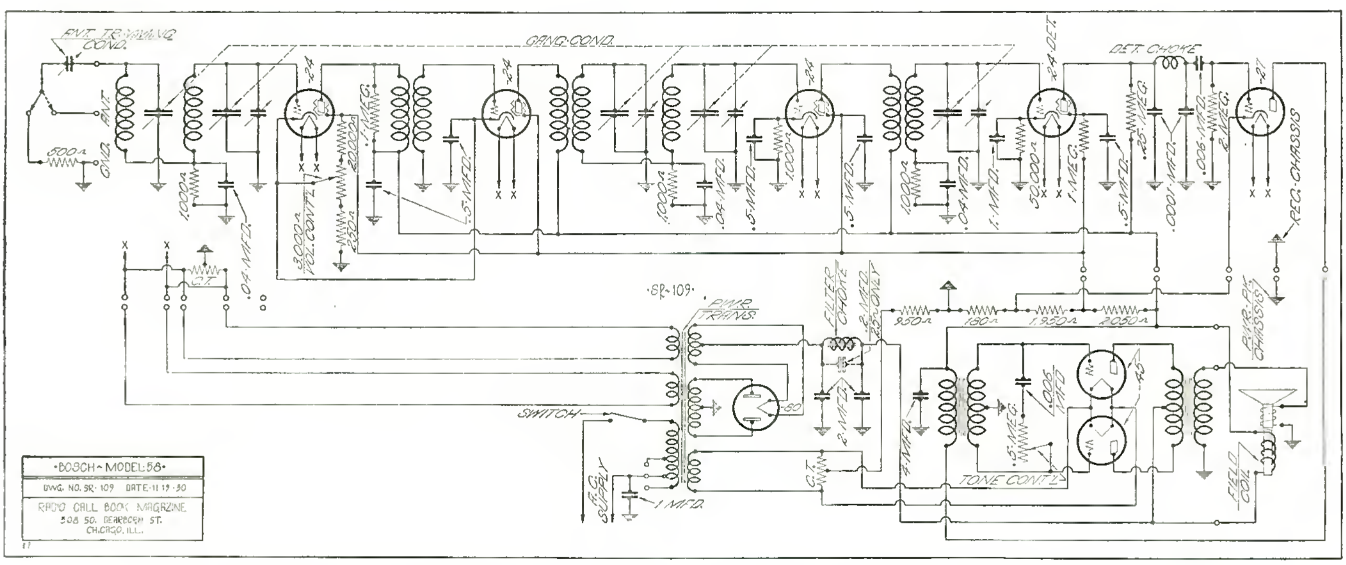


Fig. 2. The receiver and power supply of the Bosch model 58 is found in the schematic drawing above

Apex No. 31 U. S. Radio and Television

APEX series 31 is the model made by the U. S. Radio and Television Co., and illustrated schematically on this page. Response curves of this model appeared on page 63 of the November issue of this magazine.

In the section of the service manual devoted to repairs and adjustments are found a number of interesting suggestions that will doubtless be of aid to service men.

Poor Heater Welds

For example, many cases of intermittent operation in receivers are due to a poor weld at the heater connection in the heater type tubes. These tubes will have a complete circuit through the heater one moment and will then go open. After cooling down, the circuit through the heater will be completed again and the tube will function, going open again as soon as the weld contact loosens. If the volume drops during reception look at once to see that heaters are burning.

A cathode to heater short in the 224's will cause excessive hum, and there will be no control of volume due to the shorting out of the bias resistance. Traces of gas in the 224 will cause low volume. A pronounced blue glow in the 280 is caused by gas, results in low B voltage, excessive hum and in some cases distortion. A shorted 280 will cause burnout of the power transformer. For best results the 245's in pushpull should be balanced for plate current within 3 milliamperes. One good and one defective 245 may cause distortion. Dirty tube prongs may cause noisy operation or change the resistance of the filament circuit sufficiently to cause weak reception or appreciable hum in the speaker. Prongs should be cleaned periodically to insure good contact. A fine grade of sandpaper is best for this. Emery cloth or steel wool should not be used on account of possible short circuits from particles.

Excessive hum may be due to a number of causes, among which are included: defective 280 or 227 tubes; external pick-up (disconnect antenna and ground from set and see if hum disappears); open .1 mfd choke condenser open or shorted; shorted filter choke; open filter condenser; defective wiring in grid circuits; improper grounding of the shield plate in the power transformer between the primary and secondary windings; heater to cathode short in the 224, as well as an open cathode connection in this same type of tube.

Uncontrolled oscillation may ensue from any of the following causes: tubes whose mutual conductance is considerably in excess of the standard; the 227 detector has in some instances been found responsible for oscillation (the remedy in either case is to try out another tube of the same type); cover of chassis shield not in place when set is operating, this cover having on it the tube shield plates which electrostatically isolate the r.f. and detector tubes and grid circuits; an open bypass condenser; shorted detector plate choke; poor ground connection to the subpanel at any point (inspect for high resistance joints and lacquer at ground contact point).

In the table in Figure 1 may be found the operating tube voltages as indicated by the manufacturer of the set. The schematic of the receiver and its power supply is shown in Figure 2.

The tone blender used in this model is an arrangement for controlling the degree of reproduction of the higher audio frequency notes. For certain types of reception it is advisable to reproduce all of the frequencies, while for other types of reception it is more pleasing to the ear to limit the higher audio frequencies. This optional limitation is accomplished with a .006 mfd condenser and a 500,000 ohm variable resistance in series between the grids of the 245's as shown in the schematic.

Apex Model 31, U. S. Radio

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R. F.	2.25	178	3.0	3.0	86	3.4	5.8	2.4
224	2 R. F.	2.25	178	3.0	3.0	86	3.4	5.8	2.4
224	3 R. F.	2.25	178	3.0	3.0	86	3.4	5.8	2.4
227	Det.	2.25	60	9.0	9.0	----	.25	.30	.05
227	1 A. F.	2.25	160	12.0	12.0	----	4.5	5.5	1.0
245	P. P.	2.35	246	40	----	----	25.0	30.0	5.0
245	P. P.	2.35	246	40	----	----	25.0	30.0	5.0
280	Rect.	4.9	----	----	----	----	37	----	----

Line voltage 115. Volume control maximum.

Fig. 1. Tube operating values as supplied by the maker of the Apex Series 31 are indicated in this table

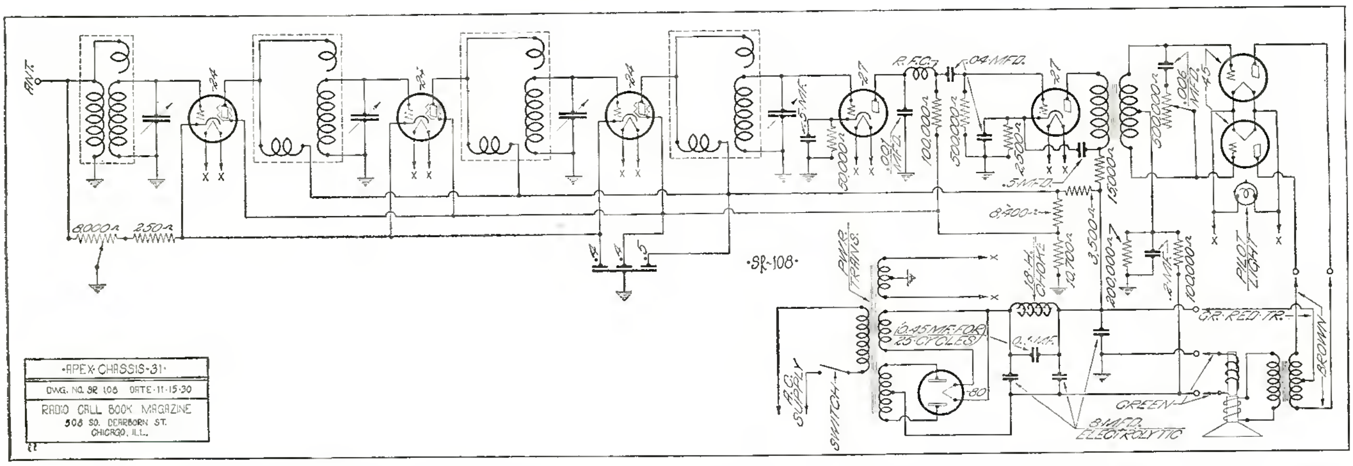


Fig. 2. The schematic diagram of the receiver and power supply for the Apex 31 series is shown in this drawing

Silver Model 36 A Superheterodyne

On this page will be found the schematic of the Silver model 36-A superheterodyne, together with a table of tube operating voltages and other service data abstracted from the manual furnished for that receiver. The 32-A power pack, 60 cycles, is designed for the 36-A receiver.

The model 36-A is shipped with a self-contained antenna connected to the antenna binding post. Where the receiver is located in districts remote from broadcasting stations, or in exceptional metropolitan locations where the field strength of various broadcasting stations is greatly attenuated by the shielding effect of metal frame buildings, greater range may be secured by using a small indoor or outdoor antenna. The former may consist of from 20 to 50 feet of No. 18 annunciator wire tucked in the picture molding, or under a rug. An outdoor antenna may be from 20 to 60 feet in length, except in metropolitan sections, where the length should not exceed 35 feet.

Excessive hum may result from: defective 280 rectifier tube; defective 339U choke; open filter condenser; defective field coil in speaker; grounded or shorted by-pass condenser; grounded filament lead. This may be in the filament wiring or dial light circuit.

An acoustic howl may result from: defective detector tube, rare and extremely annoying since the tube may test o.k. in a tube checker. Replace the defective tube. Failure to remove shipping blocks (see instruction card attached to receiver). Any defect in the support of the receiver chassis which will prevent it from being entirely suspended by the rubber cushions, may cause a howl.

Low volume may be caused by: defective or worn out tubes; poor antenna; receiver not properly aligned; audio transformer defective; opens, shorts or grounds in receiver or power pack.

In the event a receiver oscillates it should be seen that the small metal disc has been installed on top of the tube cover for the first intermediate frequency screen grid tube. This is the third tube from the left facing the receiver, the one nearest the drum dial. It is also important that a good ground connection be made to the receiver. Having made certain of these points, if the receiver still oscillates, it is likely a connection to one of the by-pass condensers has been broken, or that one of the by-pass condensers is open internally. All such connections should be checked, especially the 1000 mmf condenser connected between the plate and cathode of the second detector.

Silver Model 36A

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R. F.	2.27	162	----	7	85	4	----	----
224	1 Det.	2.27	76*	----	37.5	80	3	----	----
227	Osc.	2.27	82	----	37.5	----	11	----	----
224	1 I. F.	2.27	160	----	42.5	110	4	----	----
224	2 I. F.	2.27	160	----	45.0	110	4	----	----
224	2 Det.	2.27	245	----	7.0	162	4	----	----
245	P. P.	2.4	255	22.5*	----	----	----	----	----
245	P. P.	2.4	255	42.5	----	----	----	----	----

Line voltage. Volume control maximum.

*Misleading due to current drawn by meter.

Fig. 1. From the service manual for the Silver 36-A are abstracted the tube operating voltages shown in this table as taken with a Jewell analyzer

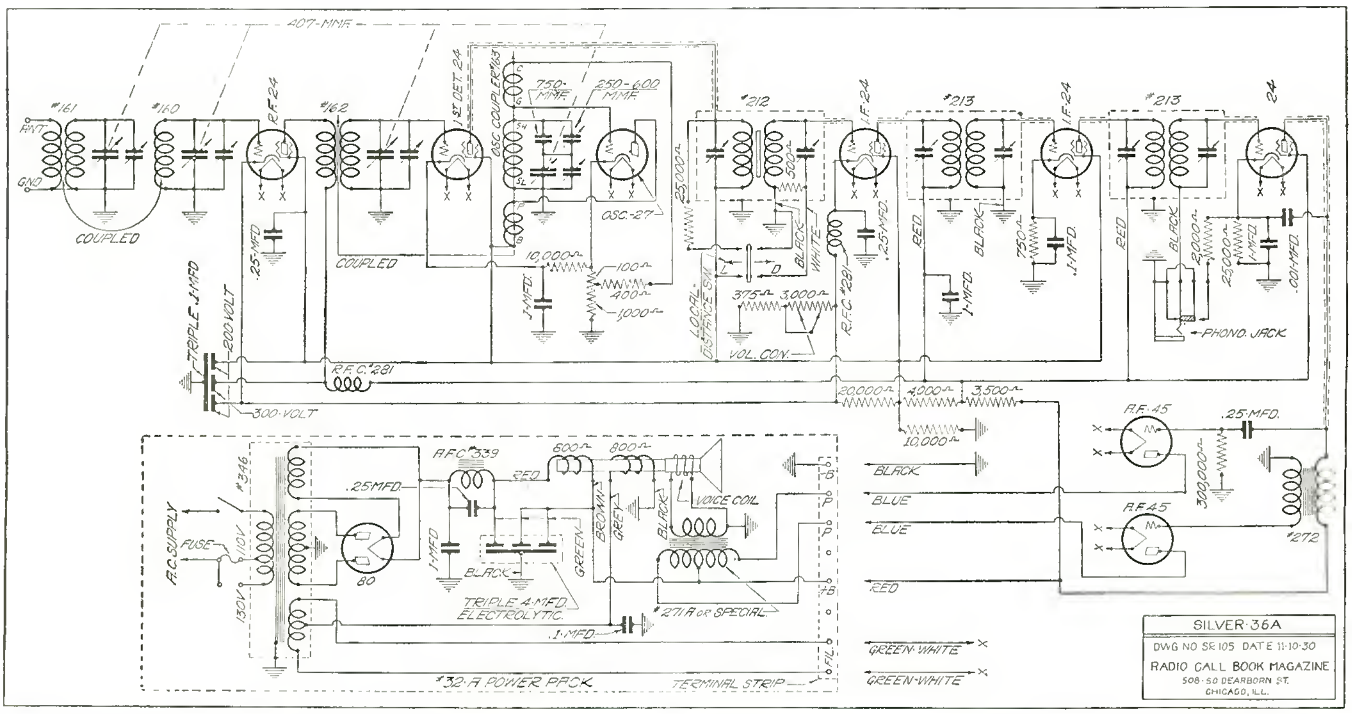


Fig. 2. Receiver and power supply schematics are shown in this illustration of the Silver 36-A receiver and 32-A power pack

Amrad Receiver Model 84

IN the schematic diagram at the bottom of this page will be found the electrical connections for the Amrad model 84 receiver. A table of the tube operating values will be found in Figure, 1, these values being taken from the voltage limits table shown in the Amrad service manual from which extracts have been made.

How Voltages Derived

An examination of the circuit diagram in Figure 2 will show that the return plate circuit from the speaker field is connected directly to the r.f. and first audio plates and through a 100,000 ohm resistor to the detector plate. Thus, practically the same voltage is applied to the r.f. and first audio plates while a somewhat lower voltage is applied to the detector plate. The appropriate positive voltage for the screen grid of the detector tube is applied through a 1 megohm resistor connected to the positive plate circuit return from the speaker field.

Below the first audio tube on the circuit diagram a branch of this positive plate circuit passes down through a string of resistors, 2500, 1100, 330 ohms and thence to ground (chassis). These resistors supply potential to the r.f. screen grids and the first audio emitter. The circuit to the r.f. screen grids runs from the junction of the 2500 and 1100 ohm resistors through a 10,000 ohm (20,000 ohm in later chassis) to the tubes. The emitter of the first a.f. tube is connected to the junction between the 330 and 1100 ohm resistors. Emitters of the r.f. tubes are grounded to chassis through proper resistors shown. Emitter of the detector is biased to ground with a 20,000 ohm resistor.

Output Grid Bias

Grids of the output tubes are biased with approximately 860 ohms from center tap of the filament resistor to ground. Biasing of the first a.f. tube is accomplished by the resistor between the emitter and ground.

Volume Control

In the grid circuit of the first a.f. tube is a variable coupling resistor which is used as a manual volume control. Since it follows the detector in the circuit, it controls the volume both of the radio signals and of the phonograph reproduction through the phonograph terminals.

R.F. and Detector Bias

The biasing of the r.f. and detector tubes is partially accomplished by maintaining the emitters at positive potentials with respect to chassis and partially, when grid current is flowing, by the drop due to the grid current in the 60,000 ohm resistor in the detector grid circuit. This latter drop due to grid current is the basis of the automatic volume control. A signal strong enough to cause grid current to flow in this circuit automatically increases the negative bias on the grids of the r.f. and detector tubes. This decreases the amplification in the r.f. and detector stages.

Local-Distance Switch

In addition to the manual volume control and automatic volume control, a local-distance switch is provided for adapting the receiver to the reception of powerful signals from nearby stations.

Amrad Model 84

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R.F.	2.3	170	2.5	----	60.	----	----	----
224	2 R.F.	2.3	170	2.5	----	60.	----	----	----
224	3 R.F.	2.3	170	2.5	----	60.	----	----	----
224	Det.	2.3	95	4.0	----	35.	----	----	----
227	1 A.F.	2.3	130	8.0	----	----	----	----	----
245	P.P.	2.3	220	40.	----	----	----	----	----
245	P.P.	2.3	220	40.	----	----	----	----	----
280	Rect.	4.6	250	----	----	----	----	----	----

Line voltage 117. Volume control maximum.

Fig. 1. Tube operating values in the above table are derived with speaker connected and line voltage of 117, with fuse in high position. Measure plate and grid voltages with a high resistance d.c. voltmeter (600 ohms or more per volt) from plate or grid contact to emitter contact, except for the grid voltage of the first a.f. tube which should be measured from emitter to chassis

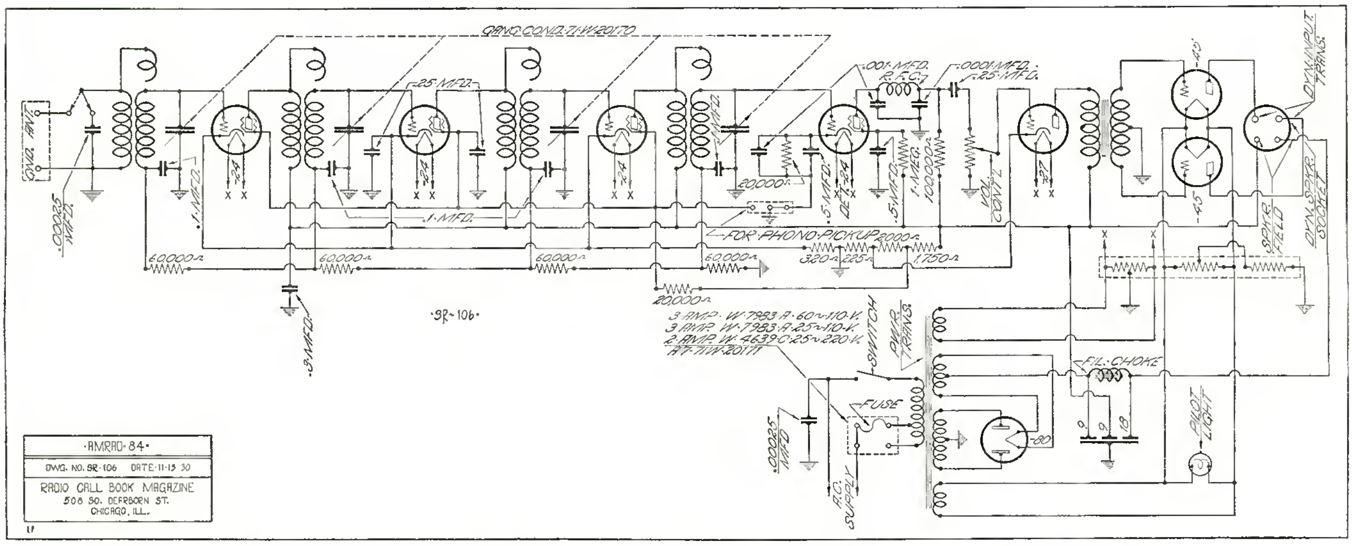


Fig. 2. The schematic diagram of the Amrad model 84 is shown in this drawing

Radiola Receiver Model 44

PROBABLY on account of the great numbers of these receivers in service in the field, our information department has been besieged with requests for information covering the Radiola 44 receiver. Tube operating values in Figure 1 and the schematic of the receiver and power supply in Figure 2 will be of interest, together with such other important service data as can be abridged from the manual for that model.

Excessive Hum

Excessive hum during operation of the receiver may be due to: external pickup. Throw switch to local position and see if hum disappears; a.c. input plug reversed, try reversing its position; open center tap resistance in socket power unit; shorted bypass and filter condensers, generally accompanied by inoperation; low emission 280 rectifier; defective dynamic if used; open resistance unit, usually accompanied by inoperation; if the .25 and 1.75 mfd tapped connections of the receiver 1 mfd bypass condenser are reversed a loud hum may be present; hum may also be caused by the speaker being out of center, check on this condition by releasing the center screw so that the cone can find its own center, and then tighten the center screw.

Oscillation

Oscillation through any part of the tuning range may be attributable to shields not properly in place, or not making contact with base on account of dirt; shield over antenna lead to local-distant switch not grounded or properly covering the leads; defective r.f. filter in detector plate circuit; there are two filters, one of which is shunted by two condensers in the plate circuit of the detector, oscillating occurring if the filters are defective or the condensers go open; contact clips between shield and condenser shaft broken or not making good contact; open bypass condenser; defective 224 tube.

Service Hints

A brief resume of the service data chart shown in the Radiola 44 manual follows:

No signals: defective operating switch, defective volume control; defective r.f. transformer; defective coupling reactor; defective bypass condenser; defective socket power unit.

Weak signals: local-distant switch not on distant position; lineup condensers not adjusted properly; defective main tuning condensers; defective parts in receiver assembly; defective parts in socket power unit; low line voltage.

Poor quality: defective coupling reactor, condenser or resistor in coupling circuit; defective output condenser or choke; local-distant switch not properly operated.

Audio howl: receiver oscillating; defective audio system; open grid in any stage.

Uncontrolled oscillation: shields not in place, or making good contact; tube shields not in place; defective r.f. filter.

Tubes fail to light: no a.c. line voltage; operating switch not on; defective a.c. input cord; defective power transformer.

Antenna Installations

Covering special antenna installations for noisy locations, it is noted: Erect as long and as high an antenna as possible and then couple it to the antenna lead of the receiver through a small coupling condenser. This condenser with a 200 foot antenna should be about .0003 mfd and smaller with larger antennas. The effect of the long antenna is to increase the pickup to a point where it will be proportionately higher than the noise level. The series condenser then reduces the effective antenna capacity and limits the input energy to the receiver.

Radiola Model 44

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R.F.	2.35	164	1.5	1.5	45.0	3.8	2.3	1.5
224	2 R.F.	2.35	164	1.5	1.5	45.0	3.8	2.3	1.5
224	Det.	2.35	100	6.0	7.0	50.0	.8	.7	.1
245	A.F.	250	230	6.0	----	----	34.	----	----
280	Rect.	5.0	260	---	----	----	----	----	----

Line voltage 120, set on 120 tap. Volume control maximum.

Fig. 1. The voltages shown in the above table are those for the Radiola 44, data being values derived through the use of a Jewell analyzer

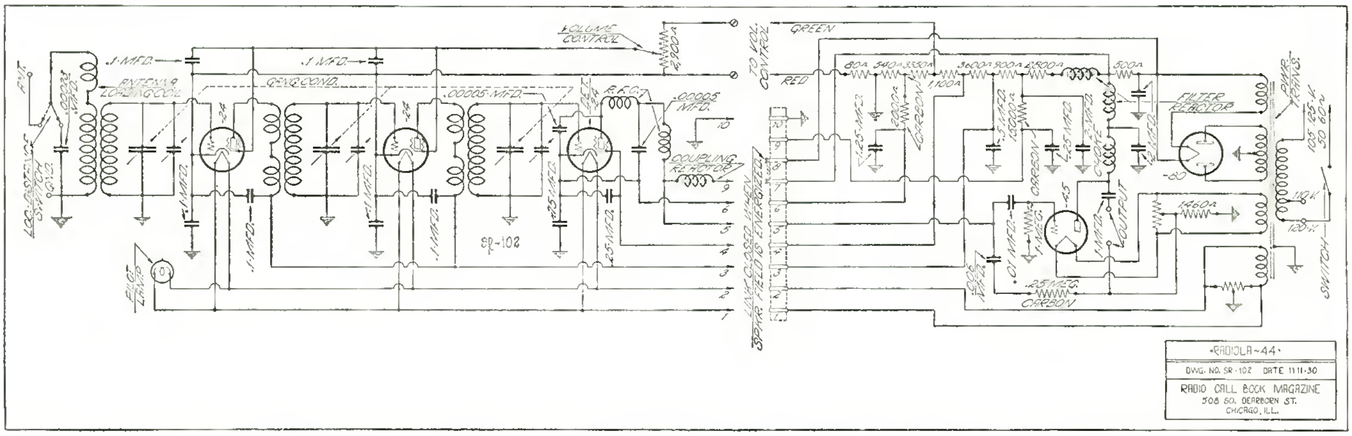


Fig. 2. The schematic of the receiver and its power unit is shown above for the Radiola 44

Westinghouse Model WR-4

ON this page are given the tube operating values and the schematic diagram of the Westinghouse WR-4 receiver, a seven-tube tuned r.f. model whose response curves appeared on page 65 of the November issue of this magazine.

Examining the circuit in Figure 2, antenna and ground are connected to each side of a 50,000-ohm potentiometer, the moving contact of the potentiometer connected to one side of the primary of the first r.f. transformer, the other side connected to ground. The action of the potentiometer is one-half the action of the volume control (the other half being in the 50,000-ohm potentiometer across the 12,000-ohm resistor, the movable arm connected to terminal 3 shown in the block in the schematic).

The secondary of the r.f. transformer is connected to grid circuit of the first 224 which is tuned by the first unit of the gang condenser. The plate circuit of this tube contains a high impedance coil inside the grid coil of the second r.f. transformer. This plate coil is of the proper impedance to match the 224 and is at right angles to the grid coil in which it is located. This is done so that the inductive coupling between these circuits is at a minimum. A single turn at one end of the grid coil is connected to the 224 and provides capacitative coupling between the circuits. The reason for using capacitative coupling instead of inductive is that the primaries of the r.f. transformer resonate at about 350 kc. with receiver capacitance and tend to increase the sensitivity at the low end of the range. Capacitative coupling has less reactance to high frequencies than to low frequencies, thereby increasing the effective coupling at the high frequency end. A combination of the two gives about equal gain throughout the tuning range.

The following two r.f. circuits function in the same manner as the one already described. The screen grid voltage of these three 224's is varied by means of the second section of the volume control. This action occurring simultaneously with the variation of input voltage to the first tube gives a positive control of volume without distortion.

The detector circuit functions as a biased-grid power detector, operating at a high plate voltage so that an output sufficient to swing the two 245 tubes to maximum output is obtained. The detector tube is operated at 250 volts plate potential and 10 volts negative bias. It will be noted that the bias reading of 1 volt for the grids of the 245's as shown in the tube operating table is the result of making this reading through a high resistance.

As the 224 detector must work into a high impedance, transformer coupling would not be suitable for coupling into the 245 tubes. Hence impedance coupling is used; one-half of a tapped reactor being in the plate circuit of the detector. This reactor is of quite high impedance and functions as an autotransformer. Two coupling condensers are used to pass the a.c. component of the detector output to the grids of the 245 tubes. Two high resistance units are used so that the proper grid bias may be impressed on these tubes.

The output of the 245 tubes is coupled to the cone coil of the dynamic through a center-tapped primary, step-down transformer.

A full wave rectifying circuit using a 280 provides the d.c. voltages necessary for the plate and grid supply of all tubes and also for the dynamic field supply. The filter circuit is of the type employed in the superheterodyne models, except that a .1 mfd condenser is used to bypass any high frequency ripple that may be present in the rectified output.

Westinghouse Model WR4

Tube Type	Position in Set	A Volts	B Volts	C Volts	Cathode Volts	Screen Volts	Normal Plate M. A.	Plate M. A. Grid Test	Change
224	1 R.F.	2.3	160	2.5	----	85	3.0	----	----
224	2 R.F.	2.3	155	2.5	----	85	3.5	----	----
224	3 R.F.	2.3	155	2.5	----	75	3.5	----	----
224	Det.	2.3	225	7.5	----	55	.5	----	----
245	P.P.	2.3	200	1.0*	----	----	25.0	----	----
245	P.P.	2.3	200	1.0*	----	----	25.0	----	----
280	Rect.	4.6	----	----	----	----	----	----	----

Line voltage 120. Volume control maximum.

*Not true reading due to resistor in circuit.

Fig. 1. The tube voltage values shown in this table are taken from the tables shown in the service manual covering the Westinghouse WR-4 receiver

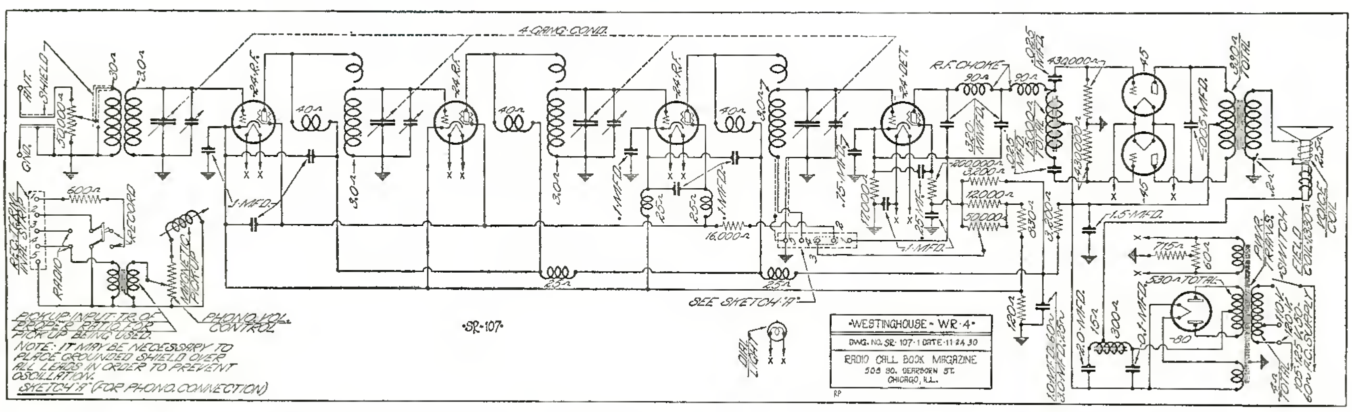
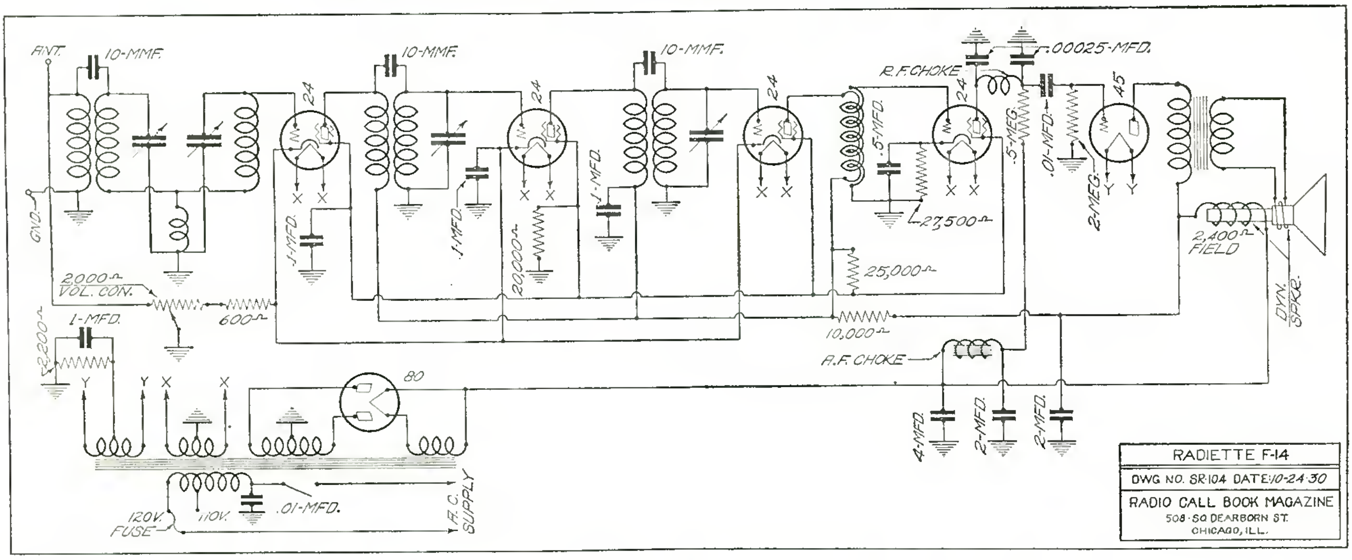
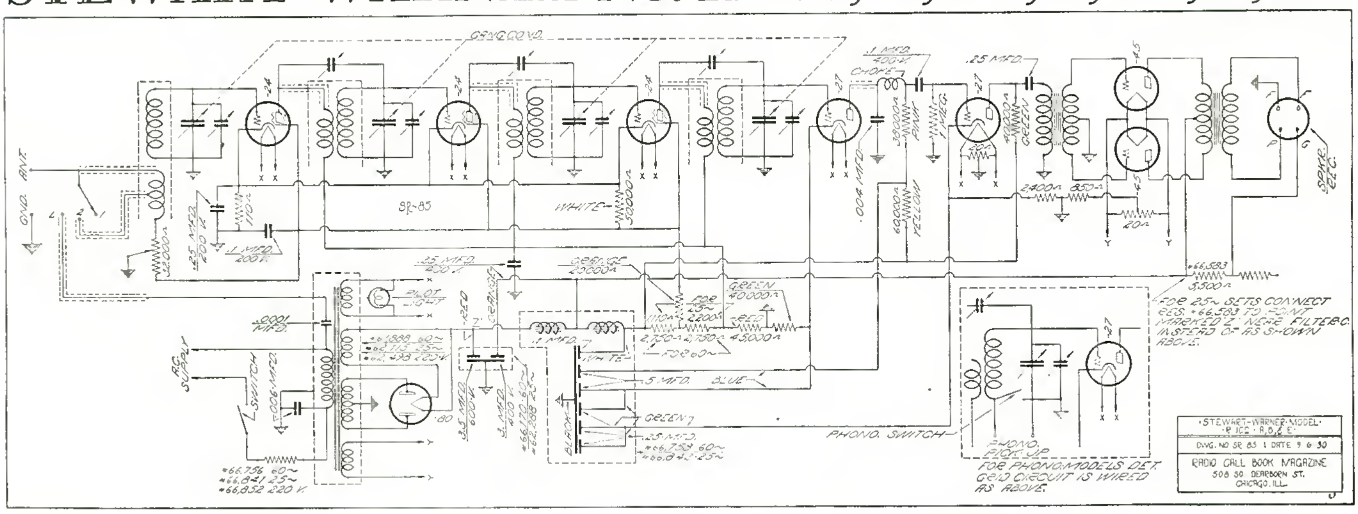


Fig. 2. The drawing here shows the electrical connections of the receiver and power supply of the Westinghouse WR-4 receiver

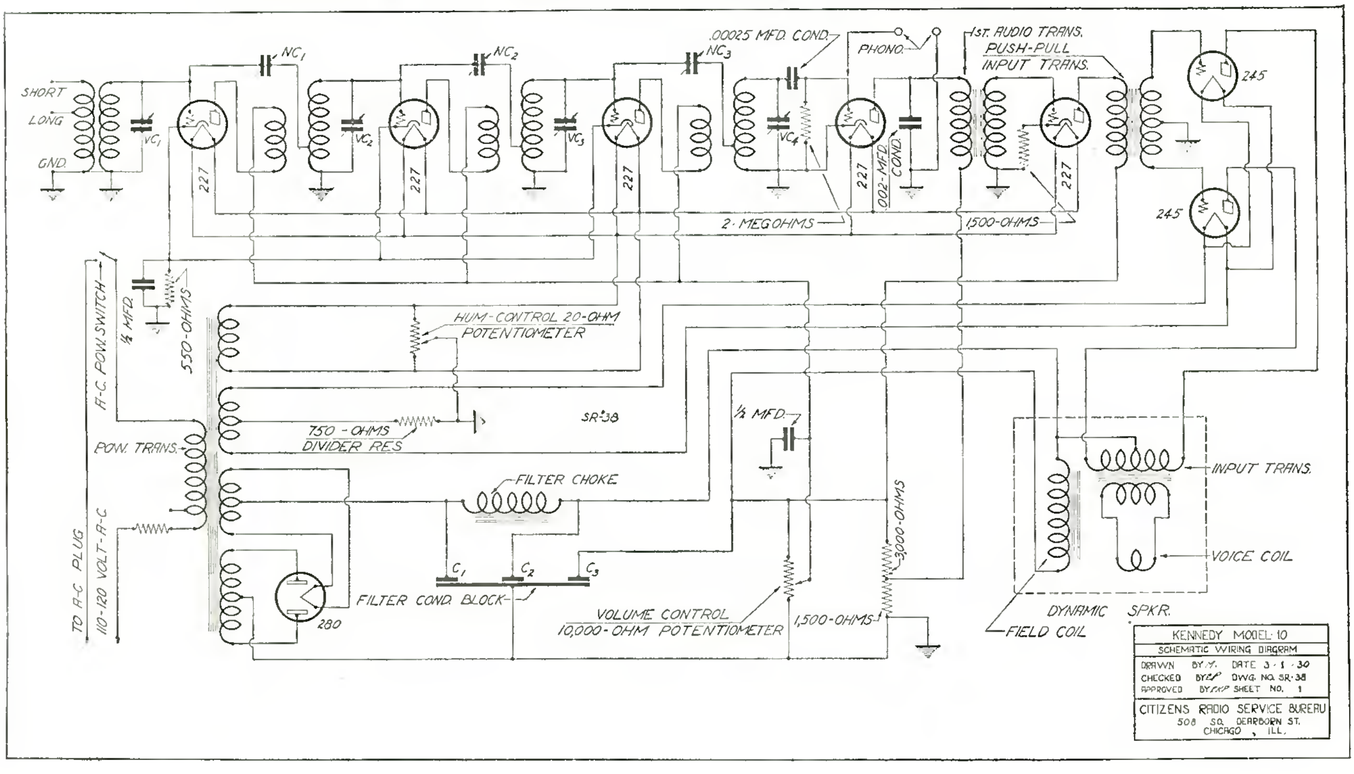
RADIETTE MODEL F 14

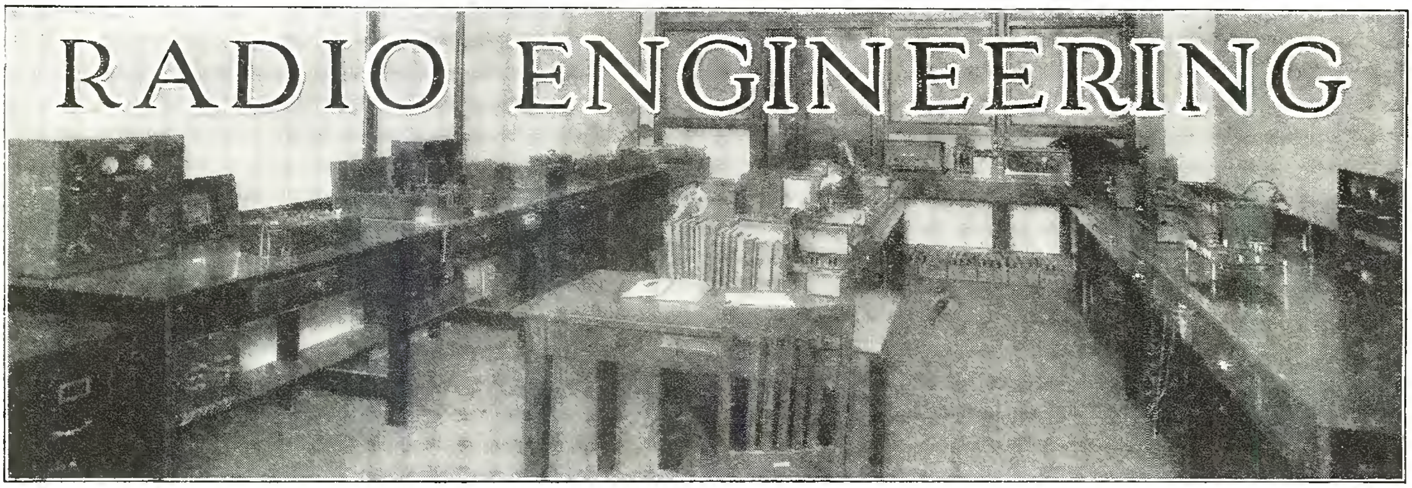


STEWART-WARNER No. R-100, A, AF, B, BF, E, EF



COLIN B. KENNEDY MODEL 10





Speakers and Theater Sound Reproduction

By Louis Malter*

Mr. Malter's paper reproduced on these pages, is reprinted from the Journal of the Society of Motion Picture Engineers, Vol. XIV, Number 6, 1930, pp. 611-622.

It is partcularly interesting to those desiring to keep pace with developments in the theater sound reproduction field.—Editor.

THE ultimate goal in theater reproduction of sound motion pictures is the complete simulation in each part of the theater of the sound originally impinging upon the pickup microphone. This goal is at present far from having been achieved, one of the weakest links in the chain between sound striking the microphone and the sound impinging upon the ear of the auditor being the loudspeaker.

At the present time the two chief types types of loudspeakers in use in theaters are the cone speaker with directional baffle and the horn type speaker.

In the following discussion the elements which measure the satisfactoriness of a loudspeaker, and the influence of these elements on the reproduction obtained from the two types of loudspeakers mentioned above will be considered. The results of certain measurements will be used to explain the quality of reproduction obtained with each type of loudspeaker in theaters.

Elements Determining Loudspeaker Performance

The extent to which a loudspeaker can deliver satisfactory reproduction is measured by five factors, which may be classified in order of importance as follows:

1. Frequency range.
2. Uniformity of response.
3. Radiation distribution characteristics.

If the pressure at a great distance from the speaker is measured at various angles with the normal to the mouth of the speaker a continuous curve is obtained. If the intensity along the normal is set equal to unity the curve obtained is defined as the radiation distribution characteristics for the particular frequency at which the measurement is obtained. The family of curves showing the radiation distribution characteristics throughout the frequency range is a measure of the quality of reproduction at various angles to the normal. The ideal characteristic is that in which the intensity is uniform for all frequencies throughout the angle defined by the entire audience in a theater at the center of the speaker mouth and which then falls off to zero very sharply outside this angle.

4. Efficiency.

The absolute efficiency of a loud-

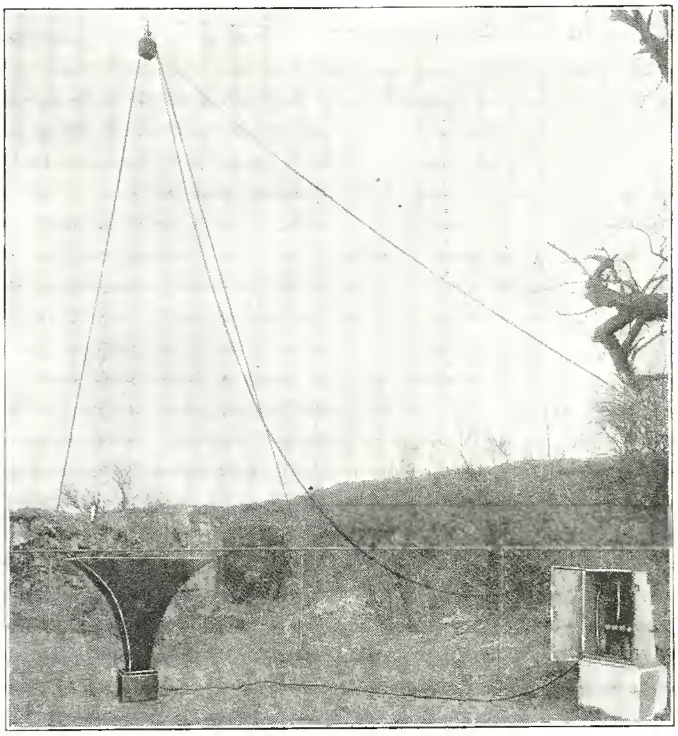


Fig. 2. This photograph shows a set-up to determine frequency response characteristics of the speaker for higher frequencies

*RCA Photophone, Inc., New York.

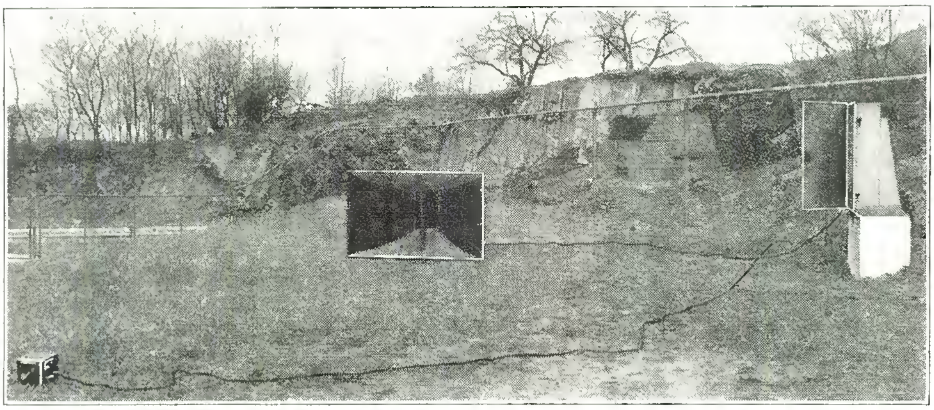


Fig. 3. Here is shown a setup to determine frequency response characteristics for lower frequencies

speaker is defined as the ratio of the total acoustic power radiated by the loudspeaker to the total acoustic power radiated by an ideal loudspeaker if fed from the same electrical source.

5. Input power capacity.

The input power capacity of a loudspeaker is measured by the value of $\frac{e^2}{4r}$, where *e is* the maximum open circuit voltage which can be impressed upon the loudspeaker terminals without producing noticeable distortion, and *r* is a resistance equal in magnitude to the impedance to which the speaker is designed to be connected.

Loudspeaker Measurements

In order to obtain an accurate and absolute comparison between the performance of the "directional baffle type" loudspeaker and the horn type loudspeaker, frequency response characteristics of the most widely used type of directional baffle type loudspeaker and of the most widely used type of horn loudspeaker were obtained in the following way.

Each loudspeaker was placed on the ground out of doors pointing directly upward and at a sufficiently great distance from buildings so that reflections from these did not affect the results obtained. A condenser microphone was suspended directly above the center of the loudspeaker mouth at a distance of 20 feet. (See Fig. 2.) The condenser microphone was connected to a sound amplifier. The entire sound measuring equipment was corrected electrically so as to possess a uniform over-all frequency characteristic.

The frequency-response characteristics obtained in this manner are correct down to a frequency at which the radiation distribution characteristic of the speaker becomes so broad that sufficient sound is reflected from the ground to interfere with the radiation shooting straight up. In order to obtain the frequency characteristic for the *lower* frequencies, the speaker is placed along the ground with its mouth pointed towards the condenser microphone, which is placed close to the ground and at a distance of 20 feet from the speaker mouth. (See Fig. 3.) In this case the phase difference at the microphone between the direct radiation and that reflected from the ground is negligibly small at low frequencies so that the actual low frequency characteristic is obtained. This low frequency characteristic, however, must be divided by two due to reflection from the ground. (The assumption of practically complete reflection from the ground has been checked by experiment.) The fact that over a certain region (300 to 500 cycles) both methods yield the identical result is a further check on the composite method.

Fig. 4 is a photograph of the beat-frequency oscillator and high quality amplifier used in making the measurements. These were set up indoors and leads run out to the speaker and the bullet amplifier associated with the condenser microphone. The recording mechanism shown permits of a rapid and accurate frequency response characteristic being taken in a few moments. A complete description of a similar sound pressure recording mechanism has been previously published.[1]

Discussion of Experimental Results

The frequency response characteristics obtained are shown in Fig. 5. In order to enable a fair comparison to be made between the frequency characteristics of the two types of speakers the two frequency response curves have been so placed as approximately to overlap in the center of the range, *i. e.*, between 300 and 800 cycles. This has necessitated raising the curve of the directional baffle type loudspeaker. (See later discussion under "Efficiency.") A careful study of these curves enables us to make a competent comparison between the two types of speakers as regards frequency range, uniformity of response, and efficiency.

[1]Wolff and Ringel: "Loudspeaker Testing Methods," Proc. Inst. Radio Eng. (May, 1927).

Frequency Range and Uniformity of Response.—It is immediately evident that the frequency range of the directional baffle type speaker is greater at both the low and high ends of the scale. The cut-off frequencies of the directional baffle type speaker are about 85 cycles and 6000 cycles at the low and high ends, respectively, whereas those of the horn type speaker are about 125 cycles and 5000 cycles, respectively. Thus at the lower end of the frequency scale the directional baffle type speaker has a half octave frequency range than the horn type and about 1/5 octave more at the higher end.

As regards uniformity of response the directional baffle type of speaker obviously has the advantage. Between 300 and 5000 cycles the response of the directional baffle type is slightly more irregular, but between these limits the variations in the response of the horn type are greater. Below 300 cycles, however, the horn type speaker is appreciably less responsive than the directional baffle type. As will be seen below, this deficiency in low frequency response in the horn type speaker is a serious defect.

Efficiency.—In order to enable a fair comparison to be made between the frequency response characteristics of the two types of speakers, the response characteristics of the two types of speakers, the response curve of the directional baffle type speaker was raised 7 decibels. In order to determine the relative average efficiencies of the two types of speakers the curve for the directional baffle type speaker was placed at its proper level, and the average response between its cut-off limits (90 and 6000 cycles) determined by means of a planimeter. The result obtained is 15.6 decibels. The average response of the horn type loudspeaker for the same input power and between the same limits is 18.3 decibels. The average straight-ahead response of the horn type loudspeaker is thus 2.7 decibels greater than that of the directional baffle type loudspeaker, for the same power input. This corresponds to a power efficiency ratio of 1.9 to 1.0. This difference corresponds to between 1 and 2 steps on the average gain control and is consequently of minor importance.

Radiation Distribution Caracteristics.—The radiation distribution characteristics of both types of speakers as now used are sufficiently good to yield satisfactory results. The distribution characteristics are fairly uniform through angles of about 20 degrees to each side of the normal to the mouth opening. In the average size of theater this is sufficient. In wider and larger houses, two or more speakers may be used, thus securing good directional characteristics as well as permitting an increase in the total amount of radiation as required by the larger size of the house.

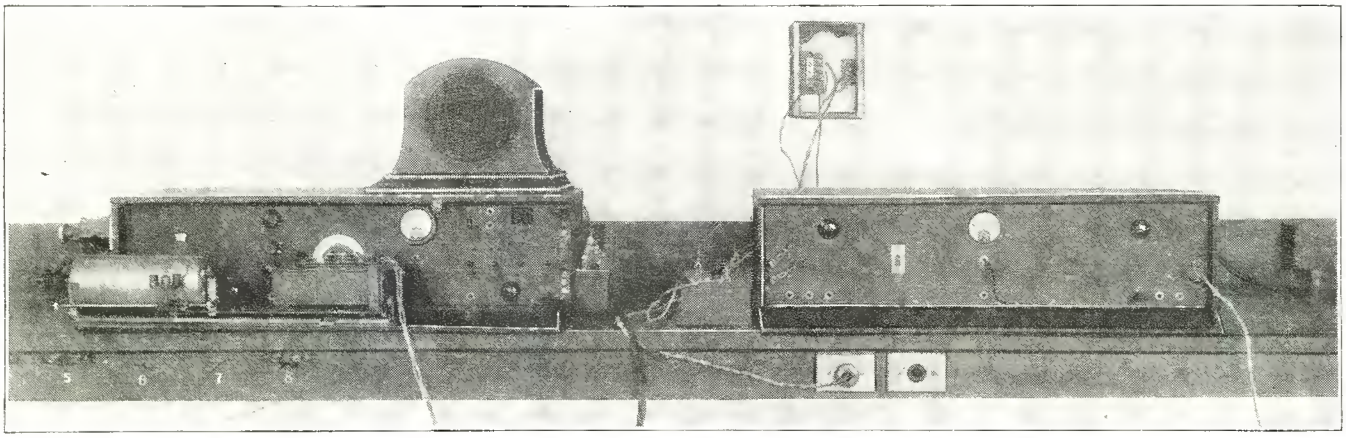


Fig. 4. This photograph shows the beat frequency oscillator and high quality amplifier used in making the measurements

Input Power Capacity.—No accurate measurements were made with respect to this quantity. However, it has been our observation that similar houses require the same number of speakers of either type for satisfactory sound reproduction. This indicates that, in view of the somewhat greater efficiency of the horn type speaker, the directional baffle type speaker has the edge in respect to input power capacity. This is what might be expected from the fact that the radiating surface of the directional baffle type speaker, *i. e.*, a cone, is much sturdier than the fragile metal diaphragm of the horn type speaker.

Results in Theaters

It is exceedingly interesting to compare the results obtained with both types of speakers on listening tests in theaters and see to what extent these results are explainable on the basis of the measurements described above.

Comparisons of this sort must be made separately for both speech and music.

If, in the reproduction of speech, we fix our attention upon the *understandability* only, we find that each of the loudspeakers is equally good. However, although speech on each of these speakers is equally understandable, the reproduction on the directional baffle type speaker is far more *natural* than on the horn type speaker. Reproduction on the horn type speaker has an unnatural quality. All voices sound very much alike whether of the same or opposite sex. Looking away from the screen makes it sometimes difficult to distinguish the sex, except from the context. Male voices, particularly, sound too high pitched and unnatural.

These results are easily explainable on the basis of the obtained frequency characteristics. It is well known that the elimination of all frequencies below 300 cycles and above 4000 cycles exerts a negligible effect upon the understandability of speech. Since, on the whole, the response of the two speakers between these limits is the same, we would expect the understandability to be the same. This is what is actually observed.

However, the characteristic frequencies of the speaking voice lie below 300 cycles. They center around 125 cycles for the male voice and around 250 cycles for the female voice. It is these "fundamental" frequencies which give to each speaking voice its individuality and distinctiveness. A lack or deficiency of the frequencies below 300 cycles will rob the voice of these characteristics. This accounts for the superiority in naturalness of speech reproduction on the directional baffle type loudspeaker. The response of the directional baffle type speaker, between 100 and 300 cycles, is considerably greater than that of the horn type speaker between the same limits. This is particularly true below 140 cycles. Around 100 cycles the difference in response is around 12 decibels.

The reproduction of music is also adversely affected by the deficiency in the response below 300 cycles. Music reproduced on a horn type speaker lacks the fullness and depth apparent in the reproduction by the directional baffle type speaker. The complete reproduction of the lower register instruments is impossible on the horn type speaker. The result is that music loses its real quality and retains merely its melody. This is particularly true for music of a symphonic nature.

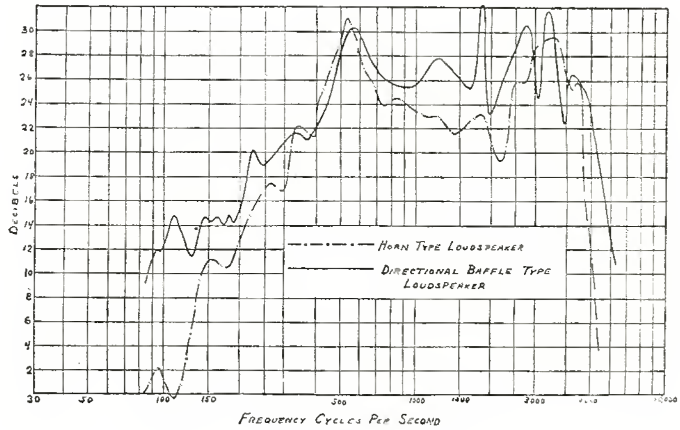
In a recent paper[2] certain statements are made in a discussion of horn and cone (or baffle) type speakers. The cone (or baffle) type speakers referred to in that paper are of a type wherein cones are set in a flat baffle, a type which is much less widely used than the directional baffle type speakers. Some of the claims made for the horn type loudspeaker are not borne out by our experiments. Thus it is claimed that the horn type loudspeaker and flat baffle type of loudspeaker are equally satisfactory as regards frequency characteristics. This may be true in theory but tests of actual devices as used in commercial practice show that the upper and lower cut-off frequencies of the flat baffle type of loudspeaker, which coincide approximately with those of the directional baffle type using the same cone, are much more widely separated than those of the horn type loudspeakers.

In addition the claim for power efficiency ratio of the horn type speaker to flat baffle type of 10 to 1 refers to a single cone in a flat baffle. In practice cones are never used this way in theaters, being either used in multiple on a flat baffle or, as is commonly the case, being set in a directional baffle. Either of these setups results in a

[2]Blattner and Bostwick: "Loudspeakers for Use in Theaters," J. Soc. Mot. Pitc. Eng. XIV (Feb., 1930), No. 2, p. 151.

(*Continued on page* 82)

Fig. 5. This graph shows the relative frequency response characteristics of the two speakers, the dotted line being the horn type, and the solid line the directional baffle type



Locating Internal Noises in Receivers

(*Continued from page* 55)

will also cause excessive regeneration or oscillation, even though the set is neutralized. The better the shielding in a set, the more amplification we can get out of it and still have the set stable. But there is a definite limit to this amplification. Now if there are any conditions which tend to increase this amplification, feed back and oscillations will occur with resultant noise. One of the causes of this is excessive plate voltage and in case of screen grid tubes—excessive screen grid voltage.

III. One important object of shielding is to prevent coupling from one coil to another. Manufactured receivers are supposed to have satisfactory shielding. Trouble frequently arises when the shields are not securely in place. Shields may not be properly grounded. The shielding should, therefore, be examined to make sure it makes perfect contact.

IV. Open by-pass condensers. Plate by-pass condensers are employed for the purpose of eliminating the coupling which is always present in the plate supply. If by-pass condensers of any sort become defective or short circuited, they are likely to cause noise.

By-pass condensers are connected across grid bias resistances. If these by-pass condensers are open, oscillation will result. Condensers suspected of producing noise should be thoroughly checked with a d.c. potential of from 200 to 500 volts. Connect the condenser across any d.c. potential lying between the above values and then short circuit its terminals. If not defective, a spark will be produced. This applies only to by-pass condensers having a capacity of above .25 mfd.

A. F. Regeneration Noises

Under this we will consider motor boating as well as other possible sources of noise.

The following noises are frequently encountered in audio frequency systems:

1. Coupling between speaker leads and detector grid circuits. If the speaker, a.c. line or plate leads are near any part of the detector grid circuit, they may cause squealing. The remedy is obvious. Keep all leads as far away from the detector grid circuit as possible.

2. An open plate circuit in the detector will cause a howling noise. Tracing back over the plate circuit will of course establish the fault.

3. Open grid circuits will cause squealing noises. Open grid circuits may be caused by open secondaries of audio transformers, open grid bias batteries, open grid bias resistors, or open grid return connections. This condition is generally indicated by an absence of grid bias on the audio frequency tubes.

4. If the trouble is due to motor boating, it manifests itself by a steady "put put" sound resembling a motor boat in action. This is due to a low oscillatory feed-back in the eliminator or power pack circuit. To eliminate this, connect large by-pass condensers across each of the voltage dividers to ground. By-pass condensers of about two microfarad capacity can be connected between the plate circuit and filament circuit to reduce motor boating.

Noises Due to Tube Howling

Microphonic tubes often cause a ringing sound in the loudspeaker gradually increasing in intensity, which is generally caused by the vibration of the tube elements in the detector or audio frequency stages. This vibration causes the plate current to change very rapidly and the change in plate current is transmitted through the set resulting in the ringing sound. It is usually sound waves coming from the speaker that set the tube into vibration.

Special heavy weights can sometimes be placed on microphonic tubes to prevent them from vibrating. An application of several turns of friction tape around the top of a tube will sometimes reduce a microphonic condition.

In most cases it is best to rearrange the tubes until you find one that is not microphonic. In the modern receiver, microphonics are rarely encountered and are most always due to a defective tube.

Further Notes on Mechanical Noises

1. Sputtering, snapping noises—these noises are caused by electric sparks due to the breakdown of insulation in some part of the circuit. They can be heard even with the loudspeaker disconnected and are invariably due to defective insulation either on wires or the terminal strip. Where this occurs, separating the wires or cleaning terminal strips is the only remedy. A visual inspection while the set is operating will reveal where the breakdown occurs.

2. If there are any loose parts in the receiver such as loose screws and nuts, these parts may be set into vibration when the loudspeaker is in operation. Noises thus developed are clicking, rattling, metallic noises. The remedy, of course, is to tighten up these parts.

3. If the power transformer vibrates or hums excessively, tighten the clamps which hold the transformer core. If the windings are loose, wedge them by means of bakelite or dry wood spacers.

Speaker Noises

These noises are mechanical in origin and consist of rattles, clicks and scratches. In most cases the defect can be established by visual inspection. The two main types of speakers in use are the magnetic and dynamic. Most troubles will be found to be in dynamics, as more dynamics than magnetics are in use.

In the case of a magnetic speaker, we generally have more moving parts, such as springs, driving pins, and more soldered connections. There are always two or three soldered connections on a magnetic speaker and they are likely to develop noise. Connections should be examined carefully and the cone and driving pin moved back and forth to see that the driving pin does not slip through the solder.

The most common trouble in dynamic speakers is caused by the voice coil dragging against pole piece. This produces scratching and distorted sounds and is easily recognized. Some dynamic speakers have an adjusting screw attached to the center of the electromagnet, which in turn is mechanically connected to the voice coil of the speaker by means of a bakelite strip which is called the spider. By adjusting the screw that is attached to the pole piece, the position of the voice coil can be varied in relation to the pole piece. This screw should be adjusted until the voice coil does not touch the pole piece at any point. A thin piece of paper inserted between pole piece and voice coil can be used to gauge the distance between the two.

Sometimes dust and foreign particles get between the pole piece and the voice coil and these in turn cause certain noises. One effective way of removing these is to use a blower from an ordinary vacuum cleaner. Before using the blower, however, turn it on to be sure that no dirt is in the pipe. Then allow the full force of air to blow between the voice coil and pole piece, moving the diaphragm up and down at the same time with your hand. This generally removes all dust from this point.

Examine the cone both at the voice coil and outer edge. If it is torn or uncemented, use ambroid cement, which can be obtained from most speaker manufacturers. If the leather strip or chamois skin is hard in spots, rub it with your fingers on each side until it becomes soft and pliable.

Tracing Noise

The best instrument which can be employed as an indicator of noise is a good speaker or headset, because, in the last analysis, what you hear is what counts. It is of the utmost importance, however, that the speaker or headset be in good mechanical condition.

The most frequent sources of noise are varying resistors, intermittent contacts or shorts. An ohmmeter and continuity tester are frequently of great assistance in detecting these. Intermittent contacts can be quickly established by using the continuity tester shown schematically in Fig. 2. This consists of a voltmeter connected in series with a 4½-volt C battery. When the two test leads are connected across the terminals of the resistor or the apparatus under test it will read less than 4½ volts.

If the meter needle flickers between certain values it indicates a varying resistance and that part of the circuit should be most carefully checked.

In checking the condition of resistors do not bear down on the resistance but pull up with your test leads. This will serve to strain the connection and if an intermittent contact is being made it will show up when making this test.

Stage by Stage Elimination

If it is determined that the noise is internal it is necessary to locate the particular circuit which is causing the trouble, namely, whether it is in the audio or radio frequency system, the detector or power pack and in which particular stage the trouble arises. The best method to follow here is the stage by stage elimination process. In this method one stage is added at a time and observation made when the noise comes in. All tubes should be kept in operation. This method of test assumes that the aerial and ground system is in perfect mechanical condition and that it is not itself a source of noise.

Assume now that the noise is internal. Therefore, disconnect the aerial and ground. The noise should still be present. Then, short circuit the grid or grids of the output tubes. This immediately disconnects all tubes ahead of the output tube or tubes. If noise is still present, it means that the source of trouble is in the output stage or in the voltage supply or the speaker and these should be examined carefully.

If noise is not present, the output stage and voltage supply for these tubes is O. K. Now add the first audio frequency stage by disconnecting the short on the grid of the output tubes. Short circuit the grid of the first r.f. tube. If noise comes in now it is in the first audio frequency stage or voltage supply to this stage. These circuits should be critically examined. If noise is still absent, both these stages and their associated voltage supplies are O. K. Next, remove the short circuit from the first audio frequency stage and short circuit the detector grid. Proceed this way until the source of trouble is definitely located in a particular circuit. Knowing the circuit in which the trouble is present, it is a simple matter to make corrections. When each radio frequency stage is checked and the grid of each radio frequency stage is shorted, rotate the variable condenser to see whether this introduces noise. Frequently, the variable condenser plates may short at some point and cause noise. This test should be made with each radio frequency stage shorted so as to determine which particular variable condenser is causing the trouble if any.

Visual Inspection

Keen visual inspection is one of the simplest and most effective means available for the serviceman's use in locating ordinary sources of noise. In this method. No instruments, other than the serviceman's eyes, are needed but he must exercise his powers of observation. A visual examination of the wiring of the set will show connections which are loose or unsoldered, soldered joints which are corroded or resinous, insulation which is punctured or mechanically injured, tube socket prongs which are bent and make imperfect contact and so on. The possible sources of trouble causing noise which can be detected by the observant eye are many. One of the first steps to be taken by the serviceman therefore, is to examine critically the wiring and construction to see what defects can be found.

Increasing the Utility of D. C. Meters

(*Continued from page* 51)

resistance of 1500 ohms. This same scale may be used for other values of voltage and calibrating resistance by using the multiplying factors shown in the table.

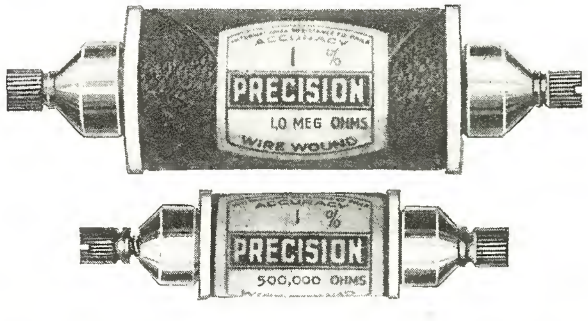


Fig. 7. Here are shown two of the different types of precision units used in the applications mentioned by the author

It is of course essential in all these arrangements that resistors having a high precision be employed in order that the accuracy of the meter be maintained. Figure 7 shows some of the different types of precision units which have been used in such applications.

New Tubes Reduce Distortion and Cross-Talk

(*Continued from page* 43)

that with a given extra signal voltage the cross-talk for the 551 will be only 1/500th that of the 24 type.

Figures 5 and 4 bring out the important fact that for reduction of cross-talk, attention must be paid to the tube parameters at large transconductance (low negative bias) whereas in the case of distortion, the control diagrams Figures 2 and 3 show that their proper adjustment at lower values of S_m is of more importance.

Briefly the 551 tube not only renders unnecessary the use of double pre-selectors for reduction of image response but in most circumstances is considerably more efficacious in reducing cross-talk. Over a large range of signal voltages the cross-talk of the 551 is of the order of 1/100th to 1/500th that of the ordinary 224 tube. In order to obtain this same improvement with 224 tubes by means of a preselector comprising a chain of resonant circuits of normal selectivity with an extra signal 20 kc. from the desired signal, at least three tuned circuits would be required.

Figure 6 shows the grid-plate transfer characteristic of an ordinary tetrode of the 24 variety. To raise the input voltage at which distortion appears the design could be changed so as to decrease the mu-factor of the tube, thus spreading out the range of grid voltages and obtaining a characteristic of the type shown at A. This however, entails a sacrifice in transconductance and amplification at the initial bias if the plate current at this point is adjusted to the same value. If the transconductance at the initial bias is to be maintained at the same value instead, then an increase in plate current must be tolerated as shown by the characteristic B.

A way out of this difficulty is shown in Figure 7. The amplifier stage in 7-a comprises two tubes in parallel. Of these tubes (A) is of the high-mu type and B is of the low-mu type. The high-mu tube A yields high amplification but can handle only small input voltages; the low-mu tube B yields low amplification but can handle high input voltages. In combination the two tubes complement each other to produce a characteristic of the desired type, 7-b, solid line.

How It's Done

For reasons of economy it is desired to incorporate this principle in a single tube structure. One way of accomplishing this is where the control grid is divided into two sections which are mounted with a gap between them. At low negative biases the entire cathode is operative and the tube has about the same characteristics it would have if the gap were not present; as the grid bias increases negatively the electron current through the upper and lower parts of the control grid are cut off, leaving a low-mu control through the gap. At these bias voltages the tube acts as if the upper and lower sections of the control grid were formed of solid metal and controlled the current through the gap in the ordinary manner. Gaps may also be placed at the ends of the cathode instead of in the middle.

Design Data on H.F.L. "Little Giant"

(*Continued from page* 39)

curve shown approximates the ideal toward which all speakers strive, and, when supplied from an adequate audio channel, provides a marked increase in fidelity.

The accompanying photograph indicates the constructional features of the whole receiver, and its one piece construction, including the speaker. The space at the right side of the tuning dial accommodates the remote control mechanism—not shown in photograph—which, in two distinct types, permits selection of 6 stations or complete remote tuning of any station which could be tuned by hand at the set dial.

Complete performance curves of the entire receiver, and its wiring diagram, will be shown in forthcoming issues, together with other notes and data on components which may be of interest.

(To preserve uniformity, the curves, etc., accompanying this article have been drawn on our standard paper.—*Editor.*)

Lincoln DC-8 Designed For Use With New Breather Battery

(*Continued from page* 41)

thanks to the development of the 2 volt low drain tubes which are now available, and the National Carbon Co. "breather" A battery. To those living in d.c. districts, 25 cycle districts, and the outlying districts where no power lines are available, the Lincoln DC-8 will be a great boon. The highly engineered features in this equipment should make possible extreme selectivity, coupled with high amplification and sensitivity. The "A" supply gives consistent service for one year without charging or inconvenience, being vitalized by oxygen taken from the air, and the low 16 mill ampere drain on the "B" supply makes possible the use of dry "B" batteries.

Another very desirable feature of the Lincoln DC-8 design is the elimination of interference ocming over the a.c. line; being absolutely independent from this source.

General Design

The design of the Lincoln DC-8 incorporates every known development of Lincoln equipment. Assembled on a cadmium steel base $8\frac{1}{2}$x15 inches, it is small enough to be mounted in an automobile if desired. There are four Lincoln high gain intermediate transformers of the tunable type. The tubes required are four of the 32 type 2 volt screen grids; three 30 type and one 31 amplifier. Mounted in the rear are spaced wound antenna and oscillator coils of the plug-in variety, convenient for the experimenter to use any high frequency short-wave coils he desires to experiment with. Controls on the front panel are simple to operate, the volume control being of the screen grid voltage regulation type and is of wire wound construction. The phone tip jacks are conveniently located in rear of chassis together with antenna and ground binding posts.

80 Meter Band

Working on entirely new principles, the Lincoln DC-8, by simply throwing a switch, will tune the interesting 80 meter amateur phone band, covering 60 degrees on the dial as easily as broadcast, utilizing only the standard broadcast parts throughout. Due to the pure d.c. current utilized, the amateur phone band comes in clear as there is no 60 cycle modulation.

The compact size of chassis allows assembly in small con-
The antenna requirements are only from 15 to 20 feet long sole with heavy motor type speaker and battery equipment. and can be easily located in any living-room.

Speaker and Theater Sound Reproduction

(*Continued from page* 76)

marked increase of efficiency. A comparison of a horn type speaker with a single cone is thus not representative of the relative characteristics of standard apparatus.

The radiation resistance characteristic shown for a horn type loudspeaker with a 50 cycle cut-off is not typical of the horns employed in practice. The construction of a horn with so low a cut-off is very expensive and the size of the horn would probably be such as to make it large for the average theater. Aside from these considerations, the smooth cut-off shown is attainable only with an infinitely long horn, that is, attainable only with the unattainable. The frequency characteristic of a finite horn always exhibits horn resonances such as those which appear on the actual horn characteristic given in Fig. 5. In addition, as has been shown above, considerations of efficiency favor the horn type of loudspeaker only to a slight extent.

Conclusions

The above results can now be summarized as follows: In power handling capacity the two speakers are about the same. In efficiency the horn type speaker is somewhat superior. The directional characteristics of both types are satisfactory. As regards frequency response characteristics, the directional baffle type speaker is markedly superior to the horn type in the reproduction of both speech and music. On the basis of these factors it appears quite conclusively that for theater reproduction, of the commercial devices in use at the present time, the directional baffle type loudspeaker yields more satisfactory results.

W9XF Short Wave Transmitter

(*Continued from page* 40)

that WENR, operating on 870 kilocycles, could be heard on 800 and on 940 kilocycles. As this could not be attributed to any harmonic of the 870 kilocycle frequency, the cause was somewhat of a mystery. Upon investigation, we found that this condition existed only when the 870 kilocycle and 6,020 kilocycle transmitters were in operation simultaneously. Furthermore, that unless both stations were transmitting the same program, no intelligible modulation could be detected.

Manifestly, this phenomenon was caused by a combination of the two frequencies. The sixth harmonic of 870 kilocycles is 5,220 kilocycles. The combination of this frequency with the 6,020 kilocycle frequency, produced a beat frequency of 800 kilocycles. This 800 kilocycle radiation was picked up by the grid leads of the main power amplifier on the fifty kilowatt set and broadcast, but of course, very little power was radiated at this frequency.

The eighth harmonic of 870 kilocycles, is 6,960 kilocycles.

Grids Were Shielded

The combination of this frequency with 6,020, results in 940 kilocycles. This frequency we found to be causing trouble on the grid circuits of the intermediate power amplifier of the fifty kilowatt set. The power radiated on this frequency seemed to be much lower than the 800 kilocycle radiation and caused less trouble than the other, due to the fact that 940 kilocycles is a regional channel.

The obvious remedy for the trouble was to shield the grid circuits, or trap out the stray frequencies. Neither of these methods was easy to accomplish with such a high powered transmitter. The shielding method was finally adopted and proved to be perfectly satisfactory.

It is probable that this trouble would not have been detected were it not for the fact that both stations were transmitting the same program. Undoubedly, there would have been a heterodyne caused on both the 800 and 940 kilocycle channels but the source of the interfering carrier would not have been known. It is possible that some of the stray heterodynes heard in the broadcast band originate from similar causes. The interfering transmitters need not be located in the same building, as we found that the 6,020 kilocycle power was delivered from the antenna 600 feet away. With the antenna disconnected, the transmitter and transmission line could be operated without interfering with the 870 kilocycle transmitter. The building which houses both transmitters has a double copper screen enclosing all four sides, ceiling and floor of the transmitter room. Therefore, it is possible that a short wave transmitter located some distance away from a broadcast station, may be causing interference within the broadcast band.

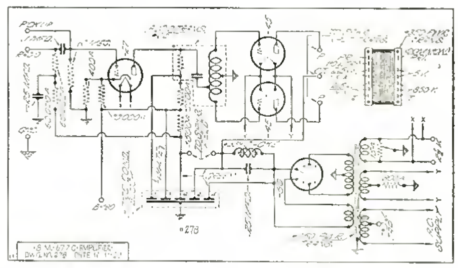
Silver 714 A.C. Superheterodyne

(*Continued from page 44*)

Band Widths

Times field strength	*Kilocycles wide* 600 kc.	1000 kc.	1400 kc.
10	7.0	7.0	7.0
100	10.0	11.2	11.2
1000	14.5	17.5	17.5

It will be noticed that the fidelity curves (electrical fidelity) are shown in solid lines covering a portion of the range, the solid lines indicating measured values, while the dotted lines indicate projected values.



The power supply schematic is shown in the drawing. The first audio, the two 245 tubes in push-pull and the 280 rectifier are placed in the power supply unit which is connected to the 714 tuner by means of a cable.

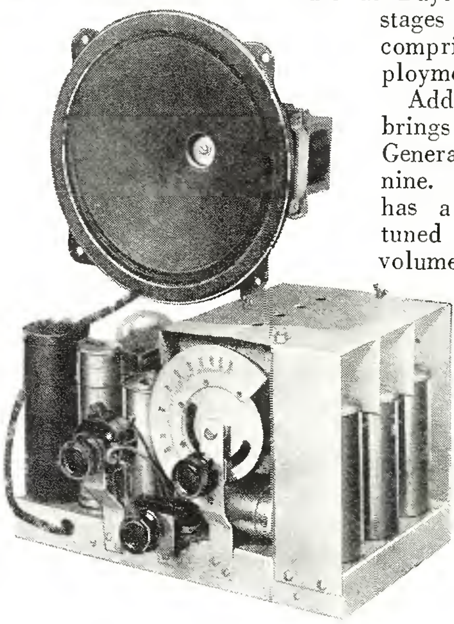
Field Strength Effect on Receivers

(*Continued from page 37*)

ceiver. This is due to the fact that not only is the received signal from the local station reduced, but it is made necessary at the same time to operate the receiver with the volume control turned near maximum. This is an advantage because on most sets the volume control operates by increasing the grid bias on the rf. amplifier tubes for low volume. Under this condition of high bias on rf. amplifier tubes they are approaching a condition where their detection efficiency is high and since this efficiency increases as the volume control is turned towards the low side it can be seen that the higher the volume control can be turned to give the desired signal strength, the less the local station will interfere with the reception of weaker stations.

General Motors Midget Out

USING four 224 screen grids, a 245 and a 280 rectifier, the "Little General" has just been put on the market by General Motors Radio at Dayton, Ohio. Three r.f. stages and a power detector comprise the screen grid employment.

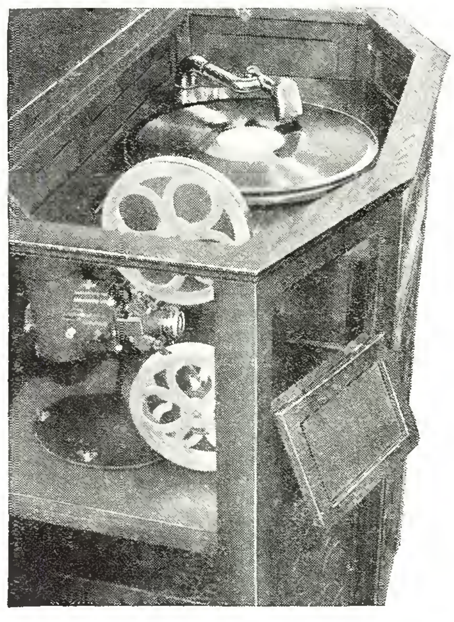


Addition of this model brings the total number of General Motors sets up to nine. The "Little General" has a tone selector, four tuned circuits, and a dual volume control. All screen grid tubes are shielded as are gang condenser sections. A photograph of the chassis is shown nere. Response curves will probably appear in a later edition of this magazine. Speaker used is of the dynamic type.

Filmophone Radio Announced

AND now comes the last word in home entertainment, consisting of home talkies, home movies, the radio and the phonograph in one combination instrument, according to a release by the Bell and Howell Co., Chicago, covering their recently announced Filmophone.

A Bell and Howell Filmo movie projector, utilizing the regular 16 mm. home movie size film, is used for the pictures and a Howard chassis is the basis for the radio feature.



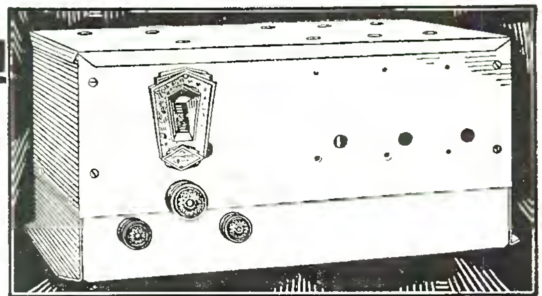
A phonograph motor is so arranged that the turntable can be operated at either the standard speed for ordinary phonograph records, or at 33⅓ revolutions per minute when the records for the sound pictures are played.

The flexibility of the new combination is such that talkies and also

(*Continued on page* 87)

SM

Now You Can Have *Seventy Stations* in Twenty Minutes!



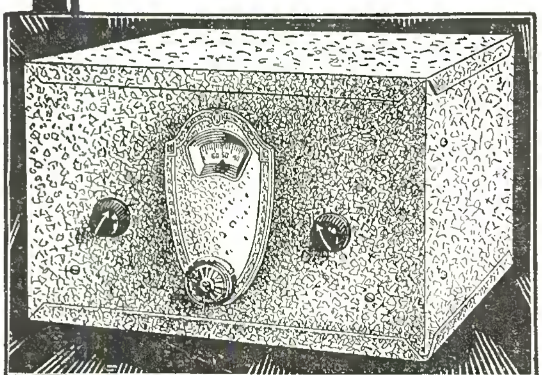
S-M 714 *Superheterodyne* Tuner

The 714 *Superheterodyne* Tuner is the finest piece of radio equipment it is possible to produce today—just as the famous Sargent-Rayment 710 was the "boss of the air" in its day. A stock model in the Silver-Marshall Main Laboratory at Chicago brought in clearly and distinctly, and at room volume, *ninety-three* stations, one after the other, including Cuba, Mexico City, and *every* station on the west coast that was on the air! Over a period of a month you should be able to log every station in the call book that is within reason.

The 714's excellence isn't an accident—it is the result of two years of painstaking development in the great S-M Laboratories under McMurdo Silver's personal supervision. It contains eleven tuned circuits (over twice as many as the most expensive t. r. f. sets): two, in a dual-selector, precede the first '24 r. f. tube, two are between the r. f. and '24 first detector, and one is in the '27 oscillator circuit. It uses a factory-aligned and tested 443 screen-grid i. f. amplifier, having in itself six tuned circuits. Imagine, if you can, adding six more tuned circuits to the 710 or 712—and all six tuned to a single frequency!

Tubes required: 4—'24's, 2—'27's.
Price (tuner only), completely factory-wired, tested and RCA licensed, less tubes................$87.50 *List*
Component parts total..$76.50 *List*

The 714 Superheterodyne Tuner can be used with any standard audio amplifier but operates at its maximum with the S-M 677B. It is a combination two-stage amplifier and power supply. It furnishes the necessary heater and plate supply for the 714 and takes its power from any 105-120 volt, 50-60 cycle source. Tubes required: 1—'27, 2—'45's, 1—'80.
Price, completely factory-wired, tested and licensed, less tubes..............................$82.50 *List*
Component parts total..$68.50 *List*



Foreign Programs in Your Home

The S-M 738 Converter turns *any* broadcast receiver into a short-wave *superheterodyne* with a range of from two to ten thousand miles, for to every bit of the sensitivity and selectivity of your broadcast set, is added the power of *three more tubes!*

There is nothing that the most expensive commercial short-wave receiver will do, in the way of distance, that the 738 will not duplicate and beat—and at one-third the cost. Under favorable weather and local receiving conditions, it will bring in every American short-wave broadcaster and the principal foreign stations.

It is built in a beautiful black crystalline case with a hammered silver dial—entirely at home in the finest living-room.

The wired model can be hooked up in three minutes—you merely remove the antenna lead from the broadcast receiver and connect it to the antenna post of the converter; then run two leads from the 738 to the antenna and ground posts of the broadcast set—and tune it in. A switch can be easily arranged to throw the set from long to short waves at will.

It tunes by a single dial (which tunes the oscillator circuit) and an auxiliary midget condenser.
It will give, in addition to short-wave broadcasting, phone and i.c.w. where there is any carrier modulation at all.
Included in the list price are eight coils (four pairs) which cover the wave length range of from 18 to 206 meters.
Tubes required: 1—'24, 1—'26, 1—'27.
Price, completely factory-wired, tested and RCA licensed, less only tubes.......................$69.50 *List*
Component parts total..$59.50 *List*

Get Your Free Copy of the S-M General Parts Catalog

Check the coupon for your copy of the SILVER-MARSHALL 1931 GENERAL PARTS CATALOG. The Radiobuilder, Silver-Marshall's official publication, tells the latest news of the great S-M laboratories. Fill in the coupon for a sample copy.

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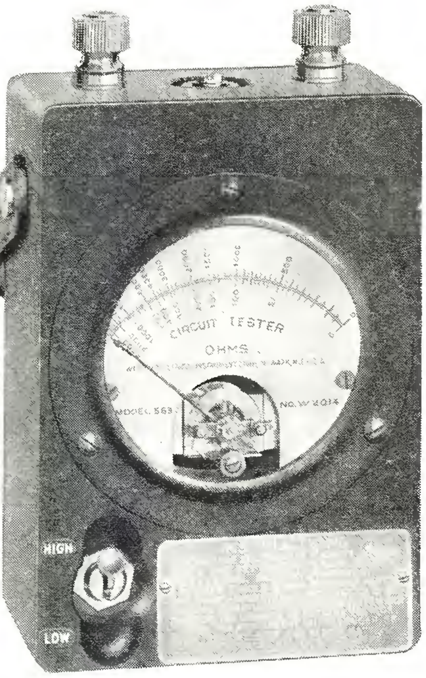
Silver-Marshall, Inc., 6413 W. 65th St., Chicago, U. S. A.
----Send me, free, your NEW 1931 CATALOG with sample copy of the RADIOBUILDER. Also Data Sheets as follows: (*Enclose 2c for each Data Sheet desired.*)
----No. 25. 714 Screen-Grid Superhet Tuner.
----No. 23. 738 Short-Wave Superhet Converter.

Name..

Address..

NEW PRODUCTS FOR THE TRADE

New Weston Circuit Tester



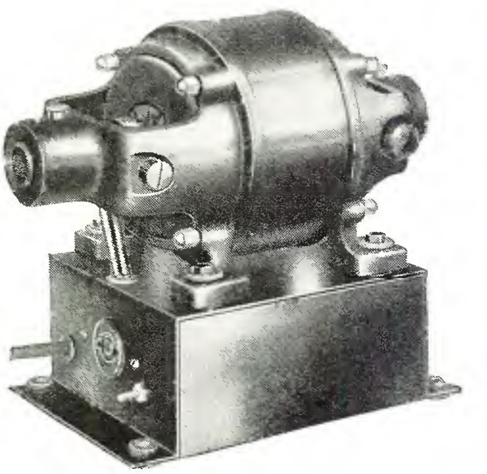
At the right is to be seen the model 563 d.c. circuit tester, just announced by the Weston Electrical Instrument Corp., of Newark, N. J.

This model is for checking resistance values and continuity of circuit during the process of manufacture, and for service and installation work on many types of electrical apparatus.

Accurate within 2 per cent, the 563 is compact, self-contained and portable. It uses a Weston 301, 3¼-inch diameter meter with two resistance ranges, 5,000 and 50,000 ohms, a 1.5-volt flashlight cell, a leather strap carrying handle, and a pair of 30-inch leads with test prods.

Janette Rotary Converter

The Janette Manufacturing Co., of Chicago, announces their new type CA-20-F rotary converter shown in the photograph at the left.



This unit has a capacity of 110 watts, sufficient for the majority of a.c. sets now on the market. It is a quiet, dynamically balanced unit which will operate an a.c. set without ripple or hum. It is available for 32, 115 or 230 volts d.c. The unit is complete with filter, cord, plug and d.c. receptacle.

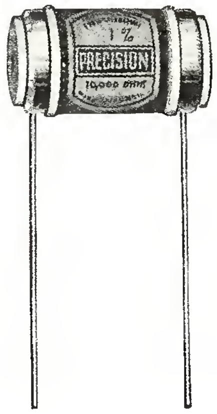
Kellogg Hand Microphone

Among the several new products designed for broadcasting, home recording, experimenting and amateur work, recently announced by the Kellogg Switchboard and Supply Co. of Chicago, is the No. 29 hand microphone illustrated at the right. It is only 6½ inches in length, and weighs about 10 ounces. Despite its small size, it is sturdily constructed and reproduces throughout the musical scale with fidelity.

Engineers of the company have also designed a modulation transformer to be used with the hand microphone, the transformer having input for either single or double button microphones, the output of the transformer being matched to the input impedance of standard amplifying tubes on the market.

The microphone may be used in standard broadcasting, public address systems, amateur work, or in home recording wherever a reliable, sensitive and inexpensive "mike" is required.

International Wire Wound Resistor



Shown at the left is an illustration of the precision wire wound resistor recently placed on the market by the International Resistance Co., of Philadelphia, Pa. The moulded end contacts are to prevent open contacts, a trouble formerly occurring in the spot soldered or spot welded joints.

The pigtail connections make for ease in assembly. These resistors have numerous other unique features that are explained in the new catalogue recently published, which will be sent on request by writing the service department of the company at 2006 Chestnut St., in Philadelphia.

(*Continued from page 84*)

movies without sound can be projected. The pictures may also be shown with radio or phonograph musical accompaniments not synchronized with the film. Of course the radio or phonograph are available each by itself if desired.

A large number of home talkies subjects can now be secured from photographic dealers. Among these are the always amusing "Felix, the Cat" cartoons, as well as numerous other entertaining and instructional features.

Chromatrope Uses Two Speakers

ILLUSTRATED in this article is the Chromatrope recently announced by the Oxford Radio Corporation of Chicago, which makes use of two speakers, both dynamics. In the photograph the upper speaker is most efficient on the higher frequencies while the lower speaker is most effective in the rendition of the lower frequencies. The designers place the two speakers, one above another, in a console eighteen inches in depth to provide a longer air column, enabling the low note speaker to reach low fundamentals which might otherwise be difficult.

Included in the receiver is a tone balancer consisting of an

audio choke, two condensers and a variable resistor. The variation of the resistance raises or lowers the amplitude of the low frequency response, but does not affect the high frequencies, the response from the speaker being very pleasing.

In the photograph it will be seen the tuner portion of the set is on the top shelf, and the amplifier and power supply located on the bottom shelf. The receiver is a licensed tuner, using three 224 screen grids, two 227's, two 245's and two 280's making a total of nine tubes. A local-distance switch is used, as well as a volume control.

G-M Photoelectric Relay

THE G-M Laboratories, Inc., Chicago, have recently completed the development of a compact photoelectric relay and light source for application to many industrial and commercial operations. It is known as type G-M No. 1281

(*Continued on page 88*)

(Continued from page 87)

and is essentially an electric switch controlled by means of a beam of light. Any interruption of this light beam operates the switch which can control any electrical devices desired.

The application of this unit is meeting with wide acceptance for counting parts on conveyors, inspecting work on presses, operating safety devices, timing of operations. In operation the light from the upper lens is reflected from the remotely placed mirror to the lower lens, where it is received by the photo-electric cell. Any interruption of this beam of light by any object causes the relay contacts to close, thereby operating a counter, power switch, signal or other device. The Visitron protoelectric cell single stage amplifier, light source and other essential parts are completely enclosed in a drawn steel case. Installation of the unit is quite simple since it is only necessary to connect the unit to a 110 volts 60 cycle line.

Commonwealth Announces Models

THE Commonwealth Radio Mfg. Co., of Chicago, announces an attractive line of superheterodynes, consisting of three models, model 91 a low boy, model 92 a high boy, and model 93 a phonograph combination. The chassis is compact in design, the power pack being integral with the tuner. Tubes used are four 224, two 227, two 245 and one 280. Output of the receiver is handled by the new Trimm, Jr., stadium speaker. Tone control is also included. The cabinets are designed along the latest vogue, stressing a simple beauty that pleases all.

This same concern announces a new line of 6 tube receivers bordering on the midget class but with a little more advanced design. Unusual sensitivity and selectivity are the two features of this chassis. The tubes are four 224, one 245 and one 280. New type "Litz" bank-wound coils are employed. The Utah midget dynamic speaker is perfectly matched to this chassis and renders good tone. The line consists of model 13 mantle cabinet, model 14 Taboret console, model 51 low boy console and model 53 phonograph combination. Model 13 and 14 are shown in the illustrations.

Polymet In Sound Field

THE entry of this important firm into the sound equipment field has been expected for some time. Widely known throughout the electrical and radio industries, Polymet products are now destined to become important factors in the newer field of sound.

The actual entry of this company has been preceded by many months of exhaustive research. Polymet is well equipped to manufacture such parts. Plants of the company, each under the exclusive direction of a specialized engineer insuring strict adherence to standards, fabricate all the elements entering into the construction of these items. The Polymet plant at Winsted, Conn., makes the copper, enameled and insulated wire. The Easton, Pa., plant fabricates the coils, solenoids, chokes and transformers. The main plant, in New

(Continued on page 89)

(Continued from page 88)

York, is entirely devoted to the manufacture of condensers and resistors.

Besides parts manufacture, Polymet also assembles complete amplifiers suitable for sound work of every sort. It is the contention of Polymet engineers that the expense of breakdowns and repair work can largely be avoided by incorporating related transformers, condensers, resistances, etc., in products, rather than attempting to get good results from "stranger" products.

Mayo Replacement Parts

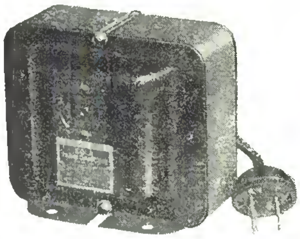
THE Mayo Laboratories, pioneers in replacement parts manufacturing, located at 280 East 137th Street, New York City, have allied with a complete service engineering department which at present is handling service for most of the distributors and large radio sales organizations in the United States.

This department conducts a free information bureau to service men in regards to servicing radio sets, public address equipment and electrical and radio measuring equipment, and has prepared a new and complete catalogue (No. 18) which contains a complete list of condenser blocks, transformers and resistors for the standard sets.

Mayo Laboratories, who have recently added to their extensive equipment additional coil winding machinery, resistance winders and condenser equipment for both paper and electrolytic condensers, can take care of either production runs on any article or the necessary one at a time that some service men need.

Sola Voltage Compensator

RECENTLY designed by the Sola Corporation of Chicago, to reduce high line voltages and increase low line voltages, the Sola voltage compensator is illustrated in the accompanying photograph.



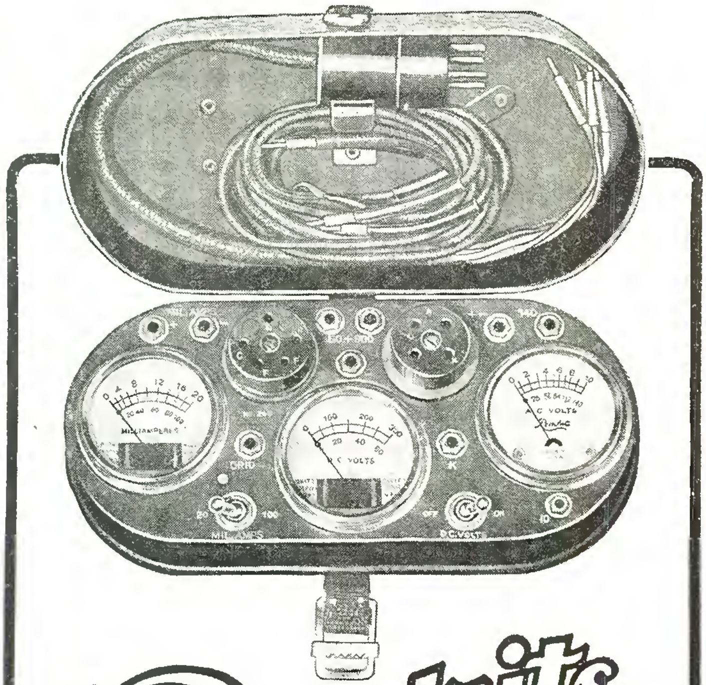
Characteristics of the compensator are: capacity 100 watts, input 95 to 135 volts (60 cycle only), output .9 amperes at 110 volts; weight 7¼ lbs., height 3¼ inches, width 4 inches, depth 3½ inches. The standard compensator will only serve sets up to and including 120 watts.

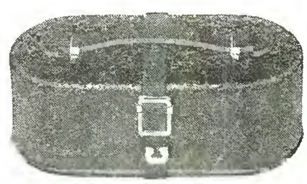
According to the designers the principle followed in securing automatic regulation lies in the ingenious design of the core. Portion "A" of the core functions as a standard step-up auto transformer when line voltage drops below a predetermined limit. This action builds up the normal voltage at this point. Arm "C" of core functions slightly under the saturation knee of the iron permeability. When line voltages rise the increase in saturation of arm "C" forces a greater portion of the flux through the higher reluctance path "B," thereby an auxiliary coil of opposite polarity counteracts the excessive voltage, delivering a corrected and steady flow of current.

Simplimus Home Recorder

ANNOUNCEMENT has just been made by Simplimus, Inc., of Boston, Mass., of the Simplimus Recorder designed for making of records in the home either from radio programs, from the voice itself. Home recording blank records are also available.

(Continued on page 90)



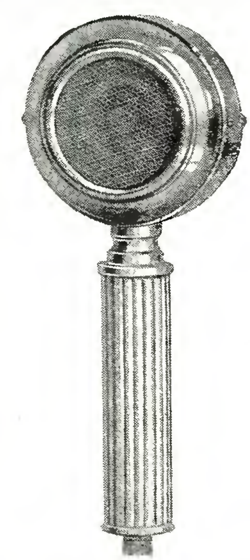


(Continued from page 89)

The equipment consists of the hand microphone, input control stage and the recorder. The input control stage can be plugged into any d.c. or a.c. receiver and the equipment is ready for recording or for playing back a record already made. All equipment comes with full instructions and diagrams.

Ellis Two Button Hand Mike

SHOWN in the illustration is the model 12-N two button hand microphone made by the Ellis Electrical Laboratory of Chicago. It has just been placed on the market and makes use of the Ellis adjustable buttons of the same type as employed in regular broadcast type units.



This hand microphone is especially recommended for home recording devices, industrial and home talking picture machines, portable public address outfits and in general wherever it is not convenient to use a regular spring mounted microphone. Each unit is carefully made and individually tested. Size 6½ inches long, head 2 7/16 inches in diameter, 1½ inches thick.

In addition to the above item Ellis also makes a line of demountable spring suspension microphones together with other necessary accessories for speech work.

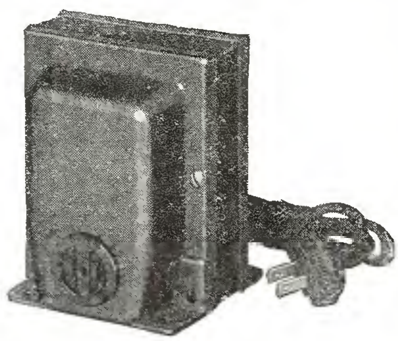
New Amperites Marketed

ACCORDING to advices from the Amperite Corporation of New York, two new Amperite models have been announced. One is the 6-30 to handle the new 2 volt tubes such as the UX 230 and UX 232 on 6 volts, and the other Amperite 6-31 to handle the 231 type tube on 6 volts.

The Amperites just mentioned are connected exactly the same as the battery type resistors, in series with one of the filament leads. The designers state that by replacing the ¼ ampere tubes with the new tubes and the Amperites here listed the storage battery will last four times as long, a point which might be of interest to the users of storage batteries.

Acme Step-Down Transformers

SHOWN in this illustration is the Midget, 50 watt Acme step-down transformer made by the Acme Electric and Manufacturing Co., of Cleveland, Ohio. This is a transformer, which with the Standard, 150, 250 and 350 watt types, find their principal application in the export field where the voltage supply ranges from 200 to 240 volts, wither 50 or 60 cycles.



Acme transformers are liberally designed and the coils are especially impregnated to meet conditions in the export field. Care is taken to give each transformer a high voltage insulation breakdown test at ten times the working voltage, as well as an induced voltage test at twice the normal working volt-

(Continued on page 91)

(Continued from page 90)

ages, doubling the frequency. Each transformer is furnished with eight feet of cord and plug.

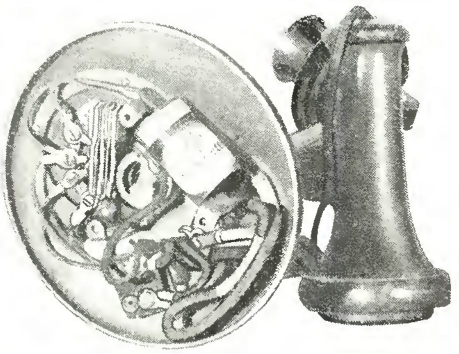
In this illusration is shown the Clara-Tone antenna tuning device marketed by the Essenbee Radio Devices Co., of Chicago.

In some types of receivers, especially those employing an periodic primary, reception may be improved by inserting in the antenna circuit an external tuning arrangement.

Cures Dialing Interference

TOBE Deutschmann Corporation of Canton, Mass., announce a new Filtcrette especially designed for use in the automatic telephone equipment for elimination of dialing interference. The Filterette is shown in the illustration accompanying this article.

Anyone with a screwdriver can install the Filterette in the



telephone stand base by merely removing three screws and the base. The Filterette has two flexible leads that fit under terminals described in the instructions that accompany the device.

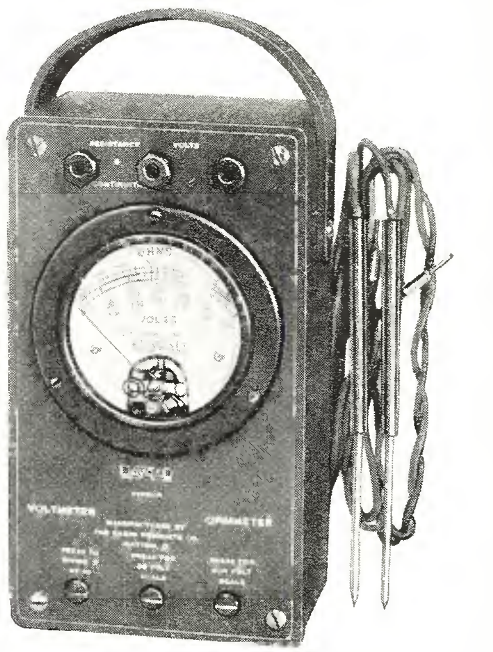
Filtermatic Loading Coil

DESIGNED to either increase the effective primary inductance by placing it in series with the antenna, or reduce the effective inductance by placing it in parallel with the primary circuit, the Filtermatic has been announced by the Filtermatic Manufacturing Co., of Philadelphia, Pa. The device is easy to install since it is merely placed either across the antenna and ground terminals of your receiver, or in series with the antenna lead and the antenna terminal. Both methods of connection should be tested to secure the best form for a particular receiver.

(Continued on page 92)

Dayrad Voltmeter-Ohmeter

A COMPLETE self-contained combination voltmeter and ohmeter for service work has been announced by the Radio Products Co., of Dayton, Ohio, and is shown in the photo accompanying this description.

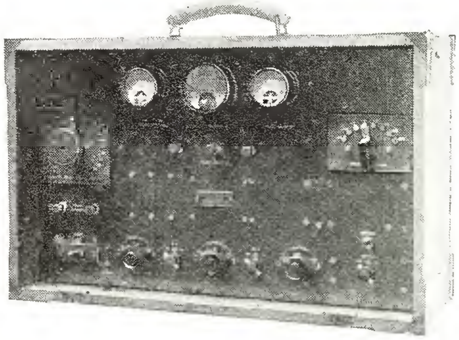


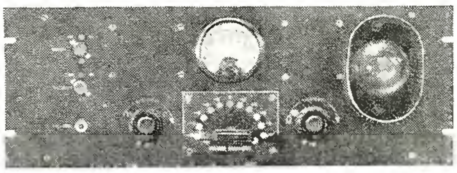
The type R shown here is equipped with genuine D'Arsonval movement meter. There are two direct reading resistance ranges, and three voltage ranges. A 4½ volt C battery is self-contained, furnishing power for the continuity and resistance test.

Two other products made by the same company are the type 180 test oscillator especially desirable for alignment work on the new superheterodynes, and the type 8-180 test panel.

Jenkins and Adair Equipment

BELOW may be seen the type B portable amplifier made by Jenkins and Adair, Inc., of Chicago, designed and built especially for broadcast station pickup work. It consists of a three stage amplifier using standard tubes together with a built in level indicator. The two position input normally for either carbon microphones or condenser transmitters, can also be built to accommodate wire lines or phonograph pickup if desired. The input circuit switch, in addition to its normal duty, controls a relay in the output circuit which prevents clicks from going out on the line.





The smaller illustration shows the type C (calibrated) level indicator panel. The circuit is simple and the components rugged. A special input transformer suitably tapped with its associated switch and control points, together with a High Mu

(*Continued on page* 93)

tube and proper filter circuit constitutes the assembly. Level is shown on a special level indicator (Weston). The range in readings is from minus 10 to plus 8 Db. in steps of 2 Db., covering the requirements for all regular broadcasting and recording work.

Portable Electric Ear

THE world's first portable "electric ear" to separate the various sounds of a whirring electric motor was demonstrated publicly for the first time recently at the Westinghouse Research Laboratories by J. P. Foltz, who developed it.

So compact that it fits into an ordinary suitcase, this new "electric ear" can easily be taken to whatever sound may be under observation.

Entirely self-actuated, it can be carried to waterwheel generators in a lonely power station in the wilds of Alaska, to motors in an automobile factory around Detroit, to motors in a ship at sea or submarine far below the surface.

This "electric ear" consists of a microphone, an amplifier of several stages to raise the energy level, a filter circuit which permits only one frequency at a time to pass, a meter for reading amplitudes, and some batteries to furnish power. The complete equipment weighs about sixty pounds and is independent of any outside current supply.

The microphone may be of either the electro-dynamic or condenser type. It is connected to the sound analyzer by a wire and plug. By turning certain knobs and dials, sensitivities on the "selector" from one to 10,000 are possible. Frequency ranges from 60 to 7,000 cycles can be obtained.

In line with the studies of various cities in an attempt to reduce the objectionable noise which, it is said, are gradually making nervous wrecks of the human race, the first step is to analyze the noise and find the parts which make it up.

"Noise is a queer phenomenom," said Mr. Foltz. "It is usually made up of various smaller noises and is seldom found in the pure state.

"When an apple is dropped on a wooden floor, the 'thud' which 'strikes' the human ear is made up of a great number of sounds having no more resemblance to the 'thud' than flour, milk, baking powder, butter and eggs have to a finished cake.

"When the apple hits the floor, the impact starts a series of complex 'broadcasts' which in physics are represented by waves, called sound waves. *It is entirely possible to 'produce' silence by two sound waves which fit into each other much like the teeth of two saw blades.*

"In a somewhat different application, it is also hoped that in the future this new portable 'electric ear' may be used as an advance fault finder for airplane motors and propellers. So much more sensitive than the human ear, it is anticipated that it will hear loose wrist-pins, piston-rings, main bearings, warped or split propellers long before they are loud enough—and consequently dangerous—to be heard by the human ear.

(*Continued on page 94*)

It is not unlikely that when developed this apparatus will be made part of airplane's required inspection before flight.

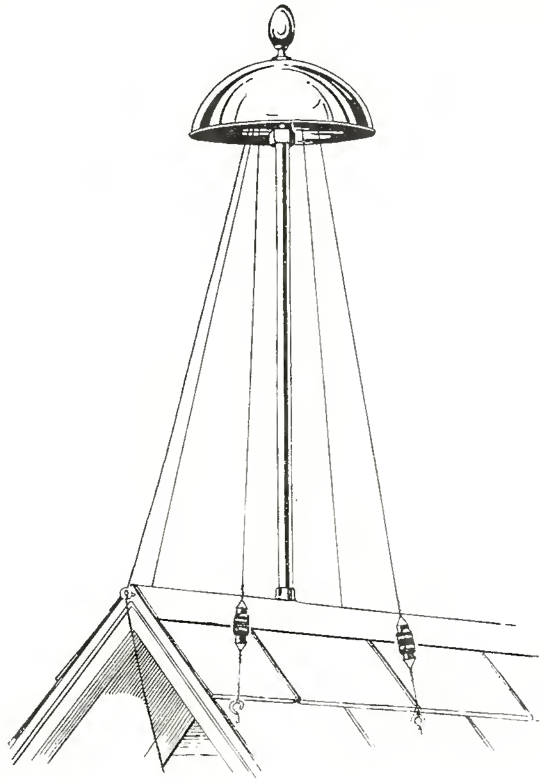
"This future 'electric ear' could be incorporated in an airplane's dashboard so that a bad motor part or propeller blade developing during flight would instantly show up as a red light to warn the pilot of prospective trouble. Then, with the cards on the table, the pilot would be able to decide whether he could safely cross the Rockies, the Alleghenies, or parts of the Atlantic Ocean without landing at the nearest airport to have the trouble remedied.

"Of course, these are only hopes at present and we will probably need considerable time to develop them. Once on a commercial basis, however, they give promise of a more enjoyable life on the earth and a safer life in the air."

While this equipment gives great promise, it is not yet in commercial production.

Airway Super Aerial

A recent product announced by the Airway Super Aerial Mfg. Co., of Fort Wayne, Indiana, is the one illustrated above.

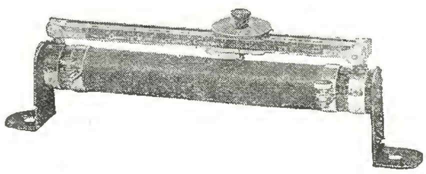


It is strongly built and properly insulated. It has copper alloy dome, tinned copper wire, and glass insulators.

New Ohmite Product

ILLUSTRATED below is one of the new products announced by the Ohmite Manufacturing Co., of Chicago.

It is a slide wire rheostat-potentiometer. Mounting legs are provided for each end. Details of the new item may be



had by writing the manufacturers at 636 North Albany Avenue.

New Transmitting Condenser

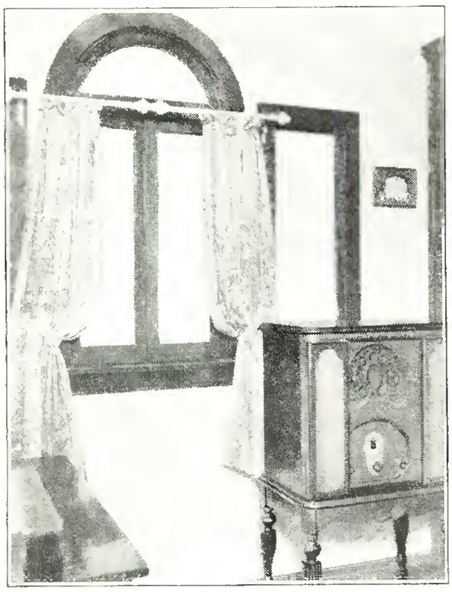
A NEW product in the transmitting line has been announced by the Air-Way Condenser Co., of Brooklyn, N. Y., which is marketing an intermediate transmitting condenser to meet the need for a condenser for low power installations where weight and space are essential factors.

The condensers are made entirely of aluminum, which accounts for a weight of 3½ ounces for the 50 mmf size and 8 ounces for the highest capacity manufactured, which is 150 mmf. The space occupied by the latter is 2¾ by 5 inches.

Among some of the features used are rigid phosphor bronze spring, extension shaft which permits ganging, three post supports for the end plates. If desired single hole mount can be supplied at slight extra cost, as well as brackets for base mounting. The voltage breakdown rating is 1500 volts.

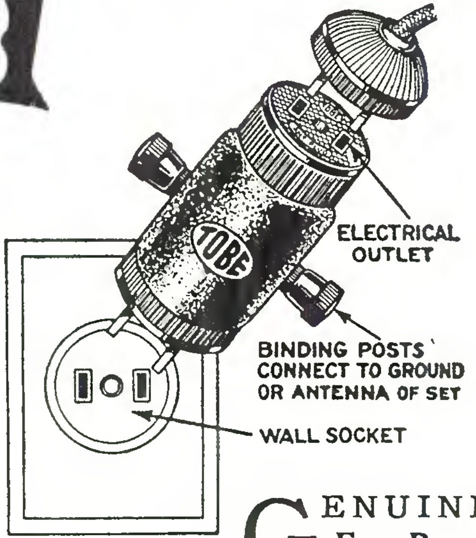
Placement of Set in Room

MANY service men overlook the fact that in many cases reception may be improved by the proper installation of the receiver in the customer's room. In the photograph shown may be seen one of the methods of installation.



In the upper picture the console is placed near the window, about four inches from the wall. The principal reason for this setting, is the fact that in certain locations best results are secured when the set is located near a window, particularly in the homes where metal lath is used in the walls.

FREE!



GENUINE Tobe Four Purpose Light Socket Aerial FREE with one year's subscription to **Citizens Radio Call Book—Radio's Greatest Magazine.**

This device saves the cost and bother of installing an aerial, lightning arrester or ground and at the same time permits the use of an electrical outlet. Just plug in your electric lamp or electric radio set as you now do to baseboard receptacle or lamp socket. Over all dimensions 2¼"x2½".

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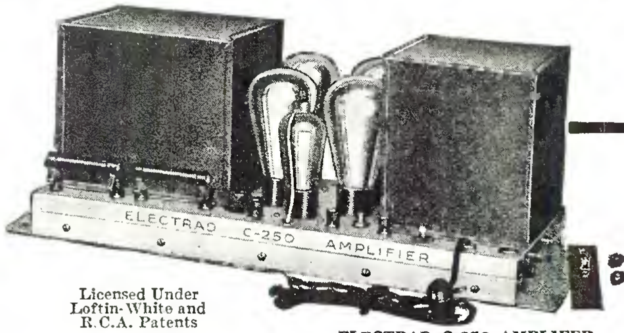

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The C-250 (illustrated above) and its companions, the A-250 and the A-245 provide the notably high quality output, general stability, low initial cost and operating economies for which this system is noted.

These Amplifiers are *perfected* products of typical Electrad high quality and offer a range of power suitable for present-day needs.

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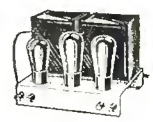
ELECTRAD A-250 AMPLIFIER

Provides 4.6 watts undistorted output. Utilizes one 224, one 250 and one 281 tube. Completely assembled only.



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ELECTRAD INC.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

OF CITIZENS RADIO CALL BOOK MAGAZINE AND TECHNICAL REVIEW, published four times yearly at Chicago, Illinois, for October 1, 1930. State of Illinois, County of Cook, ss.

Before me, a notary public in and for the state and county aforesaid, personally appeared Chas. O. Stimpson, who, having been duly sworn according to law, deposes and says that he is the Publisher of the CITIZENS RADIO CALL BOOK MAGAZINE AND TECHNICAL REVIEW and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Chas. O. Stimpson, Chicago, Ill.; Editor and Managing Editor, Fred A. Hill, Chicago, Ill.; Business Manager, H. Anheiser, Chicago, Ill.

2. That the owner is (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given): Citizens Radio Service Bureau, Chicago, Ill.; Chas. O. Stimpson, Chicago, Ill.; H. Anheiser, Chicago, Ill.; F. A. Hill, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are (if there are none, so state): There are none.

4. That the two paragraph next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is (this information is requred from daily publications only).

CHAS. O. STIMPSON,
Publisher.

Sworn to and subscribed before me this 6th day of October, 1930.

ANTON O. LANDES, Notary Public.

(My commission expires April 25, 1934.)

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Every year the Citizens Radio Call Book Magazine and Technical Review asks its readers a number of questions calculated to show preference of these readers for certain types of editorial matter to appear in future issues.

During the past three years the content of this magazine has been selected in accord with wishes of the majority of readers returning the questionnaires.

We would like a widespread expression on this year's questions so that all classes of readers may be fully represented. Remember, its your book and this is your opportunity of indicating your choice of subjects.

Please fill in the form below, tear out along the dotted line and mail to:

Citizens Radio Call Book Magazine and Technical Review

508 South Dearborn St., Chicago

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1. In your work, which components give you the most trouble? ....Condensers ....Resistors ....Transformers ....Tubes.
2. What portion of your work is devoted to tube replacements? ....10% ....25% ....50% ....75%.
3. What tubes do you recommend? ....
4. Are you part owner, or employed in a radio store? ....Part owner ....Employe.
5. What factory receivers do you recommend? ....
6. Do you wish additional curves on receivers other than the present sensitivity, selectivity and fidelity measurements in our magazine? ....Yes ....No.
7. What service test equipment do you use? ....
8. Would you consider your service work during this season as profitable? ....Yes ....No.
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10. Do you service receivers of more than one make? ....Yes ....No.
11. Have you found the response curves as published by us a help in your sales work? ....Yes ....No.
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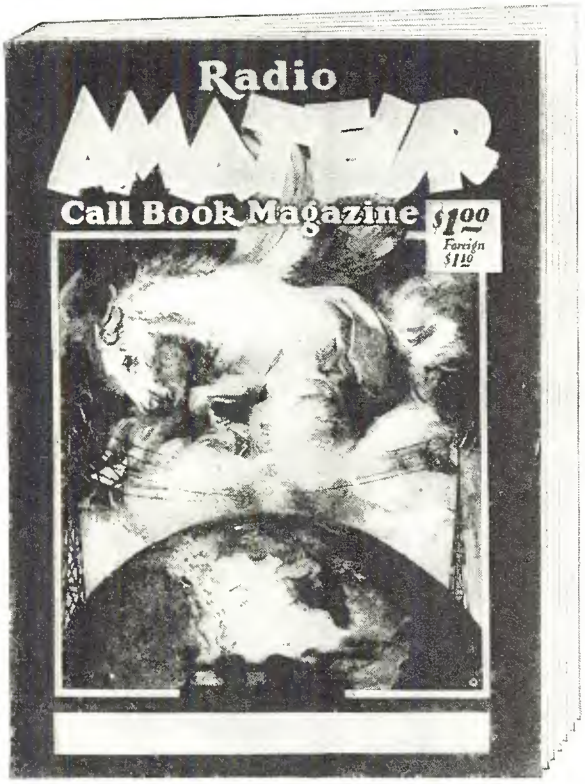

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Geo. W. Mesher, 2949 Sacramento St., San Francisco, Calif.
Offenbach Electric Co., 1452 Market St., San Francisco, Calif.
Warner Brothers, 428 Market St., San Francisco, Calif.

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American Radio Relay League, Hartford, Conn.
Hatry & Young, Inc., 119 Ann St., Hartford, Conn.

DISTRICT OF COLUMBIA

Okay Radio Co., 417 11th St., N. W., Washington, D. C.

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Western News Co., 17-29 E. Austin Ave., Chicago, Ill.
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Kruse-Radio, Inc., 33 W. Ohio St., Indianapolis, Ind.

MASSACHUSETTS

Tremont Elec. Supply Co., Inc., 228 Tremont St., Boston, Mass.

MICHIGAN

S. S. Kresge Co., Store 1185, 1403 Woodward Ave., Detroit, Mich.
Radio Specialties Co., 175 E. Jefferson Ave., Detroit, Mich.

MINNESOTA

Findley Elec. Co., Inc., 111 S. 6th St., Minneapolis, Minn.
E. F. Johnson, Waseca, Minn.

MISSOURI

Burstein-Applebee Co., 1408 McGee St., Kansas City, Mo.
E. B. MacDowell, 3145 Karnes Blvd., Kansas City, Mo.
Foster Company, 410 Washington Ave., St. Louis, Mo.

NEW YORK

Fort Orange Radio Dist. Corp., 117 N. Pearl St., Albany, N. Y.
McCarthy Bros. & Ford, 75-79 W. Mohawk St., Buffalo, N. Y.
Blan, The Radio Man, Inc., 89 Cortlandt St., New York, N. Y.
J. H. Bunnell & Co., 215 Fulton St., New York, N. Y.
Wm. Egert, 179 Greenwich St., New York, N. Y.
Leeds Radio Co., 45 Vesey St., New York, N. Y.
Sun Radio Co., 64 Vesey St., New York, N. Y.
Roy C. Stage, Montgomery & Burt Sts., Syracuse, N. Y.

OHIO

Bergman Tool & Radio Co., 628 Prospect Ave., Cleveland, O.
S. S. Kresge Co., Store 1153, 97 N. High St., Columbus, O.
Kladag Radio Labs., Kline Bldg., Kent, O.

OREGON

Rich's Cigar Store, 6th & Washington Sts., Portland, Ore.
Stubbs Electric Co., Portland, Ore.
Spokane Radio Co., Inc., 528 First Ave., Spokane, Wash.

PENNSYLVANIA

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Graphic Wiring Diagrams

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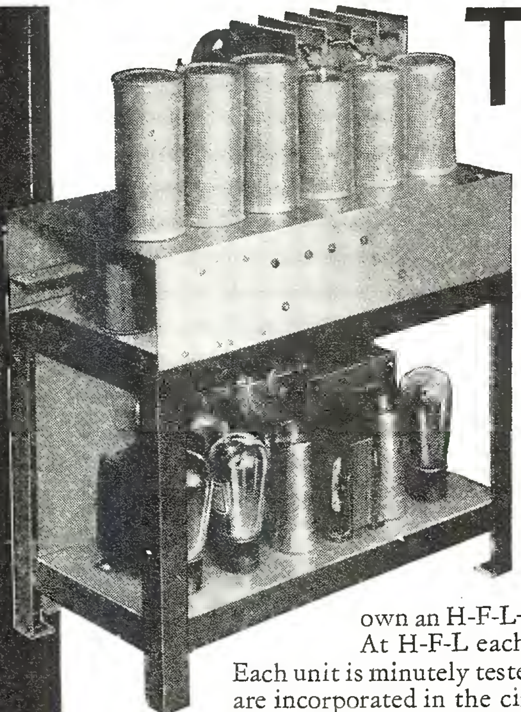

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Sensational New Circuit!

To combine 10-kilocycle selectivity with beautiful tone quality has been the dream of every radio engineer. But, not until the perfection of the Hopkins Band Rejection System was this possible. Now in the Mastertone this is accomplished. Far away stations, on bands adjacent to powerful locals, are brought in with clarity, volume and full strength. No compromising of tonal reproduction by side band clipping. Tune to the station desired and *all* the energy in that channel is accepted and reproduced. All adjacent stations are entirely avoided. Reception is *precise*, *definite*, unhampered! The Hopkins Band Rejector System is exclusive with H-F-L and is found in no other receivers.

WORLD WIDE RECEPTION POWER

Extreme Selectivity

The full value of screen grid tubes brought to perfection. Reach out to the far corners of the earth for unforced, clear-as-a-bell reception. The sensitivity is greater than 1 micro-volt per meter—*all over the dial.* This sensational circuit arrangement always provides the reliable 10-kilocycle separation at all volumes—high or low, at all wave lengths, on local or far distant stations.

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A cascaded, one-unit chassis of great ruggedness. Built like a skyscraper of steel and aluminum. The dynamic speaker is integral with the chassis. All delicate parts enclosed and protected from accidental injury. All units securely anchored so that after years of use it still functions perfectly. Very compact, measuring only 21 inches high, 16 inches wide and 8 inches deep. Ideal for use in consolette or for inbuilding in the wall.

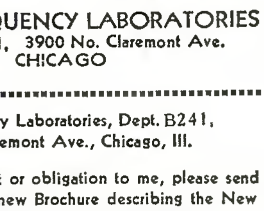
Beautiful Console Model

This wonder receiver is now available in a modern, walnut console in striking design. Neat, compact, but a fitting companion to the finest furnishings the home might have. And, best of all, it comes at a price lower than the market has ever offered. Here we have a complete, ultra powerful, beautiful tone superheterodyne receiver at a cost even less than must be paid for an ordinary trf set when secured through the usual channels.

SINGLE UNIT CHASSIS

Write for Whole Story

Learn how you can test this record-breaking, sensational new receiver and see and hear for yourself. Know the amazing price. Find out about the great new circuit embodied in it. Hear the enthusiastic praise of those who have already tuned it! All this will be brought to you in a little Brochure which will be be sent to you FREE on request. *Mail* the Coupon now and soon begin to enjoy radio in all its possibilities.



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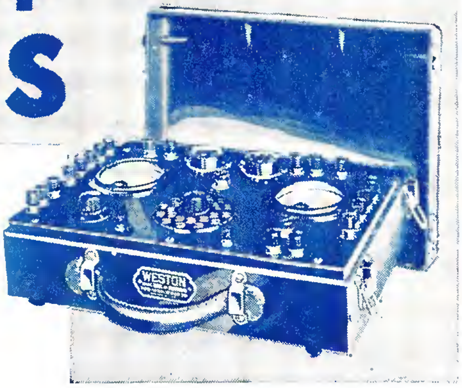

Weston's international reputation for quality testing instruments has been built on actual performance, not by extravagant advertising claims. Only Weston can give you Weston dependability. For this reason, Weston instruments, with their outstanding superior design and performance, meet the exacting requirements of discerning radio dealers and service men.

MODEL 565

Model 565 is practically a radio service laboratory—the most complete test set designed for radio servicing. (Includes R. F. Oscillator).

Servicing Scope of Model 565

Model 565 makes the required tests on every modern radio receiver. This includes D. C. sets with reversed filaments; Power Transformers; A. C. line and all heater voltages; Battery voltages and currents; Resistance and Continuity of Circuits; Condensers; Speaker-coil currents. R. F. Oscillator permits tests independent of broadcast signals. Madel 565 checks every type tube—A.C., D.C., Pentode and both plates of Rectifier at the same time; all filament, heater, cathode voltages; bias, control grid and plate voltages; plate and screen currents;—operating directly from any 50-60 cycle 90-135 volt A.C. line.

Equipment of Model 565

8 range A.C. VOLT-AM-MILLIAMMETER cantrolled by 9 point Bi-polar switch; 12 range D.C. VOLT-OHMMETER controlled by 23 point Bi-polar switch with index markings; 3 range D.C. MILLIAMMETER controlled by 3-way toggle switch; DIRECT READING OHMMETER; R.F. OSCILLATOR; CONDENSER METER; POLARITY REVERSING SWITCH; 4½ volt self-contained BATTERY; and for external tests, BINDING POSTS for all ranges, and LEADS.

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WRITE FOR CIRCULAR H H

MODEL 566

A two meter test set—inexpensive, light, convenient, and rapid in operation—designed for radio servicing in the home.

Servicing Scope of Model 566

Model 566 checks all type tubes under same conditions as exists when in the radio set. Checks all model radio sets. Checks Transformers; Line voltage; filament or heater current and voltages; cathode, bias and control grid voltages; plate current and voltage; screen currents; both plates of full-wave rectifier tubes; battery voltages; resistance and continuity of circuits; condensers and speaker-coil currents.

Equipment of Model 566

9 range A.C. VOLT-AM-MILLIAMMETER controlled by dial switch; 10 range D.C. VOLT-OHM-MILLIAMMETER controlled by 23 point Bi-polar switch with index markings; DIRECT READING OHMMETER; CONDENSER METER; OUTPUT METER (Rect. type); POLARITY REVERSING SWITCH; 4½ volt self-contained BATTERY; and for external tests, BINDING POSTS for all ranges, and LEADS.

MODEL 564—Model 564 is a compact inexpensive VOLT-OHMMETER for voltage and resistance measurements and continuity tests. Used in radia repair shops, factories, and laboratories.

Description of Model 564

Model 564 has 6 D.C. ranges—600/300/30/3 volts (all 1000 ohms per volt) and 0-100,000/0-10,000 ohms; a 4½ volt "C" battery and 30-inch test cables with prods. All ranges are brought to binding posts. 2 toggle switches permit change from voltmeter to ohmmeter, and from 100,000 to 10,000 ohm range. Size: 5½ x 3⅝ x 2⅛ inches. Weight (camplete): 2.3 lbs.

WESTON ELECTRICAL INSTRUMENT CORPORATION

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