SUMMER EDITION

CITIZENS

50¢

Radio Call Book Magazine

and TECHNICAL REVIEW

SERVICE - REPAIR - ENGINEERING
POWER AMPLIFICATION - TELEVISION

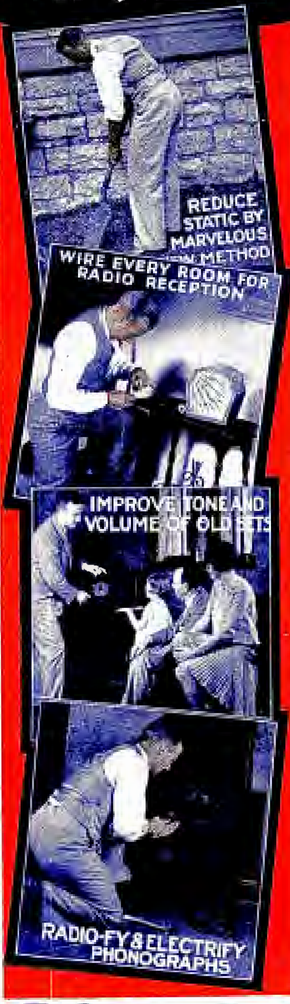
4 of the 40 Easy Ways to Make $3.00 an Hour In Your Spare Time in RADIO

THE four plans shown are but a sample of the many ways in which our members are making $3.00 an hour upwards, spare time and full time, *from the day they join the Association.* If you want to get into Radio, have a business of your own, make $50 to $75 weekly in your spare time, investigate the opportunities offered the inexperienced, ambitious man by the Association.

Our Members Earning Thousands of Dollars Every Week

The Association assists men to cash in on Radio. It makes past experience unnecessary. As a member of the Association you are trained in a quick, easy, practical way to install, service, repair, build and rebuild sets—given sure-fire money-making plans developed by us—helped to secure a position by our Employment Department. You earn while you learn, while you prepare yourself for a big-pay Radio position.

The Association will enable you to buy parts at wholesale, start in business without capital, help you get your share of the $600,000,000 spent annually for Radio. As a result of the Association, men all over the country are opening stores, increasing their pay, passing licensed operator examinations, landing big-pay positions with Radio makers.



Mail Coupon Today for the FREE HANDBOOK

It is not only chock-full of absorbing information about Radio, but it shows you how easily you can increase your income in your spare time. Mailing the coupon can mean $50 to $75 a week more for you.

Radio Training Association of America
4513 Ravenswood Avenue Dept. RCB-3 Chicago, Illinois

Below are a few of the reports from those now cashing in on the "40 Easy Ways"

Clears $3,000.00 Frank J. Deutch, Pa.—"Since joining the Association I have cleared nearly $3,000.00. It is almost impossible for a young fellow to fail, no matter how little education he has, if he will follow your easy ways of making money."

$1,100.00 in 6 Weeks J. R. Allen, Calif. — "Have done over $1,100.00 worth of business in the last 6 weeks. Next month I am going to open up a store of my own. I never knew that money could come so fast and easy."

$25.00 a Week Spare Time N. J. Friedrich, N. Y.—"I have averaged $25.00 a week for the last 7 months even though I am not a graduate but just learning."

Training Lands Him Job R. C. Kirk, N. C.—"Your training has been very valuable to me. I landed a job with the big department store out here a few weeks ago because I had my membership card with me. There were a large bunch of applications ahead of me."

ACT NOW

If You Wish NO-COST Membership

For a limited time we will give to the ambitious man a No-Cost Membership which need not—should not—cost you a cent. For the sake of making more money now, and having a better position in the future, mail coupon below *now.* You'll always be glad you did.

Radio Training Association of America
Dept. RCB-3, 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special No-Cost Membership Plan, and also a copy of your Radio Handbook.

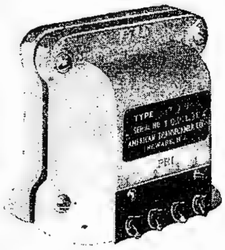
Name ____________________

Address ____________________

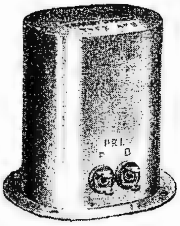
City ____________ State ____________

AMERTRAN

TRADE MARK REG. U.S. PAT. OFF.

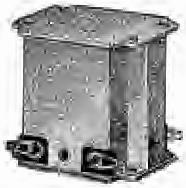


Type 710 *Audio Transformer — Between two input and two output tubes — List Price $20.00.*



Type AF-8 *Audio Transformer—Either 1st or 2nd stage audio. Turn ratio 3½—List Price $5.00.*

AmerTran Power Transformer Type PF-245A—*List Price $22.00.*



AmerTran DeLuxe Audio Transformer List Price $8.00. Type 151 *—Between one input and two output tubes —List Price $12.00.*

**AmerTran Push-Pull Amplifier* Type 2-AP. *Complete 2 stage audio amplifier with first stage AmerTran DeLuxe for XU227AC and second stage AmerTran Push-Pull for two 171 or 210 power tubes. Operates with 450 volt AmerTran Hi-Power Box. Price east of Rockies—less tubes—$80.00.*

*Licensed under patents of the Radio Corporation of America and associated companies for radio, amateur, experimental and broadcast reception.

RADIO PRODUCTS

Bring *the Studio to your Home*

The weak point in most receiving sets is in the audio system.

AmerTran Audio Transformers and Power Transformers shown here perfect the audio system and bring the programs into your home exactly as they go over the air through the microphone.

For detailed information write for the following Bulletins:

Bulletin 1084 — AmerTran DeLuxe Audio Transformer
Bulletin 1087 — AmerTran Audio Transformer Type AF-8
Bulletin 1088 — AmerTran Power Transformer Type PF245A
Bulletin 1075-A — AmerTran Push-Pull Amplifier Type 2-AP
Bulletin 1065 — The Complete AmerTran Line.

AmerTran Quality Radio Products are sold by all good dealers, or direct if they cannot supply you.

AMERICAN TRANSFORMER COMPANY
Transformer builders for over 29 years
172 Emmet Street, Newark, N. J.

AMERICAN TRANSFORMER COMPANY C. B.-3-30
172 Emmet St., Newark, N. J.

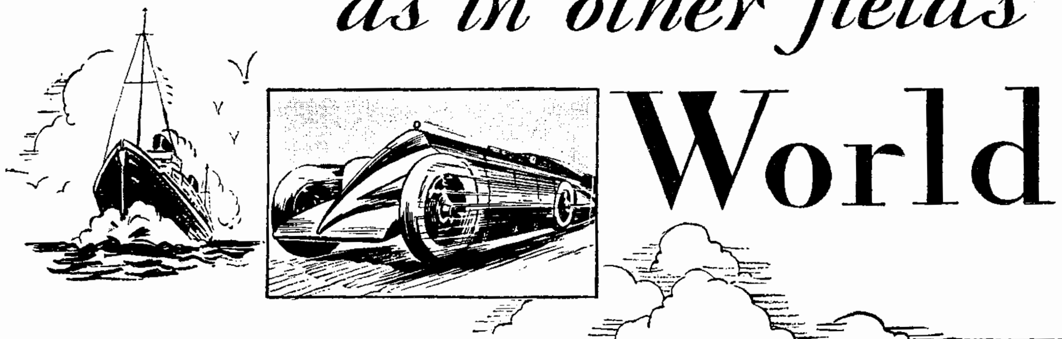
Please send me the following Bulletins (Check (✓) those you want).
Bulletin 1084 ( ); 1087 ( ); 1088 ( ); 1075-A ( ); 1065 ( ).

Name ....

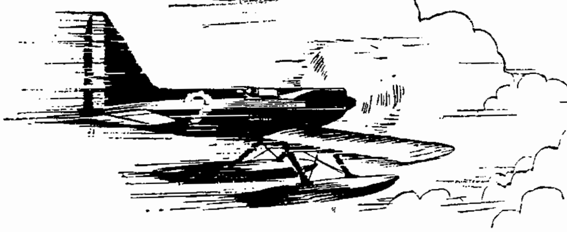
Street and No. ....

Town .... State ....

In Radio,
as in other fields of World's



ADVANCED DESIGN and



THE steamship Bremen crossed the ocean in four and one-half days, thereby setting a World Record for travel between Bremen, Germany, and New York. The 1000 H. P. "Golden Arrow," driven by Major H. O. D. Segrave, paced time at 231 miles per hour—establishing the World's Record for travel over land. The Supermarine Rolls Royce S6, piloted by Flight Lieutenant H. R. D. Waghorn of the R. A. F., won the Schneider cup race at 331 miles per hour and set the World's Record for speed in the air . . . In each instance the World Record performance of the equipment involved was due solely to *advanced design* and to the *precision engineering* with which the advanced design was given material shape. . *And so it is in Radio!*

A receiver, designed by E. H. Scott to take fullest advantage of certain advanced radio principles such as production manufacturers would not dare to even consider, established the World's Record for radio performance. This receiver, built to *perfect precision* in accord with its *advanced* specifications, brought in 117 programs from 19 stations 6000 to 8000 miles away!

The Scott World's Record Shield Grid A-C 10 offered to *you* is better, finer and far more powerful than the original World Record Model. It is hand-built in the laboratory to standards of electrical and mechanical precision ordinarily unheard of in the radio industry. The result is that the Scott A-C Shield Grid 10 will easily outperform any other receiver in existence today.

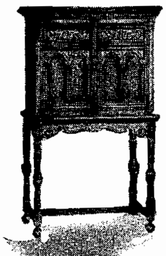
World's Records Held By Scott

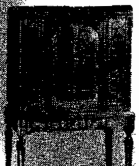
1. A world's record for number of broadcasting stations heard 6,000 to 8,000 miles.

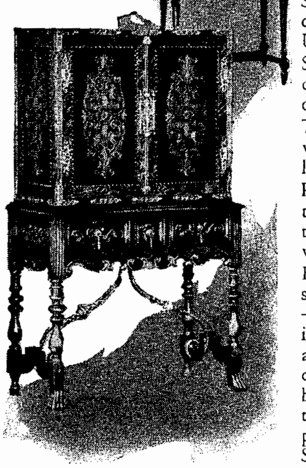
Six stations heard distant 6,000 miles.
Seven stations heard distant 7,000 miles.
Six stations heard distant 8,000 miles.

2. A world's record for greatest number of programs heard from stations distant 6,000 or more miles.

19 programs from stations 8,000 miles.
19 programs from stations 7,000 miles.
79 programs from stations 6,000 miles.







What to Expect

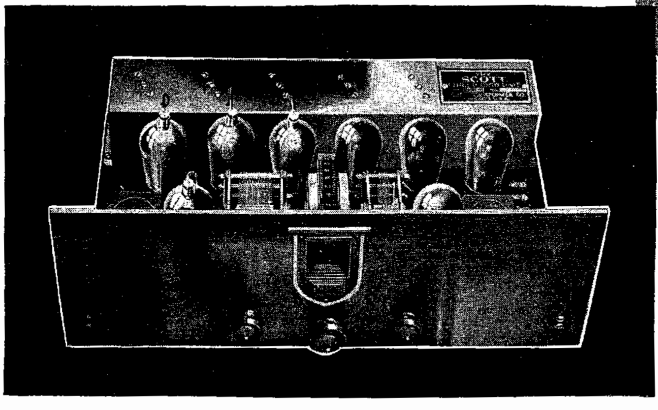
SENSITIVITY so great that practically any major station in the U.S. and Canada can be brought in.

SELECTIVITY so precise that locals do not interfere with the reception of distant stations.

TONE so perfect that all music and voice are reproduced with absolute fidelity and realism.

POWER so completely unlimited that any station worth listening to is amplified to any degree of volume desired.

BEAUTY such as you have never seen in radio cabinet-work before—because each Scott console is an individual creation of a master artist—designed not for mass production, but to present in terms of beauty, the same class and distinctive, individualized quality so apparent in the *performance* of the Scott Receiver.



The Scott World's Record Shield Grid A-C 10

This is the precision instrument of radio. It is built not to physical and electrical tolerances—but to exactness. The one individual receiver that comes to you is certain to be perfect. Only Scott Custom-Built Radio offers you this assurance.

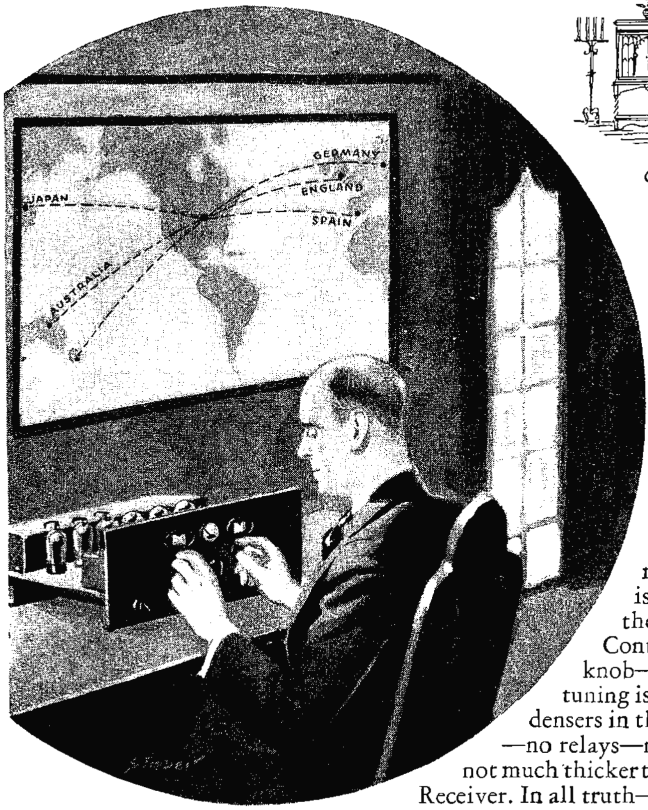
CITIZENS RADIO CALL BOOK MAGAZINE AND TECHNICAL REVIEW, March, 1930. Published 4 times yearly, January 1, March 1, September 1, November 1. Volume XI, No. 2. Published at Chicago, Ill. Subscription price, $1.75 yearly. Entered as second-class matter January 24, 1930, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Citizens Radio Service Bureau, Inc., Publishers, 508 So. Dearborn St., Chicago.

human endeavor,

Records

are achieved only thru

PRECISION ENGINEERING



THE NEW SCOTT RADIO CONTROL

This newest product of Scott *advanced design* and precision engineering is the first practical application of the idea of remote control. It is more than practical; it is *perfected!* Touch a button—there's the station of your choice—instantly. Control the volume by turning a tiny knob—that's all there is to it. The actual tuning is done in the Control itself. The condensers in the receiver do not move. No motors—no relays—nothing to get out of order. And a cord not much thicker than a lamp cord connects the Control to the Receiver. In all truth—there is nothing else like the Scott Radio Control. Nothing else so fine—so smooth—so perfect in operation. The pictures herewith illustrate a few of its many uses. The coupon will bring you *all* the facts.

MAIL THIS COUPON

Clip it—fill it in—mail it Now! It will bring you full details of the Scott World's Record Shield Grid A-C 10—photographs of the various Scott custom-made consoles, and all the facts about the wonderful new Scott Radio Control. Don't wait. Mail the coupon today.

SCOTT TRANSFORMER CO.
4450 Ravenswood Avenue · CB3 · CHICAGO, ILL.

CLIP

SCOTT TRANSFORMER CO., 4450 Ravenswood Ave., CB3, Chicago.

Send me full particulars of the new Scott World's Record Shield Grid AC 10—Also photos of Scott Consoles and details of the Scott Radio Control.

☐ Send me franchised Set-Builders proposition.

Name..

Street..

Town.................... State....................

J. E. SMITH, *Pres*
NATIONAL RADIO INSTITUTE

MEN!

Get Your Copy of My *New* Book

It shows you

How to get a good job in the Radio Industry

Hundreds of Jobs paying \$50, \$60, \$75, \$100 a week are opening in Radio every year.

I showed these men how to get *Big Pay* jobs like *these*

Seldom Under \$100 a Week

"My earnings in Radio are many times bigger than I ever expected they would be when I enrolled. In November I made \$577, December \$645, January \$465. My earnings seldom fall under \$100 a week. I merely mention this to give you some idea of what a Radio man can do who has the training."

E. E. Winborne,
1414 W. 48th St., Norfolk, Va.

\$3000 a Year in Own Business

"I cannot give N. R. I. too much credit for what I have been able to do in Radio. I can safely say that I averaged \$3000 a year for the past three years. I am in the Radio business here. Any man who really wants to advance cannot go wrong in Radio. There is certainly a lack of trained men."

Fred A. Nichols,
P. O. Box 207, Eaton, Colo.

If you are earning a penny less than \$50 a week, send for my book of information on opportunities in Radio. It is free. Radio's amazing growth is making hundreds of fine jobs every year. My book shows you where these jobs are, what they pay, how I can train you at home in your spare time to be a Radio Expert.

You have many Jobs to choose from

Broadcasting stations use engineers, operators, station managers and pay \$1,800 to \$5,000 a year. Manufacturers continually need testers, inspectors, foremen, engineers, service men, buyers for jobs paying up to \$15,000 a year. Shipping companies use hundreds of operators, give them world-wide travel with practically no expense and \$85 to \$200 a month besides. Dealers and jobbers (there are over 35,000) are always on the lookout for good service men, salesmen, buyers, managers and pay \$30 to \$100 a week for good men. Talking Movies pay as much as \$75 to \$200 a week to men with Radio training. There are openings almost everywhere to have a spare time or full time Radio business of your own—to be your own boss. Radio offers many other opportunities. My book tells you about them. Be sure to get it at once.

My New 8 Outfits of Parts give you extensive Practical Radio Experience

With me you not only get the theory of Radio—you also get practical Radio experience while learning. You can build over 100 circuits—build and experiment with the circuits used in Atwater-Kent, Majestic, Crosley, Eveready, Stewart-Warner, Philco, and many other sets. These experiments include A. C. and screen grid sets, push pull amplification and other late features. When you finish my course you won't need to take "any old job" just to get experience—you will be trained and experienced ready to take your place alongside men who have been in the field for years.

Back view of 5-tube A. C. screen grid tuned Radio frequency set—only one of many circuits you can build with the parts I give without extra charge.

I Will Train You at Home in Your Spare Time

Hold your job until you are ready for another. No need to leave home. All I ask is part of your spare time. I have doubled and tripled the salaries of hundreds through my practical home-study training. You don't have to be a high school or college graduate. My course is written in easy, simple terms that most anyone can understand.

My course includes Talking Movies, Wired Radio, Television

My course is up-to-date with Radio's latest uses and improvements. It includes Radio's application to Talking Movies, Television and home Television experiments, Wired Radio, Radio's use in Aviation, in addition to fitting you for many other lines. When you finish you won't be a "one job" man. You will be trained for many jobs.

Money Back If Not Satisfied

I will agree in writing to refund every penny of your tuition if you are not satisfied with my Lesson Texts and Instruction Service when you have finished my course. This agreement is backed by the Pioneer and World's Largest organization devoted entirely to training men and young men for good jobs in the Radio industry, by correspondence.

Find out what Radio offers you Get My Book

This book gives you the facts on Radio's opportunities and the many features and services of N.R.I. training. It gives you 100 letters from actual students who have proved that my methods are successful. Get your copy today. There is no obligation.

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

THIS COUPON IS GOOD FOR ONE *FREE* COPY OF MY NEW BOOK — *mail it NOW*

J. E. Smith, *President*
National Radio Institute, Dept. OCE
Washington, D. C.

Dear Mr. Smith:—Send me your book. I want to see what Radio offers and what you offer in Radio training. This request does not obligate me in any way.

Name...................................

Address...................................

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

Lifetime Employment Service to all Graduates

RADIO NOISES!

vanish the moment you install a TOBE FILTERETTE

Service men everywhere are reporting tremendous profits installing TOBE FILTERETTES, made by the company which has sent engineers to Hartford, Conn., Brattleboro, Vt., Carbondale, Penn., Littleton, N. H., and countless other cities successfully stamping out radio interference by filterizing the entire city.

Radio noises are everywhere. You can stop them with filterettes. Every installation means profit to you. We teach you how, and assist you, through co-operation of the TOBE Filterette Laboratories, the unique Radio Interference Research Department of the pioneer and leader of them all.

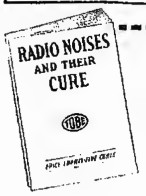
We are headquarters for eliminating MAN MADE STATIC, carrying the largest and most complete stock of TOBE FILTERETTES in the Middle West. We guarantee IMMEDIATE DELIVERY on any and all TOBE FILTERETTES. Tobe Engineers available by the day for interference surveys at a nominal charge. Write us your problems, we are specialists in radio interference.

Filterette Junior
Price $3.50
Filterette Senior
Price $7.50
Filterette 110 PO
Price $12.50

NEWARK ELECTRIC COMPANY

"Everything to Stop Radio Noises"

226 WEST MADISON STREET, CHICAGO, ILLINOIS



NEWARK ELECTRIC COMPANY

Gentlemen: I wish to learn how to make big profits installing TOBE FILTERETTES. Please find enclosed 25c for which send me one copy of RADIO NOISES and THEIR CURE.

Name..

Street and No.......................................City ....State......................................

. . . and now, a complete line of "SUPREME" Testing Instruments!

EACH meeting specific needs and conditions . . . each responding to persistent calls from all radiodom . . . each embodying "SUPREME" standards in engineering design.

SUPREME TUBE CHECKER $21.75
Model 17

Dealers Net Price F. O. B. Greenwood. Size 3-3/16x7-5/16x5-9/16. Shipping weight 4¾ lbs.

Extreme simplicity, accuracy and efficiency. Its rugged construction and protective measures make it practically foolproof. Tests all tubes, including screen grid. Each type of tube has its own testing socket—no switches to operate. All readings for tubes plainly marked on panel beside each testing socket. Weston meter, 2 scale 100/20/0. Operates from any 60 cycle A. C. line. Exceptional value—"Supreme" quality. Comparable with tube checkers selling for twice its price. A tube checker that no dealer handling tubes can afford to be without.

SUPREME TUBE TESTER
Model 50

$98.50

Dealers Net Price F. O. B. Greenwood. Size 7-5/16x10-9/16x5⅛". Shipping weight 11¾ lbs.

Equipped with automatic voltage regulator, manufactured under license from WARD-LEONARD ELECTRIC CO. Gives direct reading of amplification factor, mutual conductance, emission, normal plate current, both plates of full wave rectifier and gives meter indication of the presence of gas. A particularly high grade instrument intended for the more advance radioman; invaluable for the use in public address systems, sound picture equipment, testing laboratories and wherever a thorough and complete analysis of tubes is desired.

SUPREME OHMMETER
Model 10

$18.50

Dealers Net Price F. O. B. Greenwood. Size 2x2-5/16x4¾". Shipping weight 12 oz.

Embodying most advanced features in Ohmmeter design. Last word in simplicity. Designed for rapid and direct indication of resistances, etc., measures 10 to 10000 ohms. Built to stand rough usage. Can be carried in pocket.

SUPREME MEGOHMMETER $23.75
Model 80

Dealers Net Price F. O. B. Greenwood. Size 2x2-5/16x4¾". Shipping weight 12 oz.

See illustration of Ohmmeter for design and appearance. Reads from 10,000 ohms to 4 megohms. Like the Ohmmeter gives maximum features in minimum, pocket-size. Measures high resistances, leakage of condensers and approximate capacity of condensers.

SUPREME LABORATORY TEST PANEL

Makes your Diagnometer a dual purpose instrument—shop or portable service. Fastens to back of work bench. Staunch, good-looking, reinforced bakelite. Saves lost motion in shop. Dealers net price, F. O. B. Greenwood, $60.00.

All leading distributors stock SUPREME INSTRUMENTS. If yours cannot give full information, mail accompanying coupon. No obligation.

SUPREME DIAGNOMETER

Makes every conceivable test on any radio set

$139.50

Dealers Net Price F. O. B. Greenwood. Size 7½x12x16½".

So far-reaching now is the use of the SUPREME DIAGNOMETER among radiomen striving to give a complete and higher type of service, that it is hardly necessary to recount its many remarkable features. It is "Supremely" alone in the realm of corrective work, affording a multiplicity of functions approached by no other one instrument. By far the cheapest in price, when measured by results.

Service Depots in New York, Philadelphia, Pittsburgh, Chicago, Kansas City, Seattle, 'Frisco, Toronto

SUPREME INSTRUMENTS CORPORATION
361 Supreme Building, Greenwood, Miss.

Without obligation, please send me information on..............................

....

(Fill in name of instrument you are interested in)

(Signed)..............................

Street address..............................

City..............................State..............................

Citizens Radio Call Book Magazine

AND TECHNICAL REVIEW

Registered in U. S. Patent Office
Established 1921

C. O. STIMPSON, President
H. ANHEISER, Treasurer

Executive Offices:
508 So. Dearborn St., Chicago, Ill.

Member Audit Bureau of Circulations

F. A. HILL, Editor
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M. R. HARRIS, Circulation Manager

MARCH, 1930 Published January, March, September, November Vol. 11, No. 2

Contents This Issue

BROADCAST

AMPERE ANDY'S ASSISTORS

RADIO SCIENCE

FEATURE ARTICLES

SERVICE AND REPAIR

SERVICE AND REPAIR SCHEMATICS

FACTORY RECEIVER CURVES

RADIO ENGINEERING

MISCELLANEOUS INFORMATION

Citizens Radio Call Book Magazine is published four times a year and is on sale approximately the first of January, March, September and November. Subscription price $1.75 per year in U. S. A. Canada and Foreign $2.00 per year, payable in advance. Single copies 50 cents. Remit by check, draft, or P. O. order. No foreign stamps or coins accepted. Mail subscriptions to 508 So. Dearborn Street, Chicago. We will not be responsible for cash sent for subscriptions unless registered.

Advertising Representatives:
Chicago—A. B. Mills, 508 So. Dearborn St. Wabash 1901.
New York—(Branch Office)—154 W. 42nd St., Room 1125. Wisconsin 5681.

Entered as second class matter November 15, 1928, at the Postoffice at Chicago, Illinois, under the act of March 3, 1879.

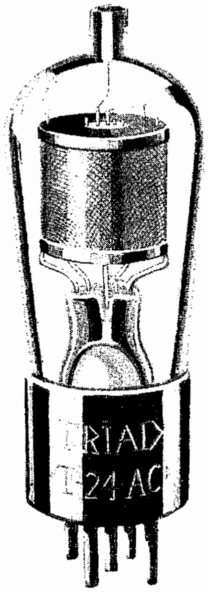
Distribution of Broadcast Chains by Cities

City	Station	Chain	Kilocycles
Akron, Ohio	WFJC	National	1450
Asheville, N. C.	WWNC	Columbia	570
Atlanta, Ga.	WSB	National	740
Baltimore, Md.	WBAL	National	1060
	WCAO	Columbia	600
Birmingham, Ala.	WAPI	National	1140
	WBRC	Columbia	930
Boston, Mass.	WEEI	National	590
	WBZA	National	990
	WNAC	Columbia	1230
Bowmanville, Can.	CKGW	Columbia	960
Buffalo, N. Y.	WGR	National	550
	WMAK	Columbia	900
	WKBW	Columbia	1480
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
Cleveland, Ohio	WTAM	National	1070
	WEAR	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
Davenport, Iowa	WOC	National	1000
Denver, Colo.	KOA	National	830
Des Moines, Iowa	WHO	National	1000
Detroit, Mich.	WWJ	National	920
	WJR	National	750
	WGHP	Columbia	1340
Dupont, Colo.	KLZ	Columbia	560
Ft. Wayne, Ind.	WOWO	Columbia	1160
Ft. Worth, Texas	WBAP	National	800
Harrisburg, Pa.	WHP	National	1430
Hartford, Conn.	WTIC	National	1060
Hot Springs, Ark.	KTHS	National	1040
Houston, Texas	KPRC	National	920
Independence, Mo.	KMBC	Columbia	950
Indianapolis, Ind.	WFBM	Columbia	1230
Jackson, Miss.	WJDX	National	1270
Jacksonville, Fla.	WJAX	National	900
Kansas City, Mo.	WDAF	National	610
Kingston, Can.	CFRB	Columbia	960
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
Miami Beach, Fla.	WIOD	National	1300
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 Orleans, La.	WSMB	National	1320
	WDSU	Columbia	1270
New York, N. Y.	WEAF	National	660
	WJZ	National	760
	WABC	Columbia	860
Norfolk, Va.	WTAR	Columbia	780
Oakland, Calif.	KGO	National	790
Oil City, Pa.	WLBW	Columbia	1260
Oklahoma City, Okla.	WKY	National	900
	KFJF	Columbia	1480
Omaha, Neb.	WOW	National	590
Philadelphia, Pa.	WFI	National	560
	WLIT	National	560
	WCAU	Columbia	1170
	WFAN	Columbia	610
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 Antonio, Texas	WOAI	National	1190
	KTSA	Columbia	1490
San Francisco, Calif.	KPO	National	680
	KFRC	Columbia	610
Schenectady, N. Y.	WGY	National	790
Seattle, Wash.	KOMO	National	970
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	National	1360
Tacoma, Wash.	KVI	Columbia	760
Tallmadge, Ohio	WADC	Columbia	1320
Toledo, Ohio	WSPD	National	1240
Toronto, Can.	CKGW	National	690
Topeka, Kan.	WIBW	Columbia	1300
Tulsa, Okla.	KVOO	National	1140
Washington, D. C.	WRC	National	950
	WMAL	Columbia	630
Whitehaven, Tenn.	WREC	Columbia	600
Wichita, Kan.	KFH	Columbia	1300
Worcester, Mass.	WTAG	National	580
Youngstown, Ohio	WKBN	Columbia	570

DON'T TAKE CHANCES

■■■■ THE NAME TRIAD IS YOUR SUREST GUARANTEE OF RADIO TUBE QUALITY

Here is still further proof of it ■■■ TRIAD Tubes are now fully licensed under all R.C.A., General Electric Co., and Westinghouse Electric Mfg. Co. patents! Quality alone has won for TRIAD Tubes a nation-wide acceptance ■■■ and continued adherence to that same quality standard is daily winning thousands of additional TRIAD users. ■■■■■■■■■■■



New—TRIAD Tubes, T-24 and T-27! Now definitely protected against burn-outs and rendered completely non-microphonic. Here is still another achievement of TRIAD engineers!

TRIAD RADIO TUBES

TRIAD MANUFACTURING CO., INC., PAWTUCKET, R. I.

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.

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

KDB
1500 kc, Santa Barbara, Calif., Santa Barbara Broadcasting Co., 100 w, P.

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

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

KDLR
1210 kc, Devils Lake, N. D., Radio Electric Co., 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.

KEJK
710 kc, Beverly Hills, Calif., R. S. MacMillan, 500 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., Nebraska Buick Automobile Co., 5,000 w, C, "Home Sweet Home."

KFBB
1360 kc, Great Falls, Mont., Buttrey Broadcast, Inc., 500 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."

KFHA
1200 kc, Gunnison, Colo., Western State College of Colorado, 50 w.

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

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

KFIO
1230 kc, Spokane, Wash., Spokane Broadcasting Corp., 100 w day, 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., Colorado State Teachers College, 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, 1000 w, C, "Up at Lawrence on the Kaw."

KFKX
See under KYW.

KFLV
1410 kc, Rockford, Ill., A. T. Frykman, 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, 15 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, Siloam Springs, Ark., Rev. Lannie W. Stewart, 50 w, C.

KFPY
1340 kc, Spokane, Wash., Symons Investment Co., 500 w, P.

KFQA
See under KMOX

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

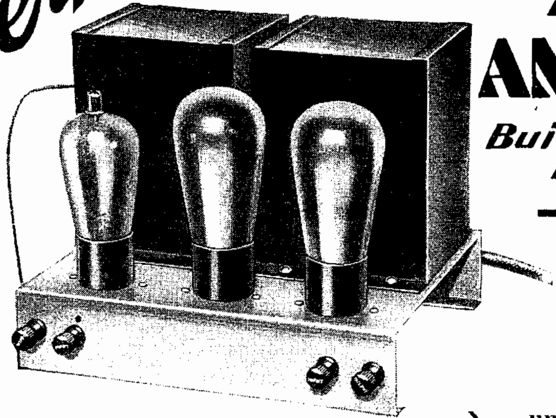
KFQU
1420 kc, Holy City, Calif., W. E. Riker, 100 w, P.

KFQW
1420 kc, Seattle, Wash., KFQW, Inc., 100 w, P, "Gateway to Alaska and the Orient."

First Perfected LOFTIN-WHITE

Direct Coupled AMPLIFIER KIT

Built by ELECTRAD



The Loftin-White Direct-Coupled Amplifier with self-contained A.C. power supply as constructed from the ELECTRAD-LOFTIN-WHITE *A-245 Kit. Utilizes one type '24, one '45 and one '80 tube.*

Authorized by, and prepared in co-operation with Edward Loftin and S. Young White, inventors of the revolutionary direct-coupled amplifier systems bearing their name.

THE amazing new Loftin-White Direct-Coupled Audio Amplifier, acclaimed by radio engineers and fans as the most far-reaching development of modern radio, is now *perfected* and made available for the first time in complete approved form by Electrad.

In the Loftin-White Amplifier the tubes are coupled *directly* to each other without intervening transformers or condensers. There is practically no frequency discrimination over the audible range, and it delivers undistorted volume restricted only by the amplification constant of the power tube used.

Extraordinary Advantages of the LOFTIN-WHITE Direct-Coupled Amplifier

Amazing simplicity in assembly and operation—fewer tubes and other parts—light weight——immense undistorted power——unlimited tone range—are the outstanding features of this Amplifier.

The experimenter will find in this Kit fascinating new fields for exploration—the Custom-Radio Builder will find it meets the most exacting standards of adaptability, power and tone, at a fraction of the cost of any other type amplifier even approaching it in quality.

Perfectly Operating Resistances Necessary

As the successful operation of the Loftin-White circuit depends almost entirely on the effective performance of its controlling resistances, it is only natural that the inventors should turn to ELECTRAD for the development of resistances which would do full justice to the principle of their extraordinary amplifier.

Let the world-wide ELECTRAD reputation for highest quality design and manufacture be *your guarantee* of maximum results from this revolutionary circuit.

ELECTRAD - LOFTIN - WHITE *Direct-Coupled* Amplifier Kit, complete, including drilled metal chassis and easy assembly and operating instructions *(less tubes)*, List Price $35

If your dealer can't supply you, write direct to us. Address Dept. CB3

175 Varick St., New York, N.Y.

ELECTRAD
INC.

MAIL COUPON FOR LOFTIN-WHITE FOLDER

ELECTRAD, INC., Dept. CB3, 175 Varick St., New York
Please send full details of Loftin-White Amplifier Kit to
Name ....
Address ....

KFQZ
860 kc, Los Angeles, Calif., Taft Radio & Broadcasting Co., Inc., 250 w, P.

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.

KFWM
930 kc, Richmond, Calif., Oakland Educational Society, 500 w, P, "The Most Good to the Most People."

KFXD
1420 kc, Jerome, 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., R. G. Howell, 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 kc, Abilene, Texas, T. E. Kirksey, 100 w, C, "Breckenridge, the Dynamo of West Texas."

KFYR
550 kc, Bismarck, N. D., Hoskins-Meyer, 500 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., Foster-Hall Tire Co., 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.

KGCI
1370 kc, San Antonio, Texas, Liberto Radio Sales, 100 w, C, "Radio Sam at San Antonio."

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, Dell Rapids, S. D., Home Auto Co., 50 w.

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

KGDM
1100 kc, Stockton, Calif., E. F. Peffer, 50 w.

KGDY
1200 kc, Oldham, S. Dak., J. Albert Loesch, 15 w, C.

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

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

KGER
1360 kc, Long Beach, Calif., C. Merwin Dobyns, 250 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., Faith Tabernacle Assn., 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
1200 kc, Hallock, Minn., Lautzenheiser Mitchell, 50 w, C.

KGFL
1370 kc, Raton, N. Mex., Hubbard & Murphy, 50 w, M.

KGFW
1310 kc, Ravenna, Neb., Otto F. Sothman, R. H. McConnell, 50 w.

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

KGGC
1420 kc, San Francisco, Calif., Golden Gate Broadcasting Co., 50 w, P.

KGGF
1010 kc, Picher, Okla., D. L. Connell, M.D., 500 w.

KGGM
1370 kc, Albuquerque, N. Mex., New Mexico Broadcasting Co., 250 w.

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

KGHG
1310 kc, McGehee, Ark., Chas. W. McCollum, 50 w.

KGHI
1200 kc, Little Rock, Ark., Berean Bible Class, 100 w.

KGHL
950 kc, Billings, Mont., Northwestern Auto Supply Co., 500 w, M.

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

KGIR
1360 kc, Butte, Mont., KGIR, Inc., 250 w, M.

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

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

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.

KGO
790 kc, Oakland, Calif., General Electric Co., 7500 w, P.

KGRC
1370 kc, San Antonio, Texas, Eugene J. Roth, 100 w, C.

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

KGU
940 kc, Honolulu, Hawaii, Marion Mulrony, Advertising Publ. Co., 500 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., Jack W. Duckworth, Jr., 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, Blytheville, Ark., C. L. Lintzenich, 50 w, C.

KLO
1370 kc, Ogden, Utah, Peery Building Co.,100 w, M.

KLPM
1420 kc, Minot, N. D., E. C. Reincke, 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, Dupont, 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."

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

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

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

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

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., 5000 w, C.

KMTR
570 kc, Hollywood, Calif., KMTR Radio Corp., 500 w, P, "Your Friend in Hollywood."

KNX
1050 kc, Hollywood, Calif., Western Broadcast Co., 50,000 w, P, "The Voice of Hollywood."

KOA
830 kc, Denver, Colo., General Electric Co., 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, 10,000 w, M, "The Sunshine State of America."

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

KOH
1370 kc, Reno, Nevada, Jay Peters, Inc., 100 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
970 kc, Seattle, Wash., Fisher's Blend Station, Inc., 1000 w, P.

KOOS
1370 kc, Marshfield, Ore., H. H. Hanseth, 50 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."

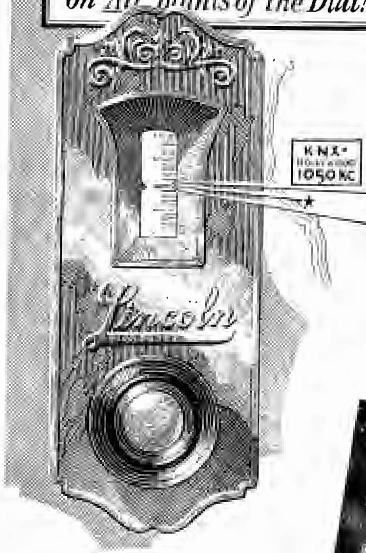
KPCB
1210 kc, Seattle, Wash., Wescoast Broadcasting Co., 100 w, P. Shared.

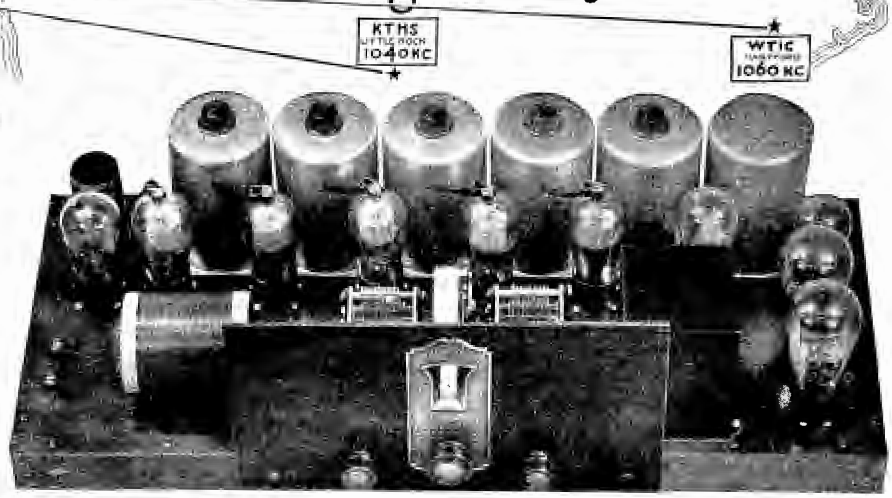
KPJM
1500 kc, Prescott, Ariz., Miller & Klahn, 100 w, M.

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

Absolute 10 kc Separation on All points of the Dial!

Your Money Should Buy You *Guaranteed Performance*
The *Lincoln* De Luxe 10
will give it to you—





Testimonials

Detroit, Mich.

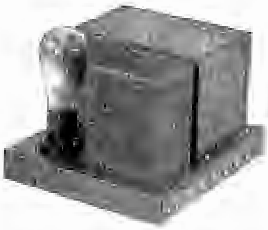
Four or five evenings with your DeLuxe 10 have fully proved it to be everything you said. It is easily the most rejective and the most sensitive set with which I have had exprience. Its quality is perfect and its ability to reach out is nothing short of amazing. My location is in almost the exact geographical center of Detroit. The weather has not been, by any means, ideal during the past week, but I have succeeded in locating almost every frequency on the dial, and I can truthfully say that I have never yet had the set anywhere near wide open.

Des Moines, Iowa.

Frankly, we are so fed up on superlative claims that we have grown very skeptical of anything we hear or read about unusual performance; but we feel that you have aroused no expectations that this job will not fulfill.

Erie, Penna.

The DeLuxe 10 arrived, set up and tested out; it is the last word in radio, super-selective, tone quality and stations galore, fifty were tuned in from Texas to New York and from Boston to Denver in rotten weather, rain and plenty of static.



Lincoln DeLuxe 10-B supplies correct B voltages for Lincoln DeLuxe 10; also 60 mills, 150 volts for field of Dynamic Speaker.

WILL your present equipment register every channel in the broadcast band, including channels 10 KC from local, at one trip across the dial?

Will it bring in every one of these stations with a volume equal to local?

Will it tune stations WTIC, Hartford, Conn., and KTHS, in the city of Los Angeles, with KNX on the air?

Will it tune both adjacent 10 KC channels from a powerful Chicago local with the receiver located 200 feet from transmitting antenna?

Will it bring these stations in with quality of tone?

If it will do this, we cannot interest you.

***Two solid years of concentrated effort* has made possible this new performance. In the Lincoln DeLuxe 10 is embodied original design, correct basic principles approved by any engineer, developed to a point of high efficiency. Parts of this design is copied by many. Watch the future trend.**

***Guaranteed Performance.* We stand back of the DeLuxe 10 performance, 100%. We have had to double our laboratory force to take care of the orders of people who have actually seen and heard this equipment perform.**

SETBUILDERS AND DISTRIBUTORS

We are protecting you 100% in your sales efforts. Write at once for full information. You can get back of this equipment housed in furniture which will grace the finest homes.

Testimonials

Santa Paula, Calif.

For just about 10 years I have been building supers. In that time I have used practically every circuit and every make of parts as they have been put on the market. This DeLuxe 10 comes nearer meeting my ideas in sensitivity, selectivity, and power than anything I have ever seen. It is not as easy to get distance from the Pacific Coast as some Eastern people would think. Saturday night I logged three stations that I have never heard before, WBZ, WTIC, WOR, and in addition practically every channel with the exception of some of the Canadian and some of the higher frequencies. This is the only radio I have ever seen that will get both adjacent channels to KFI and KNX.

White Plains, N. Y.

Lincoln 10 is the best receiver of hundreds I have tested since broadcasting began. Absolute 10 KC separation. At six tonight, despite rotten weather, received WGN and WLW flanking WOR like locals with no trace of cross talk, and later on reception on practically every wave length.

St. Louis, Mo.

It sure is a wonder. I got KNX Saturday night between KRLD and WBAL. KNX was right up against KRLD with quite a dead spot from WBAL. Never had a bit of trouble from KRLD. Had Brownwood, Texas, 100 watt station, like local while WLAC was on air. Get WCKY, KFJF, one after the other.

LINCOLN RADIO CORPORATION
329 SOUTH WOOD ST. — CHICAGO — ILLINOIS.

CHASSIS
22⅞"x10¾"

LINCOLN RADIO CORP., Dept. C
329 S. Wood St., Chicago
Send full information on the Lincoln DeLuxe 10.

Name..

Address..

....

TUBES
5—'24 screen grid
3—'27 screen grid
2—'45 screen grid

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

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

KPQ
1210 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.

KPWF
1490 kc, Westminster, Calif., Pacific Western Broadcasting Federation, 10,000 w, P.

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

KQW
1010 kc, San Jose, Calif., First Baptist Church, 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, Valley Radio Electric Corp., 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.

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

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

KSAT
1240 kc, Ft. Worth, Texas, Texas Air Transport Broadcasting Co., 1000 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 Valley R. R. 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., 1000 w, C.

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

KTAB
560 kc, Oakland, 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., KAR Broadcasting Co., 500 w, M, "Phoenix, Where Winter Never Comes."

KTBI
1300 kc, Los Angeles, Calif., Bible Institute of Los Angeles, 750 w, P.

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

KTBS
1450 kc, Shreveport, La., S. R. Elliott and A. C. Steere, 1000 w, E.

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

KTLC
1500 kc, Richmond, Tex., Houston Brdcstg. Co., 50 w, C.

KTM
780 kc, Santa Monica, 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."

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.

KTUE
1420 kc, Houston, Texas, Uhalt Electric, 100 w, C.

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

KUJ
1500 kc, Longview, Wash., Columbia Broadcasting Co., Inc., 10 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.

KVEP
1500 kc, Portland, Ore., Schaeffer Radio Co., 15 w, P.

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

KVL
1370 kc, Seattle, Wash., Arthur C. Dailey, 100 w.

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.

KWEA
1210 kc, Shreveport, La., William E. Antony, 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, Kennonwood, La., W. K. Henderson, 10,000 w, C.

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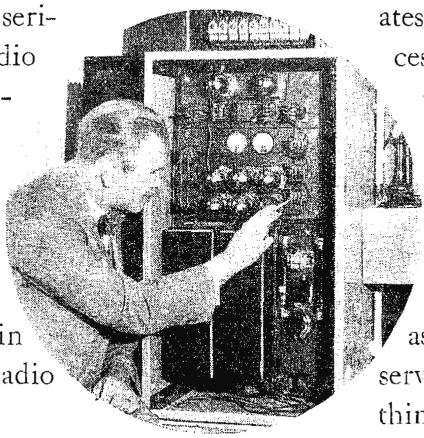
REACH out for a big-pay job in Radio... Tie-up to the fastest-growing industry in the world today... See for yourself what other men have done... You, too, can do the same! Hundreds of fellows just like you are now earning from $2,000 to $25,000 a year in RADIO. J. H. Barron, Radio Inspector of the U. S. Department of Commerce says that a most serious shortage in trained Radio men exists right now. Thousands of trained men are needed. Broadcasting stations, manufacturing plants, retail and wholesale dealers, as well as ships at sea and planes in the air, require trained Radio men.



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RCA sets the standards for the entire radio industry. The RCA Institutes Home Laboratory Training Course gives you the real, inside, practical training in Radio, quicker than you could obtain it in any other way. It's easy to learn at home in your spare time. You get your lessons and criticisms direct from RCA... the very source of radio achievement... the vast world-wide organization that has made Radio what it is today... that sponsors every lesson in this course.

RCA Graduates Find it Easy to Fill Good Radio Jobs

There has been a radio job for practically every graduate of RCA Institutes. Graduates are actually *Trained* for Success because they learn radio by actual experience with the RCA Institutes famous outlay of apparatus given to every student of this course. You learn to solve every radio problem such as repairing, installing, and servicing fine sets. Here is everything you need know in order to fill a well-paid position in Radio.

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Read these 40 fascinating pages, each one packed with pictures and text that tell you everything you want to know about the many brilliant opportunities in Radio and about RCA Institutes, the world's oldest and largest radio training organization. Tune in on Radio. Send for this free book today and speed up your earning capacity!

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Name ________________

Address ________________

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

KWSC
1220 kc. Pullman, Wash., State College of Washington, 500 w, P, "The Voice of the Cougars."

KWWG
1260 kc. Brownsville, Texas, Chamber of Commerce, 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
1300 kc, El Centro, Calif., Irey & Bowles, 100 w, P.

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

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

KYW
1020 kc, Chicago, Ill., Westinghouse E. & M. Co., 5000 w, C.

KYWA
1020 kc, Chicago, Ill., Westinghouse Elec. & Mfg. Co., 500 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
1070 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, First Universalist Church, 100 w, E, "The Pine Tree Wave."

WABO
See under WHEC.

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

WADC
1320 kc, Tallmadge, Ohio, Allen T. Simmons, 1000 w, E, "Watch Akron Develop Commercially."

WAGM
1310 kc, Royal Oak, Mich., Robert L. Miller, 50 w, E.

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

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

WASH
1270 kc, Grand Rapids, Mich., WASH Broadcasting Corp., 500 w, C.

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., 50,000 w, C.

WBAW
1490 kc, Nashville, Tenn., Tennessee Publishing Co., 5000 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
1370 kc, Richmond, Va., Grace Covenant Presbyterian Church, 100 w, E, "Richmond, the Gateway North and South."

WBBM
770 kc, Chicago, Ill., Atlas Investment Co., 25,000 w, C.

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

WBBY
1200 kc, Charleston, S. C., Washington Light Infantry, 75 w, E, "The Seaport of the Southeast."

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.

WBIS
See under WNAC.

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

WBNY
1350 kc, New York, N. Y., Baruchrome Corp., 250 w, E, "The Voice of the Heart of New York."

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.

WBRL
1430 kc, Tilton, N. H., Booth Radio Laboratories, 500 w, E.

WBSO
920 kc, Wellesley Hills, 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."

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. 500 w, E, "Where Prosperity Begins."

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

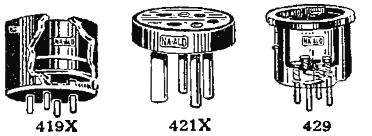
NA-ALD

TRADE MARK
REG. U.S.A. PAT. OFF.

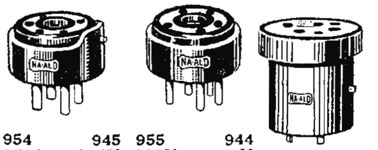
PRODUCTS

Whatever Your Requirements of Adapters, Plugs, Sockets and Connectoralds, We Have Them or Can Make Them

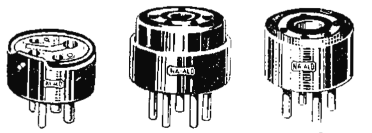
GROUP A
Adapters for Putting Any Tube into Any Socket



419X 421X 429

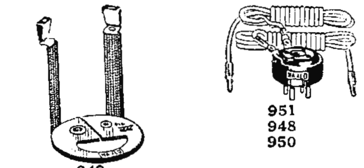


954 954A 945 945H 955 955N 955GD 944 944N 999



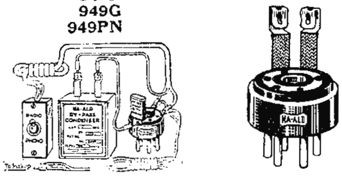
968 967 955E 944E 954D 945D

GROUP D
Adapters for Electric Pickup



951 948 950

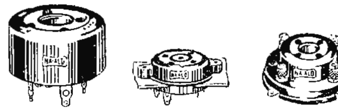
949 949P 949G 949PN



948A 955KTS

GROUP I—SOCKETS

474 475 464 465

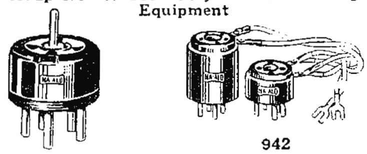


422 423 424 425 426 427

GROUP E
Adapters for Connecting Power Amplifiers to Any Set

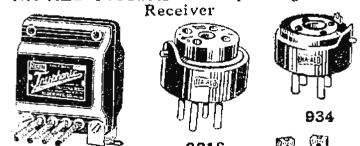
933 947 953 953A 952 952A

GROUP F
Adapters for Set Analyzers and Testing Equipment



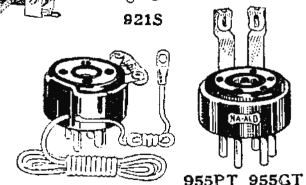
957 958 942 932

GROUP G
NA-ALD Products for Improving Your Receiver



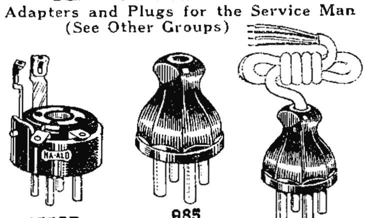
934 921S

300 301 301R 310LS 311LS 311LSR

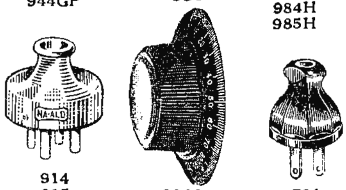


923 955PT 955GT 944PT 944GT

GROUP H
For the RADIOTRICIAN and the SERVICE DEPARTMENT
Adapters and Plugs for the Service Man
(See Other Groups)



955GP 944GP 985 984 984H 985H



914 915 3044 701

GROUP A—Adapters for Putting Any Tube Into Any Socket

419X—UX-199 Tubes to UV-201-A Sockets........$0.35
421X—UX Tubes to WD-11 Sockets.................. .75
429—UV-199 Tubes to UX or UV-201-A Sockets .75
944—UX to UX Raises Tube ⅝"........................ 1.00
944E UX to UX Raises Tube ⅞" 1.00
945—UX Tubes to UY Sockets........................ 1.00
945D—UX Tubes to UY Sockets (small diam.).... 1.00
954—UY Tubes to UX Sockets 1.00
954D—UY Tubes to UX Sockets (small diam.).... 1.00
955—UY to UY Raises Tube ⅝"........................ 1.00
955E—UY to UY Raises Tube ⅞"........................ 1.00
967—UV-201-A Tubes to UX Sockets................ 1.00
968—WD-11 Tubes to UX or UV-201-A Sockets.. 1.25
999—UX Tubes to UV-199 Sockets.................. 1.00

GROUPS B and C—Connectoralds for Adding Power Tubes to Any Set and for Converting Battery Sets to A.C.—Please Write for Price Sheets

GROUP D—Adapters for Electric Pickup

949—Connects Pickup to Grid Circuit of UX or UY Tubes $0.60
948A—Connects Pickup to Plate Circuit of UY Tubes, includes Radio Phono Switch and By-Pass Condensers 4.00
955KTS—Connects Pickup to Kathode Circuit of Screen Grid Sets.. 1.25

And several other types. Write for details.

GROUP E—Adapters for Connecting Power Amplifiers to Any Set

952A—Recommended by Samson for connecting PAM Amplifiers to A.C. Sets with R.F. By-Pass Condenser 2.25
953A—Recommended by Samson for connecting PAM Amplifiers to D.C. Sets with R.F. By-Pass Condenser 2.00

And several other types. Write for details.

GROUP F—Adapters for Set Analyzers and Testing Equipment

927H—5 hole 4 prong—lead clips to HH. Fil. prongs not shorted—for replacing McCullough Tubes with A.C. Tubes........................$1.25
927N—5 hole 4 prong—lead clips to HH. Fil. prongs are shorted........................ 1.25
932—Testing 222 Tubes in Jewell Testers.......... 4.00
942—Testing UY Tubes in Jewell Testers.......... 4.00
957—4 hole 5 prong with Top Center Stud.......... 1.25
958—5 hole 4 prong with Bottom Center Stud.... 1.25

GROUP G—NA-ALD Products for Improving Your Receiver

304—3 Stage Truphonic Amplifier to replace the audio end of any receiver—gives clear reception with beautiful tone quality and a fidelity of reproduction unsurpassed (for battery operation). Special Price, Net........................$9.50
300-301-301R—Truphonic Couplers respectively Output Unit, Intermediate Coupler and First Stage, Each 5.00
310LS-311LS-311LSR—Same Couplers with mountings for manufacturers. Prices on application.
921S—Adapter for cushioning microphonic tubes in either UX or UV-201-A Sockets........................ 1.25
923—Adapter for adapting any UX Socket for UX-222 Shielded Grid Tube........................ 1.50
934—Adapter for oscillation control in R.F. stages (Takes Grid Suppressors of values 200, 300, 500, 700, 1000 ohms........................ 1.25
R200 to R1000—Grid Suppressors for 934 Adapter .25
944PT—Adapter for listening in on UX Detector Tubes with headphones........................ 1.25
955PT—Adapter for UY Detector Tubes.............. 1.25
955GD—Adapter for Testing 224 Screen Grid Tubes—G post dead........................ 1.00
955GP—UY Test Adapter, making detector of any stage, breaks grid circuit for grid leak and condenser, also breaks plate with phone tip terminals for headphones........................ 1.25
955GT—UY Adapter breaks G with Tip Jacks—other connections through........................ 1.25
955HH—UY Adapter—connects ammeter to H prongs 1.25
955N—UY Neutralizing Adapter—One H Dead.... 1.00
955X—(Coming) 4" long UY Extension Adapter.
982—Victor Adapter—Recommended in Service Manual 5.00
984—4 Prong all Bakelite Plug (No Harness).... .50
984H—4 Prong all Bakelite Plug with Harness.... 1.50
985—5 Prong all Bakelite Plug (No Harness).... .50
985H—5 Prong all Bakelite Plug with Harness.... 1.50

IF YOUR DEALER OR JOBBER CANNOT SUPPLY, ORDER DIRECT

GROUP H—Adapters and Plugs for the Service Man

(See Other Groups)

Coming! An Adapter Kit for Service Men. Write if interested.

701—Alden Suregrip Attachment Plug......$0.15
901—Adapter Plug Stud—Provides optional union between 984 or 985 Plugs and any NA-ALD Adapter........................ .15
914—4 Prong Metal Cap Plug (No Harness) .... .25
914H—4 Prong Metal Cap Plug with 40" Harness 1.25
915—5 Prong Metal Cap Plug (No Harness) .... .25
915H—5 Prong Metal Cap Plug with 40" Harness 1.25
944FF—UX Adapter—Connects Ammeter to Fil. Prongs........................ 1.25
944GP—Test Adapter 4 prong, making detector of any stage, breaks grid circuit for grid leak and condenser, also breaks plate with phone tip terminals for headphones 1.25
944GPL—Adapter for measuring voltage impress on both plates of No. 280 tubes 1.50
944GT—UX Adapter—Breaks G with Tip Jacks. Other connections through.......... 1.25
944N—UX Neutralizing Adapter—One F dead 1.00
944X—(Coming) 4" long UX Extension Adapter.

GROUP I—Sockets

400—DeLuxe Socket with neck and slot for Bayonet Pin........................$0.75
422—Small Space UX Socket for below panel soldering .... .35
423—Small Space UY Socket for below panel soldering .... .35
424—UX Socket with 2 mounting holes for above or below panel mounting, below panel soldering........................ .50
425—UY Socket with 2 mounting holes, below panel mounting, below panel soldering .... .50
426—UX Socket with contacts for above panel soldering .... .50
427—UY Socket with contacts for above panel soldering .... .50
428—UX Small Space Socket especially for Rectifier Tubes, for above panel soldering .... .25
464—UX Sport Model A.C. Socket.......... .50
465—UY Sport Model A.C. Socket.......... .50
474—UX Laminated A.C. Socket.......... .25
475—UY Laminated A.C. Socket.......... .25
481XS—NA-ALD 4 Prong Non-Microphonic Socket with mounting base.......... .65
482S—NA-ALD 4 Prong Non-Microphonic Socket for direct panel mounting .35

Dept. C-3 ALDEN MANUFACTURING CO. Brockton, Mass.

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., Carthage College, 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., 250 w, E.

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

WCCO
810 kc, Minneapolis, Minn., Northwestern Bdcstg., 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, Coney Island, N. Y., U. S. Broadcasting Corp, 500 w, E.

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

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

WCLO
1200 kc, Kenosha, Wis., C. Whitmore, 100 w, C.

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

WCMA
1400 kc, Culver, Ind., Culver Military Academy, 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., Crystal Oil 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.

WCSH
940 kc, Portland, Me., Congress Square Hotel Co., 500 w, E, "The Voice From Sunrise Land."

WCSO
1450 kc, Springfield, Ohio, Wittenberg College, 500 w, E.

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, Trinity Methodist Church, 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.

WDOD
1280 kc, Chattanooga, Tenn., Chattanooga Radio 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., 500 w, E.

WEAN
780 kc, Providence, R. I., The Shepard Stores Co., 250 w, E, "We Entertain a Nation."

WEAO
550 kc, Columbus, Ohio, Ohio State University, 750 w, E.

WEAR
1070 kc, Cleveland, Ohio, WTAM and WEAR, Inc., 1000 w, E.

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

WEBE
1210 kc, Cambridge, Ohio, Roy W. Waller, 100 w, E.

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."

WEBW
560 kc, Beloit, Wis., Beloit College, 500 w, C.

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
1370 kc, Emory, Va., Emory and Henry College, 100 w, E.

WEHS
1420 kc, Evanston, Ill., Victor C. Carlson, 100 w, C.

FERRANTI

AUDIO FREQUENCY TRANSFORMERS AND AMPLIFIERS

Engineering Information and Prices Furnished on Application

FERRANTI, INC.
130 West 42nd Street
New York City

WELK
1370 kc, Philadelphia, Pa., Howard R. Miller, 100, E.

WEMC
590 kc, Berrien Springs, Mich., Emmanuel Missionary College, 1000 w, C, "The Radio Lighthouse."

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

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.

WFAA
800 kc, Dallas, Texas, Dallas News and Journal, 5000 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, Parkview Hotel, 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."

WFBJ
1370 kc, Collegeville, Minn., St. Johns University, 100 w, C, "In the Heart of the Landscape Paradise."

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.

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

WFIW
940 kc, Hopkinsville, Ky., The Acme Mills, Inc., 1000 w, C.

WFJC
'450 kc, Akron, Ohio, W. F. Jones Broadcasting, nc., 500 w, E.

WFKD
1310 kc, Philadelphia, Pa., Foulkrod Radio Eng. Co., 50 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., Lancaster Elec. Sup. & Const. Co., 15 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., First Baptist Church, 500 w, C. Shared.

WGBF
630 kc, Evansville, Ind., Evansville on Air, 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., Virginia Broadcasting Co., Inc., 100 w, E.

WGHP
1340 kc, Detroit, Mich., American Broadcasting Corp., Inc., 1000 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., WGR, Inc., 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, E.

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

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

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

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

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

WHAT
1310 kc, Philadelphia, Pa., A. A. Walker, 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., Broadcasting 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.

WHDL
1420 kc, Tupper Lake, N. Y., G. F. Bissell, 10 w, E.

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

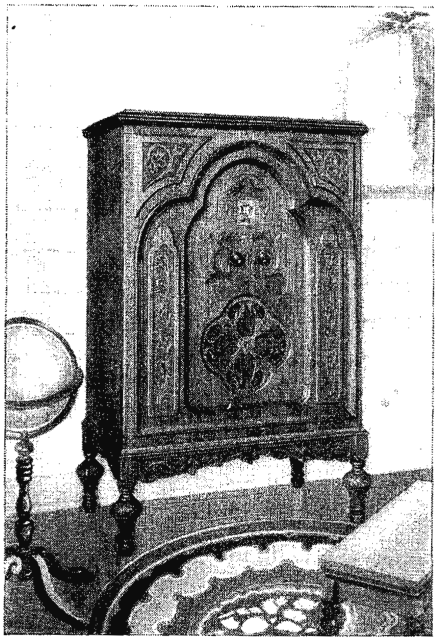
WHDI
1180 kc, Minneapolis, Minn., Wm. Hood Dunwoody Ind. Inst., 500 w, C.

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

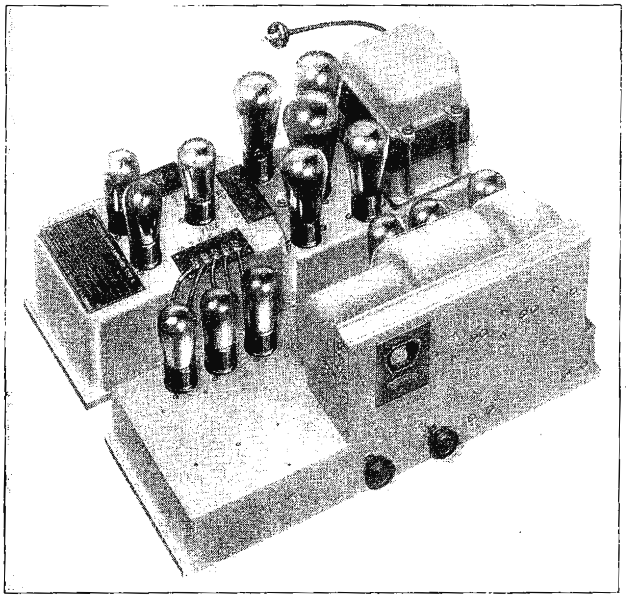
WHFC
1420 kc, Cicero, Ill., Triangle Broadcasters, 100 w, C.

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

J. A. Victoreen



Today—the only Radio that justifies a list price of $345.00



—and the only chassis and speaker listed at $277.00

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The Chassis

itself, is a distinct departure from accepted construction practice, designed by J. A. Victoreen—pioneer radio engineer. Built in two parts—receiver and amplifier—each encased in cast aluminum.

The circuit provides for 6 tubes in the tuner, consisting of a stage of r.f., oscillator, first detector and three stages of intermediate frequency. The amplifier contains the second detector as well as the first and second audio stages.

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Please send free and without obligation, complete information about the VICTOREEN 14-TUBE SUPER-HETERODYNE.

Name...

Address..

(Please write on business stationery or state your occupation and position)

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, Bankers Life Co., 5000 w, C, "W-H-O, Who? Banker's Life, Des Moines."

WHP
1430 kc, Harrisburg, Pa., Pennsylvania Broadcasting Co., 500 w, E.

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

WIBA
1210 kc, Madison, Wis., Capital Times Co., 100 w, C.

WIBG
930 kc, Elkins Park, Pa., St. Paul's M. E. Church, 50 w, E.

WIBM
1370 kc, Jackson, Mich., C. L. Carrell, 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."

WIBS
1450 kc, Elizabeth, N. J., New Jersey Broadcasting Co., 250 w, E.

WIBU
1310 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 Beach, 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."

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."

WJAD
1240 kc, Waco, Texas, Frank P. Jackson, 1000 w, C, shared, "Waco, Texas, All Around It."

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., enith Radio Corp., 5000 w, C.

WJBC
1200 kc, LaSalle, Ill., Hummer Furniture Co., 100 w, C.

WJBI
1210 kc, Red Bank, N. J., Robt. S. Johnson, 100 w, E.

WJBK
1370 kc, Ypsilanti, 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., 500 w, C.

WJJD
1130 kc, Mooseheart, 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., 500 w, C.

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

WJSV
1460 kc, Mt. Vernon Hills, Va., Independent Pub. Co., 10,000 w.

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

WJZ
760 kc, New York City, N. Y., Radio Corporation of America, 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 k, C.

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

WKBF
1400 kc, Indianapolis, Ind., Noble Butler Watson, 500 w, C, "We Keep Building Friendships."

WKBH
1380 kc, LaCrosse, Wis., Callaway Music Co., 1000 w, C.

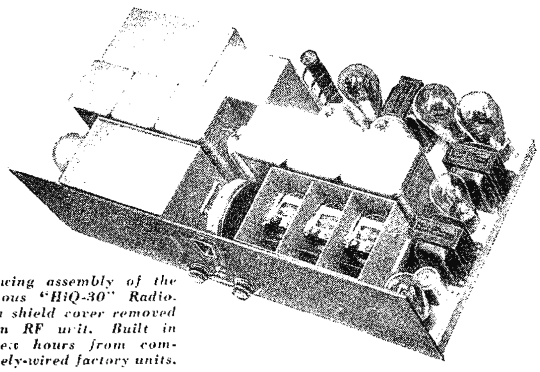
WKBI
1420 kc, Chicago, Ill., Fred L. Schoenwolf, 50 w, C.

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

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

When You Build—Build WELL!

The World's Premier *Custom* RADIO *Perfected With* HAMMARLUND PARTS



Showing assembly of the famous "HiQ-30" Radio, with shield cover removed from RF unit. Built in a few hours from completely-wired factory units.

THOUSANDS have built the new Hammarlund "HiQ-30" and call it "*revolutionary.*"

It is in fact an amazing receiver—superb in design, perfect in parts and delivers results that surprise even us.

Custom-Built with special Hammarlund units and backed by the twenty-year Hammarlund reputation for doing things *right.*

If you want the most selective, the most sensitive and the most beautifully-toned receiver you have ever owned—build or have built for you the new "HiQ-30" Band-Filter, Screen-Grid Radio with six tuned circuits. *Mail coupon for complete information.*

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PRECISION
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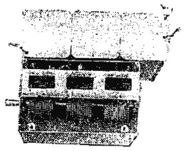
3-STAGE BAND FILTER *and* R. F. AMPLIFIER UNITS

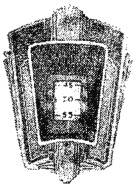


Completely wired, shielded and tested. Band Filter for 10-kilocycle selectivity. Flat-top tuning without side-band cutting. R. F. Amplifier with amazing amplification of 3 Screen-Grid tubes. Both units complete in every detail, except tubes, for immediate installation. Sub-panel connections.

SHIELDED, POLARIZED R. F. CHOKE

A radio-frequency choke specially developed for modern high-gain, shield-grid receivers. Aluminum-shielded and polarized. Minimum external field. No undesired coupling to cause circuit instability or feed-back. High inductance, low distributed capacity. Efficient, compact. Sub panel connections.

New DRUM DIAL PANEL PLATE

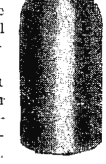


Richly embossed, pebbled bronze, in the modern mode. It has grace and charm appropriate to the superb dial mechanism back-panel that delighted thousands of set builders last season. The control knob can be mounted anywhere on the panel. Illuminated scale.

AUDIO TRANSFORMERS *Including* PUSH-PULL

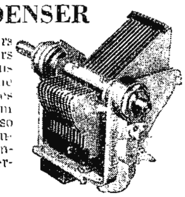
Designed for fidelity of response over the audible frequency range with a sharp cut-off at the high frequency noise level. Large cross-section core of specially treated laminations permits high primary currents without saturation. Completely shielded. Pigtail terminal leads for sub-panel connection.

SCREEN-GRID TUBE SHIELD



Essential for '22 and '24 type shield-grid tubes to insure full advantage of their great amplification. Aluminum, with a soft rubber grommet at top to protect control grid outlet. Designed for use with sub-panel sockets. Mounting screws and control grid connector included with each shield.

The Famous "MIDLINE" CONDENSER



More than three years the favorite of engineers and advanced radio fans—and still new in the sense that its features and workmanship from the beginning were so far ahead that its popularity has steadily increased and its leadership still stands unchallenged. All standard capacities

WKBP
1420 kc, Battle Creek, Mich., Enquirer-News Co., 50 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, Brookville, Ind., Knox Battery & Electric Co., 100 w, C.

WKBW
1480 kc, Buffalo, N. Y., Churchill Evan. Assn., Inc., 5000 w, E.

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

WKEN
1040 kc, Buffalo, N. Y., WKEN, Inc., 1000 w, E.

WKJC
1200 kc, Lancaster, Pa., Kirk Johnson & Co., 100 w, E.

WKRC
550 kc, Cincinnati, Ohio, WKRC, Inc., 500 w, E, "WKRC, K—Kodel, R—Radio, C—Corporation."

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

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, 30 w, C.

WLB
1250 kc, Minneapolis, Minn., University of Minnesota, 500 w, C.

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

WLBF
1420 kc, Kansas City, Kan., Everett L. Dillard, 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.

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
570 kc, Casenovia, N. Y., Clive B. Meredith, 250 w, E. "Voice of Central New York."

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

WMAK
900 kc, Buffalo, N. Y., WMAK Broadcasting System, Inc., 750 w, E.

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

WMAN
1210 kc, Columbus, Ohio, W. E. Heskitt, 50 w, E.

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

WMAY
1200 kc, St. Louis, Mo., Kingshighway Presbyterian Church, 100 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, Pittsburgh, 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."

WMES
1500 kc, Boston, Mass., Boston Broadcasting Co., 50 w.

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
1420 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.

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No. SR 2	All-American Mohawk 8 and Power Supply	.50
No. SR 3	Acme A. C. 7 aud Power Supply	.50
No. SR 4	Acme A. C. 4 and Power Supply	.50
No. SR 5	Crosley Gembox A. C. Model 608 and Power Pack	.50
No. SR 6	Crosley D. C. Showbox, Model 705	.50
No. SR 7	The Majestic Receiver, Model 70	.50
No. SR 8	Kolster 4 Tube Chassis and Supply	.50
No. SR 9	Sparton A. C. 89 Receiver and Pack	.50
No. SR10	Bremer-Tully Model 7-70 and Supply	.50
No. SR11	DayFan 5080 Receiver and Supply	.50
No. SR12	Balkite Model A Receiver and Pack	.50
No. SR13	Fada 7 A. C. Model and Type C Unit	.50
No. SR14	Freshman 2-N-12 and Power Unit	.50
No. SR15	Steinite Model 261 and Supply	.50
No. SH16	Howard Green Diamond Set, Model 8	.50
No. SR17	Grebe Synchrophase 7 A. C. Set	.50
No. SR18	Stromberg-Carlson 635-636	.50
No. SR19	Federal Model "H" A. C.	.50
No. SR20	Freed-Eisemann NR-80	.50
No. SR21	Bosch Model 28 and 29	.50
No. SR22	Amrad Model 70 A. C.	.50
No. SR23	Brunswick No. 3KRO	.50
No. SR24	A. C. Dayton Navigator	.50
No. SR25	Sonora DeLuxe Model 5-R	$0.50
No. SR26	Philco Model 86 and 82	.50
No. SR27	Slagle Model 9	.50
No. SR28	Atwater-Kent Model 38	.50
No. SR29	Colonial Radio Model 31 A. C.	.50
No. SR30	RCA Model 60	.50
No. SR31	King Radio Model J	.50
No. SR32	Gilfillan Model 100	.50
No. SR33	Erla Model R-2	.50
No. SR34	Stewart Warner Model 900	.50
No. SR35	Silver-Marshall Model 30	.50
No. SR36	Splitdorf Model E-175	.50
*No. SR37	Temple 8-60; 8-80; 8-90	.50
No. SR38	Kennedy Model 10	.50
*No. SR39	U. S. Radio & Television Model 37	.50
*No. SR40	Gulbransen Nine-in-Line	.50
*No. SR41	Crosley Jewel Box 704B	.50
*No. SR42	Graybar 600	.50
*No. SR43	Zenith 52	.50
*No. SR44	Amrad Model 81	.50
*No. SR45	Kolster 21-23	.50
*No. SR46	Slagle Model R-20	.50
*No. SR47	Columbia SG8	.50
*No. SR48	Kennedy Model 20	.50

*Circuits described in present issue.

Kit Receiver Blueprints

Full sized blueprints are available of any circuit ever published in the Call Book. Space permits listing only a few of the more popular ones. Write us if the desired print is not shown here.

No. 12	Madison-Moore Super-heterodyne Receiver using 201-A Tubes	$1.00
No. 14	Browning-Drake 4 Tube Receiver Using Audio Frequency Amplification	1.00
No. 32	Scott "World's Record" Super Eight	1.00
No. 37	Madison-Moore "One-Spot" Receiver	1.00
No. 56	Improved Browning-Drake	1.00
No. 58	"World's Record" Super Nine	1.00
No. 64	Aero Seven Tube T. R. F. Receiver (5 drawings)	1.00
No. 68	Improved Remler 45 K. C. Super-heterodyne Receiver (5 drawings)	1.00
No. 73	Magnaformer Super-heterodyne Receiver (5 drawings)	1.00
No. 79	Silver-Marshall High Amplification Super-heterodyne Receiver (5 drawings)	1.00
No. 93	Knickerbocker Four (5 drawings)	1.00
No. 99	Magnaformer 9-8 A. C. (5 drawings)	1.00
No. 115	Tyrman Amplimax "70" Shielded Grid (6 drawings)	1.00
No. 123	World's Record Super Ten & Power Pack (6 drawings)	$1.00
No. 147	Custom-built Model Madison-Moore International One-Spot A. C.—Sub-panel Job (6 drawings)	1.00
No. 162	National Screen Grid Five (5 drawings)	1.00
No. 167	Scott World's Record SG Nine "Power Pack Operated" (4 drawings)	1.00
No. 172	Remler 1929—115 K. C. SG Super (3 drawings)	1.00
No. 179	Lincoln 8-80 One-Spot Super—(3 drawings)	1.00
No. 198	Tyrman 72 A. C. Super	1.00
No. 218	Aero International Four Receiver (4 drawings)	1.00
No. 226	Hammarlund-Roberts Hi-Q 29 Receiver, Master A. C. model (5 drawings)	1.00
No. 231	Custom-built Model World's Record Shield Grid A. C. 10 (4 drawings)	1.00
No. 241	Capacity Bridge (3 drawings)	1.00
No. 246	Pilot Super-Wasp Short Wave Receiver (3 drawings)	1.00

Graphic Wiring Diagrams

No. 20	Silver-Marshall Improved 7 Tube Super-heterodyne Receiver	$0.60
No. 101	World's Record Economy Super 8	.60
No. 134	Nine-in-Line A. C. Operated	.60
No. 136	Citizens Crystal Receiver	.60
No. 154	Silver-Marshall 4 Tube Shield Grid Receiver	.60
No. 160	Thordarson 210 Power Compact	.60
No. 165	Citizens SG Booster Stage	.60
No. 166	Silver-Marshall SG Six (no output choke)	.60
No. 170	Silver-Marshall SG Super Nine	.60
No. 174	Sargent-Rayment Seven Receiver	.60
No. 178	Silver-Marshall 731 Short Wave Adapter	.60
No. 182	Halldorson A. C. 56—T. R. F.	.60
No. 183	National Short Wave Receiver	.60
No. 185	Silver-Marshall "Coast to Coast" Four	.60
No. 187	Citizens Special Short Wave Receiver	.60
No. 195	Junior 2 Tube Receiver	.10
No. 196	Aero A. C. Short Wave Converter	$0.60
No. 200	Silver-Marshall Phonograph Amplifier	.60
No. 202	Silver-Marshall 730 Four Tube Receiver	.60
No. 204	Sangamo Push-Pull Lab. Amplifier	.60
No. 210	Silver-Marshall 6 Tube Receiver (using output choke)	.60
No. 213	Junior 4 Tube Receiver	.10
No. 221	Modulated Oscillator	60
No. 223	Silver-Marshall 720 A. C. Shield Grid Six	.60
No. 225	Hollister A. C. Super Eight	.60
No. 236	S-M 722 A. C. Screen Grid Receiver	.60
No. 237	S-M 735 Short Wave Receiver, A. C.	.60
No. 242	National Screen Grid MB-29 Receiver	.60
No. 244	S-M S. G. A. C. 712 Rec. (to be used with 677 Power Pack)	.60
No. 245	S-M 677 Power Pack (to be used with 712 Receiver)	.60
*No. 232	Thordarson 245 push-pull power pack	.60

Schematic Wiring Diagrams Primarily for Service Work

No. 164a	Thordarson 250 Power Supply and Amplifier	$0.50
No. 170a	Silver-Marshall SG Super Nine	.50
No. 171a	Thordarson Dealer's Amplifier	.50
No. 174a	Sargent-Rayment Seven Receiver	.50
No. 183a	National Short Wave Receiver	.50
No. 185a	Silver-Marshall "Coast to Coast" Four	.50
No. 187a	Citizens Special Short Wave Receiver	.50
No. 191a	Scott World's Record SG Nine "Battery Operated"	.50
No. 196a	Aero A.C. Short Wave Converter	.50
No. 197a	Aero A. C. 21 Chronophase Receiver	.50
No. 202a	Silver-Marshall 730 4 Tube Receiver	.50
No. 206a	HFL Special Nine A. C. Super	.50
No. 211a	Magnaformer 1929 A. C. Super	.50
No. 220a	Thordarson R-480 Power Amplifier (171 Push-Pull)	.50
No. 221a	Modulated Oscillator	.50
No. 223a	Silver-Marshall 720 A. C. Shield Grid Six	.50
No. 225a	Hollister A. C. Super Eight	.50
No. 233a	Keystone Electric 67 Receiver Kit	.50
No. 234a	HFL Mastertone Receiver, A. C.	$0.50
No. 236a	S-M 722 A. C. Screen Grid Receiver	.50
No. 237a	S-M 735 Short Wave A. C. Receiver	.50
No. 238a	Lincoln 8-40 Screen Grid A. C. Super	.50
No. 239a	C. R. Leutz "Seven Seas" Console Receiver	.50
No. 240a	Remler Type 111 Screen Grid Receiver and Amplifier	.50
No. 242a	National Screen Grid MB-29 Receiver	.50
No. 243a	Citizens 3 Tube Rec. using 224 Tube as Power Detector	.50
No. 244a	S-M S. G. A. C. 712 Rec. (to be used with 677 Power Pack)	.50
No. 245a	S-M Power Pack (to be used with 712 Receiver)	.50
No. 249a	Hammarlund-Roberts Hi-Q 30	.50
No. 250a	Braxton-King A. C. S. G. Super. Model A	.50
No. 282a	Thordarson 245 push-pull power pack	.50
No. 254a	Lincoln DeLuxe Ten A. C. S. G. Receiver	.50
No. 255a	Silver-Marshall 722 S. G. D. C. Receiver	.50
No. 256a	Pilot 6 Tube T. R. F. A. C. S. G. No. PE6	.50
*No. 257a	Hammarlund-Roberts HiQ-30 D. C.	.50
*No. 258a	Silver-Marshall 692 Amplifier	.50

*Circuits Described in Present Issue

Any of the above blue prints will be sent postpaid by return mail upon receipt of the proper amount. C. O. D. orders not accepted.

CITIZENS RADIO SERVICE BUREAU 508 SOUTH DEARBORN STREET 7TH FLOOR—CHICAGO, ILLINOIS

WNAC
1230 kc, Boston, Mass., The Shepard Norwell Co., 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., Dakota Radio Apparatus Co., 1000 w, C.

WNBF
1500 kc, Binghamton, N. Y., Howitt-Wood Radio Co., 50 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."

WNBJ
1310 kc, Knoxville, Tenn., Lonsdale Baptist Church, 50 w, C.

WNBO
1200 kc, Washington, Pa., J. B. Spriggs, 100 w, E.

WNBR
1430 kc, Memphis, Tenn., John Ulrich, 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., Stercki Bros., 1000 w, C, "Smoky Mountain Station."

WNRC
1440 kc, Greensboro, N. C., Wayne M. Nelson, 500 w, E.

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., 5000 w, C, "The Winter Playground of America."

WOAN
600 kc, Lawrenceburg, Tenn., J. D. Vaughan, 500 w, C, "Watch Our Annual Normal."

WOAX
1280 kc, Trenton, N. J., Franklyn J. Wolff, 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., Charleston Radio Broadcasting Co., 250 w, E.

WOC
1000 kc, Davenport, Iowa, Palmer School of Chiropractic, 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., H. E. Smith and R. M. Curtis, 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., Wilson Radiophone Service Co., 100 w, E.

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

WOR
710 kc, Newark, N. J., L. Bamberger & Co., 5000 w, E.

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

WORD
1480 kc, Chicago, Ill., People's Pulpit Association, 5000 w, C, "The Watch Tower—Radio WORD."

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.

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., Municipality of Atlantic City, 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., 100 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, UtUica, Miss., Delta Broadcasting Co., 300 w, C.

WQBZ
1420 kc, Weirton, W. Va., J. H. Thompson, 60 w, E.

WRAF
1200 kc, La Porte, Ind., The Radio Club, Inc., 100 w.

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

WRAW
1310 kc, Reading, Pa., Avenue Radio & Electric Shop, 100 w, E, "The Schuylkill Valley Echo."

WRAX
1020 kc, Philadelphia, Pa., Berachah Church, Inc., 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, 100 w, C.

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

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

WRC
950 kc, Washington, D. C., Radio Corporation of America, 500 w, E, "The Voice of the Capital."

WREC
600 kc, Whitehaven, 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.

WRK
1310 kc, Hamilton, Ohio, S. W. Doron & John C. Slade, 100 w, E, "The Voice of Hamilton."

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

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., 1000 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.

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

WSGH
1400 kc, Brooklyn, N. Y., Amateur Radio Specialty Co., 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."

WSOA
1490 kc, Forest Park, Ill., Radiophone Broadcasting Corp., 5000 w, C.

WSPD
1240 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 Cocational 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, WTAM & WEAR, Inc., 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, Streator, Ill., Williams Hardware Co., 50 w.

WTBO
1420 kc, Cumberland, Md., Associated Brdcstg. Corp., 50 w, E.

WTFI
1450 kc, Toccoa, Ga., Toccoa Falls Institute, 250 w, E.

WTIC
1060 kc, Hartford, Conn., Travels 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.

Consolidated Broadcast List

Call	Town
KCRC	Enid, Okla.
KDB	Santa Barbara, Calif.
KDFN	Casper, Wyo.
KDKA	East Pittsburgh, Pa.
KDLR	Devils Lake, N. D.
KDYL	Salt Lake City, Utah
KECA	Los Angeles, Calif.
KEJK	Beverly Hills, 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.
KFHA	Gunnison, Colo.
KFI	Los Angeles, Calif.
KFIF	Portland, Ore.
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	Siloam Springs, Ark.
KFPY	Spokane, Wash.
KFQA	St. Louis, Mo.
KFQD	Anchorage, Alaska
KFQU	Holy City, Calif.
KFQW	Seattle, Wash.
KFQZ	Los Angeles, Calif.
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.
KFWM	Richmond, Calif.
KFXD	Jerome, 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.
KGCI	San Antonio, Tex.
KGCR	Watertown, S. D.
KGCU	Mandan, N. D.
KGCX	Wolf Point, Mont.
KGDA	Dell Rapids, S. D.
KGDE	Fergus Falls, Minn.
KGDM	Stockton, Calif.
KGDY	Oldham, 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	Hallock, Minn.
KGFL	Raton, N. M.
KGFW	Ravenna, Neb.
KGFX	Pierre, S. D.
KGGC	San Francisco, Cal.
KGGF	Picher, Okla.
KGGM	Albuquerque, N. M.
KGHF	Pueblo, Colo.
KGHG	McGehee, Ark.
KGHI	Little Rock, Ark.
KGHL	Billings, Mont.
KGHX	Richmond, Tex.
KGIQ	Twin Falls, Idaho
KGIR	Butte, Mont.
KGIW	Trinidad, Colo.
KGIX	Las Vegas, Nev.
KGJF	Little Rock, Ark.
KGKB	Brownwood, Tex.
KGKL	San Angelo, Tex.
KGKO	Wichita Falls, Tex.
KGKX	Sandpoint, Idaho
KGO	Oakland, Calif.
KGRC	San Antonio, Tex.
KGRS	Amarillo, Tex.
KGU	Honolulu, T. H.
KGW	Portland, Ore.
KGY	Lacey, Wash.
KHJ	Los Angeles, Calif.
KHQ	Spokane, Wash.
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	Dupont, Colo.
KMA	Shenandoah, Ia.
KMBC	Kansas City, Mo.
KMED	Medford, Ore.
KMIC	Inglewood, Calif.
KMJ	Fresno, Calif.
KMMJ	Clay Center, Neb.
KMO	Tacoma, Wash.
KMOX	St. Louis, Mo.
KMTR	Hollywood, 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.
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.
KPWF	Westminster, Calif.
KQV	Pittsburgh, Pa.
KQW	San Jose, Calif.
KRE	Berkeley, Calif.
KREG	Santa Ana, Calif.
KRGV	Harlingen, Tex.
KRLD	Dallas, Tex.
KRMD	Shreveport, La.
KRSC	Seattle, Wash.
KSAC	Manhattan, Kans.
KSAT	Ft. Worth, Tex.
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	Oakland, Calif.
KTAP	San Antonio, Tex.
KTAR	Phoenix, Ariz.
KTBI	Los Angeles, Calif.
KTBR	Portland, Ore.
KTBS	Shreveport, La.
KTLC	Richmond, Tex.
KTHS	Hot Springs, Ark.
KTM	Santa Monica, Calif.
KTNT	Muscatine, Ia.
KTSA	San Antonio, Tex.
KTSL	Shreveport, La.
KTSM	El Paso, Tex.
KTUE	Houston, Tex.
KTW	Seattle, Wash.
KUJ	Longview, Wash.
KUOA	Fayetteville, Ark.
KUSD	Vermillion, S. D.
KVEP	Portland, Ore.
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	Kennonwood, La.
KWLC	Decorah, Ia.
KWSC	Pullman, Wash.
KWWG	Brownsville, Tex.
KXA	Seattle, Wash.
KXL	Portland, Ore.
KXO	El Centro, Calif.
KXRO	Aberdeen, Wash.
KYA	San Francisco, Calif.
KYW	Chicago, Ill.
KYWA	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.
WADC	Tallmadge, Ohio
WAGM	Royal Oak, Mich.
WAIU	Columbus, Ohio
WAPI	Birmingham, Ala.
WASH	Grand Rapids, Mich.
WBAA	Lafayette, Ind.
WBAK	Harrisburg, Pa.
WBAL	Baltimore, Md.
WBAP	Fort Worth, Tex.
WBAW	Nashville, Tenn.
WBAX	Wilkes-Barre, Pa.
WBBC	Brooklyn, N. Y.
WBBL	Richmond, Va.
WBBM	Chicago, Ill.
WBBR	Rossville, N. Y.
WBBY	Charleston, S. C.
WBBZ	Ponca City, Okla.
WBCM	Bay City, Mich.
WBCN	Chicago, Ill.
WBIS	Boston, Mass.
WBMS	Hackensack, N. J.
WBNY	New York, N. Y.
WBOQ	New York, N. Y.
WBOW	Terre Haute, Ind.
WBRC	Birmingham, Ala.
WBRE	Wilkes-Barre, Pa.
WBRL	Tilton, N. H.
WBSO	Wellesley Hills, Mass.
WBT	Charlotte, N. C.
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	Coney Island, N. Y.
WCKY	Covington, Ky.
WCLB	Long Beach, N. Y.
WCLO	Kenosha, Wis.
WCLS	Joliet, Ill.
WCMA	Culver, Ind.
WCOA	Pensacola, Fla.
WCOC	Meridian, Miss.
WCOD	Harrisburg, Pa.
WCOH	Yonkers, N. Y.
WCRW	Chicago, Ill.
WCSH	Portland, Me.
WCSO	Springfield, Ohio
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.
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
WEAR	Cleveland, Ohio
WEBC	Superior, Wis.
WEBE	Cambridge, Ohio
WEBQ	Harrisburg, Ill.
WEBR	Buffalo, N. Y.
WEBW	Beloit, Wis.
WEDC	Chicago, Ill.
WEDH	Erie, Pa.
WEEI	Boston, Mass.
WEHC	Emory, Va.
WEHS	Evanston, Ill.
WELK	Philadelphia, Pa.
WEMC	Berrien Springs, Mich.
WENR	Chicago, Ill.
WEVD	New York, N. Y.
WEW	St. Louis, Mo.
WFAA	Dallas, Tex.
WFAN	Philadelphia, Pa.
WFBC	Knoxville, Tenn.
WFBE	Cincinnati, Ohio
WFBG	Altoona, Pa.
WFBJ	Collegeville, Minn.
WFBL	Syracuse, N. Y.
WFBM	Indianapolis, Ind.
WFBR	Baltimore, Md.
WFDF	Flint, Mich.
WFI	Philadelphia, Pa.
WFIW	Hopkinsville, Ky.
WFJC	Akron, Ohio
WFKD	Philadelphia, Pa.
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.
WGHP	Detroit, Mich.
WGL	Fort Wayne, Ind.
WGMS	Minneapolis, Minn.
WGN	Chicago, Ill.
WGR	Buffalo, N. Y.
WGST	Atlanta, Ga.
WGY	Schenectady, N. Y.
WHA	Madison, Wis.
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	Gloucester, 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
WHP	Harrisburg, Pa.
WIAS	Ottumwa, Ia.
WIBA	Madison, Wis.
WIBG	Elkins Park, Pa.
WIBM	Jackson, Mich.
WIBO	Chicago, Ill.
WIBR	Steubenville, Ohio
WIBS	Elizabeth, N. J.
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 Beach, Fla.
WIP	Philadelphia, Pa.
WISN	Milwaukee, Wis.
WJAC	Johnstown, Pa.
WJAD	Waco, Tex.
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	Ypsilanti, 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	Mooseheart, Ill.
WJKS	Gary, Ind.
WJR	Detroit, Mich.
WJSV	Mt. Vernon Hills, 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.
WKBP	Battle Creek, Mich.
WKBQ	New York, N. Y.
WKBS	Galesburg, Ill.
WKBV	Brookville, Ind.
WKBW	Buffalo, N. Y.
WKBZ	Ludington, Mich.
WKEN	Buffalo, N. Y.
WKJC	Lancaster, Pa.
WKRC	Cincinnati, Ohio
WKY	Oklahoma City, Okla.
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.
WLW	Cincinnati, Ohio
WLWL	New York, N. Y.
WMAC	Cazenovia, N. Y.
WMAF	S. Dartmouth, Mass.
WMAK	Buffalo, N. Y.
WMAL	Washington, D. C.
WMAN	Columbus, Ohio
WMAQ	Chicago, Ill.
WMAY	St. Louis, Mo.
WMAZ	Macon, Ga.
WMBA	Newport, R. I.
WMBC	Detroit, Mich.
WMBD	Peoria Heights, Ill.
WMBF	Miami Beach, Fla.
WMBG	Richmond, Va.
WMBH	Joplin, Mo.
WMBI	Chicago, Ill.
WMBJ	Pittsburgh, Pa.
WMBO	Auburn, N. Y.
WMBQ	Brooklyn, N. Y.
WMBR	Tampa, Fla.
WMC	Memphis, Tenn.
WMCA	New York, N. Y.
WMES	Boston, Mass.
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.
WNAT	Philadelphia, Pa.
WNAX	Yankton, S. D.
WNBF	Binghamton, N. Y.
WNBH	New Bedford, Mass.
WNBJ	Knoxville, Tenn.
WNBO	Washington, Pa.
WNBR	Memphis, Tenn.
WNBW	Carbondale, Pa.
WNBX	Springfield, Vt.
WNBZ	Saranac Lake, N. Y.
WNJ	Newark, N. J.
WNOX	Knoxville, Tenn.
WNRC	Greensboro, N. C.
WNYC	New York, N. Y.
WOAI	San Antonio, Tex.
WOAN	Lawrenceburg, 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.
WOPI	Bristol, Tenn.
WOOD	Grand Rapids, Mich.
WOQ	Kansas City, Mo.
WOR	Newark, N. J.
WORC	Worcester, Mass.
WORD	Chicago, Ill.
WOS	Jefferson City, Mo.
WOV	New York, N. Y.
WOW	Omaha, Neb.
WOWO	Ft. Wayne, Ind.
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	Utica, Miss.
WQBZ	Weirton, W. Va.
WRAF	La Porte, Ind.
WRAK	Erie, Pa.
WRAW	Reading, Pa.
WRAX	Philadelphia, Pa.
WRBI	Tifton, Ga.
WRBJ	Hattiesburg, Miss.
WRBL	Columbus, Ga.
WRBQ	Greenville, Miss.
WRBT	Wilmington, N. C.
WRBU	Gastonia, N. C.
WRC	Washington, D. C.
WREC	Whitehaven, Tenn.
WREN	Lawrence, Kans.
WRHM	Minneapolis, Minn.
WRJN	Racine, Wis.
WRK	Hamilton, Ohio
WRNY	New York, N. Y.
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.
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
WSOA	Forest Park, Ill.
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	Streator, Ill.
WTBO	Cumberland, Md.
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.

U. S. Broadcasting Stations by Frequencies

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

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

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

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

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

600 Kilocycles, 499.7 Meters—Canadian Shared:
WTIC, 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

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, KEJK

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

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, KFQZ, 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:
WMAK, WKY, WLBL, KHJ, KSEI, KGBU, WJAX

910 Kilocycles, 329.5 Meters—Canadian Wave:

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

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

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

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

960 Kilocycles, 312.3 Meters—Canadian Wave:

970 Kilocycles, 309.1 Meters:
KOMO, 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

1020 Kilocycles, 293.9 Meters:
KYW, KFKX, KYWA, WRAX

1030 Kilocycles, 291.1 Meters—Canadian Wave:

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

1050 Kilocycles, 285.5 Meters:
KNX, KFKB

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

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

1080 Kilocycles, 277.6 Meters:
WBT, WCBD, WMBI

1090 Kilocycles, 275.1 Meters:
KMOX, KFQA

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, KMIC, KRSC, WDEL, WDBO

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, WGDY, WHDI

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, WBBY, WBBZ, WFBC, WRBL, KGCU, WJBC, WJBL, WWAE, WRAF, WMT, KFJB, WCAT, KGDY, KFWF, KGDE, KGFK, WCLO, WHBY, KXO, KSMR, WIL, KFHA, KVOS, KGY, WMAY, KWG, KGEK, KGEW, KGHI, WCAX, WCOD, WFBE

1210 Kilocycles, 247.8 Meters—Canadian Shared:
WJBI, WGBB, WCOH, WOCL, WLCI, WPAW, WDWF, WLSI, WMAN, WJW, WEBE, WBAX, WJBU, WMBG, WSIX, WRBU, WJBY, WRBO, WGCM, KWEA, KDLR, KGCR, KFOR, WHBU, KFVS, WEBO, WCRW, WEDC, WCBS, WTAX, WHBF, WIBA, WOMT, KPQ, KPCB, WSBC, KFDN, KMJ, KFXM, KPPC, KGFJ

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

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

1240 Kilocycles, 241.8 Meters:
WJAD, KSAT, WSPD

1250 Kilocycles, 239.9 Meters:
WGCP, WODA, WAAM, WLB, WGMS, WRHM, KFMX, WCAL, KIDO, WFOX, 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

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, WRK, WAGM, WFDF, WHAT, WFKD, WFBG, WRAW, WGAL, WSAJ, WBRE, WKBC, KGHG, WOBT, WNBJ, KRMD, KFPM, WDAH, KFPL, KFXR, WKBS, WRBI, WCLS, WKBB, KWCR, KFJY, KFGO, WBOW, WJAK, WLBC, WIBU, KFBK, KTSL, KGEZ, KFUP, KFXJ, KFBK, KGEZ, KMED, KTSM, KGCX, WJAC, WSJS, KXRO, KGFW, KFIU, KGBX, KIT, WMBO

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

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

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

1350 Kilocycles, 222.1 Meters:
WBNY, WMSG, WCDA, WKBQ, KWK

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

1370 Kilocycles, 218.8 Meters:
WSVS, WCBM, WBBL, WHBD, WJBK, WIBM, WRAK, WELK, WHBQ, WRBT, KGFG, KGCI, KGRC, KFJZ, KGKL, KFLX, WFBJ, KGDA, KZM, KRE, WPOE, KFBL, KWKC, WRJN, KGAR, KLO, KOH, KVL, KFJI, KGFL, KGGM, WHDF, KOOS, WGL, KFJM, KCRC, WEHC, WMBR, WRBJ, WLEY

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

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

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

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

1420 Kilocycles, 211.1 Meters:
WMRJ, WTBO, WKBI, WIBR, WEDH, WMBC, WKBP, WQBZ, KGFF, WHIS, KTAP, KTUE, KFYO, KICK, WIAS, KGCC, WLBF, WMBH, KFIZ, KORE, WILM, KGIW, KGKX, KFQW, KLPM, KXL, WHDL, WHFC, WEHS, KFQU, KFXD, KGIX, KFIF, WJBO

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

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

1450 Kilocycles, 206.8 Meters:
WBMS, WNJ, WIBS, WKBO, WSAR, WFJC, WTFI, KTBS, WCSO

1460 Kilocycles, 205.4 Meters:
WJSV, KSTP

1470 Kilocycles, 204.0 Meters:
KGA, WTNT, WLAC

1480 Kilocycles, 202.6 Meters:
WORD, KFJF, WKBW

1490 Kilocycles, 201.6 Meters:
WBAW, KPWF, WCKY, WJAZ, WSOA

1500 Kilocycles, 199.9 Meters:
WMBA, WLOE, WMES, WNBF, WMBQ, WLBX, WWRL, WKBZ, WMPC, WOPI, WPEN, KGKB, WKBV, KPJM, KVEP, KDB, KUJ, KGFI, WMBJ, KREG, KTLC, WCLB

U. S. Broadcasting Stations Listed by States

ALABAMA

Birmingham, WBRC, WKBC, WAPI
Gadsden, WJBY
Mobile, WODX
Montgomery, WSFA

ALASKA

Anchorage, KFQD
Juneau, KFIU
Ketchikan, KGBU

ARIZONA

Flagstaff, KFXY
Phoenix, KTAR, KOY
Prescott, KPJM
Tuscon, KGAR, KVOA

ARKANSAS

Blytheville, KLCN
Fayetteville, KUOA
Hot Springs, KTHS
Little Rock, KLRA, KGHI, KGJF
McGehee, KGHG
Siloam Springs, KFPW

CALIFORNIA

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

COLORADO

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

CONNECTICUT

Bridgeport, WICC
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 Beach, WIOD, WMBF, WQAM
Orlando, WDBO
Pensacola, WCOA
Tampa, WDAE, WMBR

GEORGIA

Atlanta, WGST, WSB
Columbus, WRBL
Macon, WMAZ
Savannah, WTOC
Tifton, WRBI
Toccoa, WTFI

HAWAII

Honolulu, KGU

IDAHO

Boise, KIDO
Idaho Falls, KID
Jerome, 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, KYWA, WSBC, WBCN, WIBO, WJAZ, WJBT, WLIB, WLS, WORD, KFKX
Cicero, WHFC
Decatur, WJBL
Evanston, WEHS
Forest Park, WSOA
Galesburg, WKBS
Harrisburg, WEBQ
Joliet, WCLS, WKBB
La Salle, WJBC
Mooseheart, WJJD
Peoria Heights, WMBD
Quincy, WTAD
Rockford, KFLV
Rock Island, WHBF
Springfield, WCBS
Streator, WTAX
Tuscola, WDZ
Urbana, WILL
Zion, WCBD

INDIANA

Anderson, WHBU
Brookville, 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

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

KENTUCKY

Covington, WCKY
Hopkinsville, WFIW
Louisville, WHAS, WLAP

LOUISIANA

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

MAINE

Bangor, WABI, WLBZ
Portland, WCSH

MARYLAND

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

MASSACHUSETTS

Boston, WBZA, WEEI, WNAC, WSSH, WMES, WBIS
Fall River, WSAR
Gloucester, WHDH
Lexington, WLEX, WLEY
New Bedford, WNBH
Springfield, WBZ
Wellesley Hills, WBSO
Worcester, WTAG, WORC

MICHIGAN

Battle Creek, WKBP
Bay City, WBCM
Berrien Springs, WEMC
Calumet, WHDF
Detroit, WMBC, WWJ, WJR, WGHP
East Lansing, WKAR
Flint, WFDF
Grand Rapids, WASH, WOOD
Jackson, WIBM
Lapeer, WMPC
Ludington, WKBZ
Royal Oak, WAGM
Ypsilanti, WJBK

MINNESOTA

Anoka, WCCO
Collegeville, WFBJ
Fergus Falls, KGDE
Hallock, KGFK
Minneapolis, WDGY, WHDI, WLB, WRHM, WCCO, WGMS
Northfield, KFMX, WCAL
St. Paul, KSTP

MISSISSIPPI

Greenville, WRBQ
Gulfport, WGCM
Hattiesburg, WRBJ
Jackson, WJDX
Meridian, WCOC
Utica, WQBC

MISSOURI

Cape Girardeau, KFVS
Columbia, KFRU
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, WMAY, KFQA

MONTANA

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

NEBRASKA

Clay Center, KMMJ
Lincoln, KFAB, KFOR, WCAJ
Norfolk, WJAG
Omaha, WAAW, WOW
Ravenna, KGFW
York, KGBZ

NEVADA

Las Vegas, KGIX
Reno, KOH

NEW HAMPSHIRE

Laconia, WKAV
Tilton, WBRL

NEW JERSEY

Asbury Park, WCAP
Atlantic City, WPG
Camden, WCAM
Elizabeth, WIBS
Hackensack, WBMS
Jersey City, WAAT, WKBO
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
Buffalo, WEBR, WGR, WKBW, WKEN, WSVS, WMAK
Canton, WCAD
Cazenovia, WMAC
Coney Island, WCGU
Freeport, WGBB
Ithaca, WLCI, WEAI
Jamaica, WMRJ
Jamestown, WOCL
Long Beach, WCLB
Long Island City, WLBX
New York, WBNY, WHN, WJZ, WKBQ, WMCA, WMSG, WNYC, WPCH, WRNY, WABC, WOV, WQAO, WLWL, WBOQ, WCDA, WEAF, WEVD, WGBS, WHAP, WPAP
Patchogue, WPOE
Poughkeepsie, WOKO
Rochester, WHAM, WHEC
Rossville, WBBR
Saranac Lake, WNBZ
Schenectady, WGY
Syracuse, WFBL, WSYR
Tupper Lake, WHDL
Troy, WHAZ
Utica, WIBX
Woodhaven, WEVD
Woodside, WWRL
Yonkers, WCOH

NORTH CAROLINA

Asheville, WWNC
Charlotte, WBT
Gastonia, WRBU
Greensboro, WNRC
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
Cambridge, WEBE
Cincinnati, WKRC, WSAI, WLW, WFBE
Cleveland, WEAR, WHK, WJAY, WTAM
Columbus, WAIU, WCAH, WEAO, WMAN
Dayton, WSMK
Hamilton, WRK
Mansfield, WJW
Middleton, WSRO
Mt. Orab, WHBD
Springfield, WCSO
Steubenville, WIBR
Tallmadge, WADC
Youngstown, WKBN

OKLAHOMA

Alva, KGFF
Chickasha, KOCW
Enid, KCRC
Norman, WNAD
Oklahoma City, KFJF, KFXR, KGCB, KGFG, WKY
Picher, KGGF
Ponca City, WBBZ
Tulsa, KVOO

OREGON

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

PENNSYLVANIA

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

PORTO RICO

San Juan, WKAQ

RHODE ISLAND

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

SOUTH CAROLINA

Charleston, WBBY

SOUTH DAKOTA

Brookings, KFDY, KGOR
Dell Rapids, KGDA
Oldham, KGDY
Pierre, KGFX
Rapid City, WCAT
Sioux Falls, KSOO
Vermillion, KUSD
Watertown, KGCR
Yankton, WNAX

TENNESSEE

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

TEXAS

Abilene, KFYO
Amarillo, KGRS, WDAG
Beaumont, KFDM
Brownsville, KWWG
Brownwood, KGKB
College Station, WTAW
Corpus Christi, KGFI
Dallas, KRLD, WFAA, WRR
Dublin, KFPL
El Paso, WDAH, KTSM
Forth Worth, KFJZ, WBAP, KSAT
Galveston, KFLX, KFUL
Greenville, KFPM
Harlingen, KRGV
Houston, KPRC, KTUE
Richmond, KTLC
San Angelo, KGFI, KGKL
San Antonio, KGRC, KTAP, KTSA, WOAI
Waco, WJAD
Wichita Falls, KGKO

UTAH

Ogden, KLO
Salt Lake City, KDYL, KSL

VERMONT

Burlington, WCAX
Springfield, WNBX

VIRGINIA

Arlington, NAA
Emory, WEHC
Mt. Vernon Hills, WJSV
Newport News, WGH
Norfolk, WTAR, WPOR
Petersburg, WLBG
Richmond, WBBL, WMBG, WRVA
Roanoke, WDBJ

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
Wierton, WQBZ

WISCONSIN

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

WYOMING

Casper, KDFN

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	31.3
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.	11,880	25.25
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
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
XDO	Chapultepec, Mexico	17,440	17.2
G5SW	Chelmsford, England	12,500	24
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	9,560	31.38
PHI	Huizen, Holland	17,773	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	Sidney, 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	25.60
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

VISUAL BROADCASTING STATIONS

Call	Kilocycles	Meters	Owner
W1XAE	2000-2100	150-143	Westinghouse, Springfield, Mass.
W1XAY	2000-2100	150-143	Air Station, Lexington, Mass.
W1XB	2100-2200	143-136	General Industries, Somerville, Mass.
W1XB	2750-2850	109-105	General Industries, Somerville, Mass.
W2XBA	2750-2850	109-105	WAAM, Inc., Newark, N. J.
W2XBS	2000-2100	150-143	R. C. A., New York, N. Y.
W2XBU	2000-2100	150-143	H. E. Smith, Beacon, N. Y.
W2XBW	2000-2100	150-143	R. C. A., New York, N. Y.
W2XCL	2000-2100	150-143	Pilot Electric, Brooklyn, N. Y.
W2XCO	2100-2200	143-136	R. C. A., New York, N. Y.
W2XCP	2000-2100	150-143	Freed-Eisemann, New York, N. Y.
W2XCP	2850-2950	105-102	Freed-Eisemann, New York, N. Y.
W2XCR	2750-2850	109-105	Jenkins, Jersey City, N. J.
W2XCW	2100-2200	143-136	General Electric, Schenectady, N. Y.
W2XR	2850-2950	105-102	Radio Pictures, Inc., New York, N. Y.
W2XR	2100-2200	143-136	Radio Pictures, Inc., New York, N. Y.
W2XX	2000-2100	150-143	R. F. Gowen, Ossining, N. Y.
W3XAK	2000-2100	150-143	R. C. A., Bound Brook, N. J.
W3XK	2000-2100	150-143	Jenkins, Washington, D. C.
W3XK	2850-2950	105-102	Jenkins, Washington, D. C.
W4XE	2000-2100	150-143	W. J. Lee, Winter Park, Fla.
W6XAM	2000-2100	150-143	B. S. McGlashan, Los Angeles Calif.
W7XAO	2750-2850	109-105	W. Jerman, Portland, Ore.
W8XAV	2000-2100	150-143	Westinghouse, Pittsburgh, Pa.
W8XAV	2100-2200	143-136	Westinghouse, Pittsburgh, Pa.
W8XAV	2750-2850	109-105	Westinghouse, Pittsburgh, Pa.
W9XAA	6080-	49.34	Federation of Labor, Chicago, Ill.
W9XAA	11,840-	25.34	Federation of Labor, Chicago, Ill.
W9XAA	17,780-	16.87	Federation of Labor, Chicago, Ill.
W9XAG	2000-2100	150-143	Aero Products, Chicago, Ill.
W9XAO	2000-2100	150-143	Nelson Bros. Co., Chicago, Ill.
W9XAP	2750-2850	109.1-105.3	Chicago Daily News, Chicago, Ill.
W9XAZ	2000-2100	150-143	University of Iowa, Iowa City, Ia.
W9XR	2850-2950	105-102	Great Lakes Broadcasting Co., Chicago, Ill.
WRNY	1010-	297-	Aviation Radio, Coytesville, N. J.

FOREIGN BROADCAST STATIONS

AFGHANISTAN

ALBANIA

ARGENTINA

Call		Meters
LOZ	Buenos Aires	330
LOS	Buenos Aires	291.2
LON	Buenos Aires	210
LOR	Buenos Aires	344.8
LOV	Buenos Aires	361.5
LOY	Buenos Aires	315.2
LOX	Buenos Aires	380
LOQ	Buenos Aires	261.8
LOO	Buenos Aires	252
LOJ	Buenos Aires	270
LOW	Buenos Aires	303
LOT	Buenos Aires	400
LOL	Buenos Aires	236
D3	Buenos Aires	253.3
B2	Buenos Aires	275
H5	Cordova	275
H6	Cordova	250
LOP	La Plata	425
LOU	Mendoza	380
M6	Mendoza	348
F2	Rosaria	270
F1	Santa Fe	279

AUSTRALIA

Call		Meters
5CL	Adelaide	409
5DN	Adelaide	313
5KA	Adelaide	250
2MK	Bathhurst	275
4QG	Brisbane	385
7ZL	Hobart	516
3AR	Melbourne	484
3LO	Melbourne	371
3UZ	Melbourne	319
3DB	Melbourne	255
2HD	Newcastle	288
6WF	Perth	440
2KY	Sydney	280
2FC	Sydney	451
2BL	Sydney	353
2BE	Sydney	316
2GB	Sydney	316
2UE	Sydney	293
2UW	Sydney	267
4GR	Toowoomba	294

AUSTRIA

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

BELGIAN COLONIES

BELGIUM

Call		Meters
EB4ED	Anvers	250
EB4GT	Bruxells	260
EB4RB	Bruxells	508.5
EB4RC	Bruxells	215
EB4FO	Bruxells	230
EB4CE	Chatelineau	220
EB4FG	Dampremy	210
EB4RG	Gand	275
EB4RW	Liege	280
EB4BQ	Marchienne-Docherie	290
EB4EX	Ottomont	225
EB4CF	Verriers	215

BOLIVIA

Call		Meters
	La Paz	175
	La Paz	300

BRAZIL

Call		Meters
PRAM	Amparo	230
PRAH	Bahia	350
PRAN	Curytiba	340
PRAZ	Franca	270
PRAJ	Juiz de Fora	350
PRAY	Mogy das Cruzes	300
PRAD	Pelotas	326
PRAG	Porto Alegre	275
PRAP	Recife	400
PRAI	Ribeirao Preto	260
PRAA	Rio de Janeiro	400
PRAB	Rio de Janeiro	320
PRAC	Rio de Janeiro	360
PRAK	Rio de Janeiro	260
PRAS	Santos	300
PRAE	Sao Paulo	350
PRAL	Sao Paulo	400
PRAO	Sao Paulo	320
PRAR	Sao Paulo	295

BRITISH COLONIES

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

BRITISH INDIA

Call		Meters
VUB	Bombay	357.1
VUC	Calcutta	370.4
VPB	Colombo	480
VUR	Rangoon	398

BULGARIA

CANADA

Call		Meters
CKCR	Brantford	296.9
CFAC	Calgary	434.5
CKCN	Calgary	434.5
CHCA	Calgary	434.5
CJCJ	Calgary	434.5
CNRC	Calgary	434.5
CFCY	Charlottetown	312.3
CHCK	Charlottetown	312.3
CHWK	Chilliwack	247.8
CKMC	Cobault	247.8
CJRW	Fleming	296.9
CFNB	Fredericton	247.8
CHMA	Edmonton	516.9
CJCA	Edmonton	516.9
CKUA	Edmonton	516.9
CNRE	Edmonton	516.9
CHNS	Halifax	322.4
CHNS	Halifax	322.4
CKOC	Hamilton	340.9
CHCS	Hamilton	340.9
CFCH	Iroquois Falls	499.7
CFJC	Kamloops	267.7
CFMC	Kingston	267.7
CFRB	King	312.3
CFRC	Kingston	267.7
CJOC	Lethbridge	267.7
CNRL	London	329.7
CJGC	London	329.5
CKPR	Midland	267.7
CFCF	Montreal	410.7
CHYC	Montreal	410.7
CKAC	Montreal	410.7
CNRM	Montreal	410.7
CJRM	Moose Jaw	296.9
CNRA	Moncton	475.9
CHML	Mt. Hamilton	340.9
CKCO	Ottawa	434.5
CNRO	Ottawa	434.5
CFLC	Prescott	296.9
CKPC	Preston	247.8
CKCI	Quebec	340.9
CKCV	Quebec	340.7
CNRQ	Quebec	340.9
CHRC	Quebec	340.9
CFCR	Regina	312.5
CHWC	Regina	312.3
CJBR	Regina	312.3
CNRR	Regina	312.3
CKCK	Regina	312.3
CHCT	Red Deer	356.9
CKLC	Red Deer	356.9
CNRD	Red Deer	357.1
CJHS	Saskatoon	329.5
CFQC	Saskatoon	329.5
CNRS	Saskatoon	329.5
CJOR	Sea Island	291.1
CKSH	St. Hyacinthe	296.9
CFBO	St. John	336.9
CHGS	Summerside	267.7
CJCB	Sydney, N. S.	340.9
CHNC	Toronto	516.9
CKNC	Toronto	516.9
CKGW	Toronto	434.8
CJBC	Toronto	517.2
CNRT	Toronto	356.9
CJSC	Toronto	516.9
CKCL	Toronto	516.9
CKOW	Toronto	356.9
CFCA	Toronto	356.9
CHLS	Vancouver	410.7
CKCD	Vancouver	410.7
CKFC	Vancouver	410.7
CKMO	Vancouver	410.7
CKWX	Vancouver	410.7
CNRV	Vancouver	291.1
CFCT	Victoria	475.9
CKY	Winnipeg	384.4
CNRW	Winnipeg	384.4
CJGX	Yorktown	475.9

CHILE

Call		Meters
CMAO	Antofagasta	
	Asuncion	
CMAI	Concepcion	345
CMAD	Santiago	820
CMAE	Santiago	280
CMAT	Tacna	550
CMAK	Temuco	245
	Valparaiso	400

CHINA

Call		Meters
COHB	Harbin	445
COMK	Mukden	425
	Shanghai	342
XOL	Tientsin	480
GEC	Tientsin	280

COLOMBIA

COSTA RICA

CUBA

Call		Meters
CM6EV	Caibarien	250
CM6LO	Caibarien	325
CM7AZ	Camaguey	225
CM7LO	Camaguey	230
CM6YR	Camajuani	200
CM7BY	Ciego de Avila	235
CM7FU	Ciego de Avila	200
CM7HS	Ciego de Avila	192
CM6BY	Cienfuegos	260
CM5EV	Colon	360
CM1PK	Guanajay	190
CMI	Habana	376
CMC	Habana	357
CM2AB	Habana	250
CM2AR	Habana	248
CM2AZ	Habana	334
CM2CP	Habana	280
CM2HP	Habana	205
CM2JP	Habana	270
CM2OH	Habana	300
CM2OK	Habana	360
CM2RK	Habana	326
CM2SE	Habana	208
CM2TW	Habana	255
CM2UF	Habana	228
CM2WX	Habana	341
CM2XA	Habana	230
CM2XX	Habana	225
CM2BX	Habana	312.5
CM2JK	Habana	342.5
CM2LC	Habana	315
CM2LP	Habana	350
CM2LR	Habana	215
CM2MC	Habana	243
CM2MG	Habana	292
CM2PC	Habana	212
CM2RC	Habana	258
CM2FG	Hershey	226
CM2WD	Marianao	274
CM2XX	Marianao	225

Call		Meters
CM2JF	Marianao	252
CM2JL	Marianao	294
CM2MA	Marianao	275
CM2SW	Marianao	274
CM1AZ	Mariel	275
CM7NM	Nuevitas	264
CM6HS	Sagua la Grande	200
CM6KP	Sancti Spiritus	280
CM6MN	Santa Clara	210
CM8HS	Santa Clara	200
CM6WT	Santiago	200
CM8BY	Santiago	150
CM8KW	Santiago	250
CM6KW	Tuinucu	368

CURACAO

CZECHOSLOVAKIA

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

DANZIG

Call	Location	Meters
	Danzig	453

DENMARK

Call	Location	Meters
	Kalundborg	1153.8
	Kobenhavn	281
	Soro	1153.8

DOMINICAN REPUBLIC

DUTCH EAST INDIES

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

ECUADOR

EGYPT

Call	Location	Meters
SRE	Cairo	255

ETHIOPIA

ESTONIA

Call	Location	Meters
	Tallinn	295

FINLAND

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

FRANCE

Call	Location	Meters
PTT	Bordeaux	304
	Corsica	237
	Grenoble	329
	Limoges	293
	Lille	265
	Lyon	466
	Marseilles	316
	Montpelier	286
	Nice	237
	Paris	1725
FL	Paris	1444
	Paris	447
	Rennes	272
	Strasbourg	346
	Toulousse	381
	Toulousse	255

FRENCH COLONIES

Call	Location	Meters
8DB	Algiers	310
8KR	Constantine	42.8
	Haiphong	320
	Radio S. Denis, Reunion	500
TUA	Tunis	1450

GERMANY

Call	Location	Meters
	Aachen	453
	Augsburg	560
	Berlin I	419
	Berlin II	283
	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
	Nurnberg	239
	Stettin	283
	Stuttgart	360
	Zeesen	1635

GREAT BRITAIN

Call	Location	Meters
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

GREECE

GUATEMALA

HAITI

Call	Location	Meters
HHK	Port au Prince	361.2

HEDJAZ

HOLLAND

Call	Location	Meters
	Bloemendaal	200
	Hilversum	1875
HDO	Hilversum	1071
	Hilversum	298
	Huizen	298
	Huizen	1875
	Scheveningen	1870

HONDURAS

HUNGARY

Call	Location	Meters
	Lakihegy	550

ICELAND

Call	Location	Meters
	Akureyri	192
	Reykjavik	

IRAQ

IRISH FREE STATE

Call	Location	Meters
6CK	Cork	225
2RN	Dublin	413

ITALY

Call	Location	Meters
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

ITALIAN COLONIES

JAPAN

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

JUGOSLAVIA

Call	Location	Meters
	Belgrade	429
	Ljubljana	566
	Zagreb	308

LATVIA

Call	Location	Meters
YLZ	Riga	525

LIBERIA

LITHUANIA

Call	Location	Meters
RYK	Kaunas	1935

LUXEMBURG

MEXICO

Call	Location	Meters
XFF	Chihuahua	325
XEA	Guadalajara	250
XFC	Jalapa	475
XES	Lerdo	250
XEY	Merida	548.6
XEX	Mexico City	325
XFX	Mexico City	357
XEN	Mexico City	410
XEB	Mexico City	450
XFG	Mexico City	470
XFI	Mexico City	507
XFA	Mexico City	600-500
XEO	Mexico City	254
XER	Mexico City	254
XEH	Monterey	311
XEI	Morelia	300
XEF	Oaxaca	265
XEE	Puebla	312

MONACO

Call	Location	Meters
	Monaco	237

MOROCCO

Call	Location	Meters
CNO	Casablanca	250
AIN	Casablanca	51
	Rabat	416
	Rabat	724.6

NEWFOUNDLAND

NEW HEBRIDES

NEW ZEALAND

Call	Location	Meters
1ZB	Auckland	275.2
1ZQ	Auckland	252.1
1YA	Auckland	333.3
3ZC	Christchurch	250
3YA	Christchurch	306.1
4ZB	Dunedin	277.8
4ZO	Dunedin	277.8
4ZL	Dunedin	245.9
4ZM	Dunedin	277.8
4YA	Dunedin	461.5
2ZM	Gisborne	260.9
2ZF	Palmerston	285.7
2ZK	Wanganui	500
2YA	Wellington	416.7

NICARAGUA

NORWAY

Call	Location	Meters
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
	Trondhen	1072

PANAMA

PARAGUAY

PERSIA

PERU

Call	Location	Meters
OAX	Lima	380

PHILIPPINE ISLANDS

Call	Location	Meters
KZRC	Cebu	230.8
KZIB	Manila	260
KZKZ	Manila	270.3
KZRM	Manila	413

POLAND

Call	Location	Meters
	Krakow	313
	Krakow	244
	Kattowitz	408
	Lodz	234
	Poznan	335
	Warszawa	214
	Warszawa	1411
	Wilno	385.1

PORTUGAL

Call	Location	Meters
PIAA	Lisbon	305

PORTUGUESE COLONIES

ROUMANIA

Call	Location	Meters
	Bucharest	394
	Bucharest	226
	Jassy	211

SAAR TERRITORY

SALVADOR

Call	Location	Meters
AQM	Salvador	482

SIAM

SPAIN

Call	Location	Meters
EAJ18	Almeria	251
EAJ13	Barcelona	462
EAJ1	Barcelona	344.8
EAJ12	Barcelona	268
EAJ9	Bilbao	434.8
EAJ3	Cadiz	400
EAJ16	Cartagena	248
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

SURINAM

SWEDEN

Call	Location	Meters
SBE	Boden	1200
SCA	Boras	231
SCB	Eskilstuna	246
SCC	Falun	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	Kristinehamn	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
SBA	Stockholm	436
SBD	Sundsvall	542
SCQ	Trollhattan	270
SCR	Uddevalla	283
SCS	Umea	231
SCT	Uppsla	453
SCU	Varborg	283

SWITZERLAND

Call	Location	Meters
HB3	Bale	1010
	Berne	403
	Geneva	760
	Lausanne	680
HBZ	Zurich	459

TURKEY

Call	Location	Meters
	Angora	1806
TAL	Istanbul	1200
	Osmanieh	1200

UNION OF SOVIET SOCIALIST REPUBLICS

Call	Location	Meters
RV19	Achkhabad	899.1
RV26	Artemovsk	370
RV35	Astrakhan	690
RV8	Bakou	1380
RV80	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	879
RV42	Nijni-Novgorod	406
RV48	Nikolaev	366
RV6	Novosibirsk	1250
RV13	Odessa	411
RV44	Omsk	636
RV45	Orenbourg	650
RV22	Oufa	554.7
RV46	Petroparlovsk	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

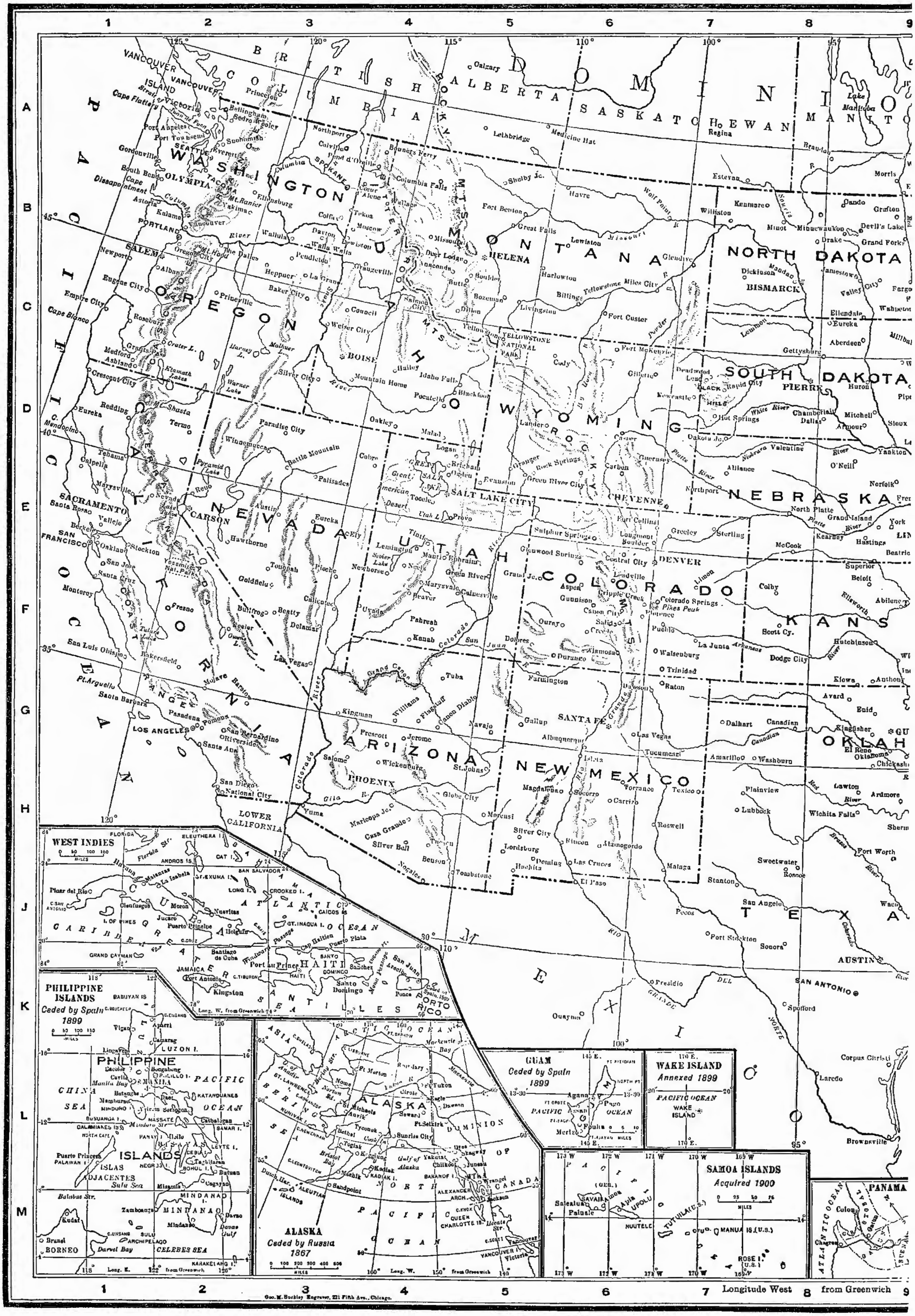
Call	Location	Meters
CWOA	Montevideo	428.4
CWOH	Montevideo	300
CWOO	Montevideo	294.1
CWOR	Montevideo	394.6
CWOS	Montevideo	380
CWSK	Montevideo	250
CWSC	Montevideo	277.8
CWOB	Montevideo	290
CWOW	Montevideo	450
CWSI	Paysandu	268
CWOI	Salto	246
CWOJ	Salto	250

UNION OF SOUTH AFRICA

Call	Location	Meters
ZTC	Capetown	375
ZTD	Durban	406.5
ZTJ	Johannesburg	450
ZTJ	Johannesburg	32
	Pretoria	323

VENEZUELA

Call	Location	Meters
AYRE	Caracas	375


WASHINGTON
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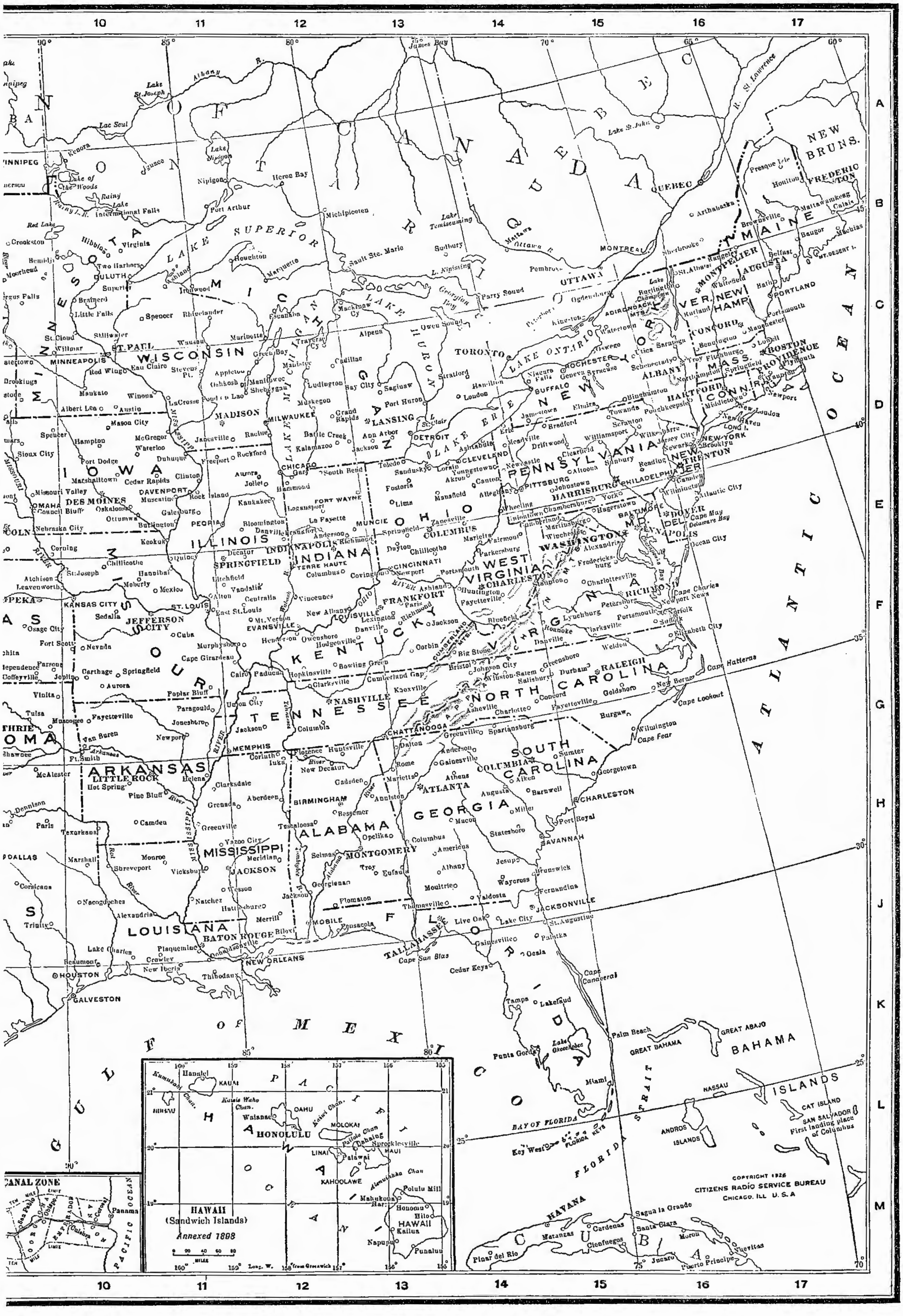
SOUTH DAKOTA
NEBRASKA
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
DOMINION
PACIFIC OCEAN
MEXICO
LOWER CALIFORNIA
WEST INDIES
ATLANTIC OCEAN
PHILIPPINE ISLANDS Ceded by Spain 1899
ALASKA Ceded by Russia 1867
GUAM Ceded by Spain 1899
WAKE ISLAND Annexed 1899
SAMOA ISLANDS Acquired 1900
PANAMA
Longitude West from Greenwich
Geo. M. Buckley Engraver, 221 Fifth Ave., Chicago.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LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
ATLANTIC OCEAN
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VER.
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R.I.
NEW YORK
PENNSYLVANIA
NEW JERSEY
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MD.
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ALABAMA
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KANSAS CITY
ATLANTA
MONTGOMERY
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JACKSON
BATON ROUGE
NEW ORLEANS
HOUSTON
GALVESTON
TALLAHASSEE
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CANAL ZONE
HAWAII
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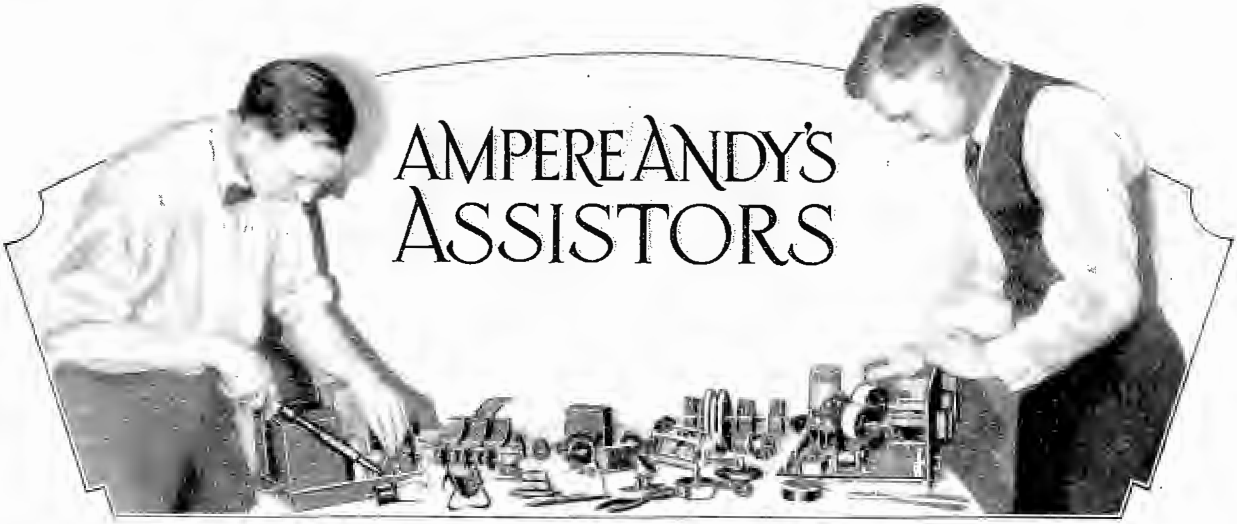
Albuquerque, N. Mex.	...	1273	1670	774	1967	838	1577	1126	1248	1417	332	833	1360	228	968	561	803	588	773	1252	1492	717	663	1174	938
Atlanta, Ga.	1273	...	575	1830	933	960	695	583	368	550	1208	738	595	1293	1112	750	688	901	498	947	286	675	1935	317	335
Baltimore, Md.	1670	575	...	2055	358	1525	273	603	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	802	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

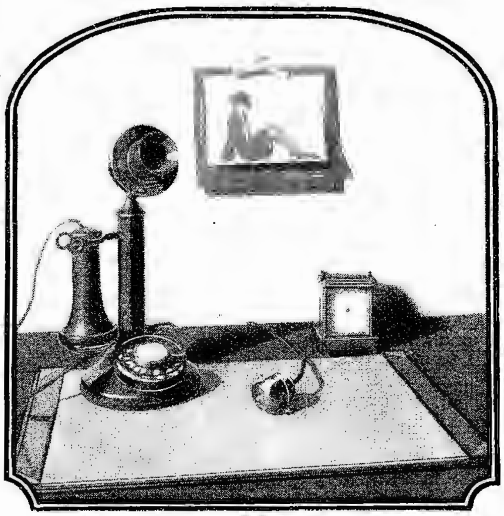
FROM/TO	Miami, Fla.	Minneapolis, Minn.	Missoula, Mont.	Nashville, Tenn.	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma, Okla.	Omaha, Nebr.	Philadelphia, Pa.	Phoenix, Ariz.	Pittsburgh, Pa.	Portland, Me.	Portland, Ore.	Richmond, Va.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Schenectady, 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			



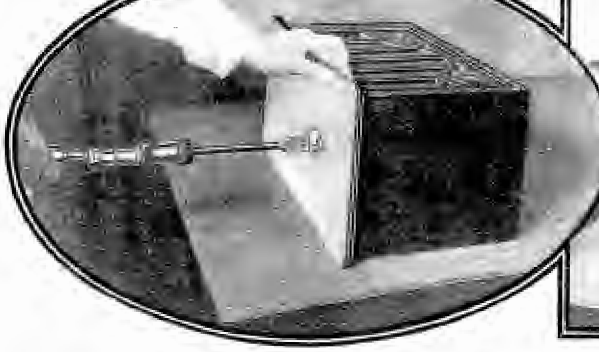
Switch for Shutting Off Set While Using Telephone



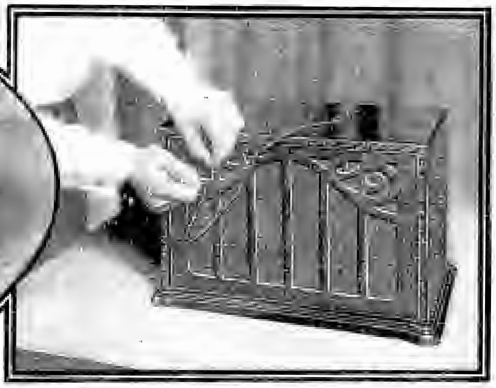
Left. Interference encountered by radio listeners when attempting to use the telephone while the radio set is playing, may be obviated by inserting a pendant snap switch in the 110 volt line to the radio set, and placing the pendant switch on the desk near the 'phone. Then when telephonic conversation is desired the snap switch may be used to kill the 110 volt line until after the phone conversation has been finished

Console Back May Cause Rattling of French Windows

Right. If you hear a rattle while your radio set is playing, do not blame it on the set, for it may not be caused by the receiver itself, but rather by its proximity to French windows or doors in which loose panes are set into vibration by the sound waves from the open rear of the console. This is particularly true if the console backs right up against the window or door. Sometimes even a glass in a picture frame in a room will be set into vibration at certain frequencies



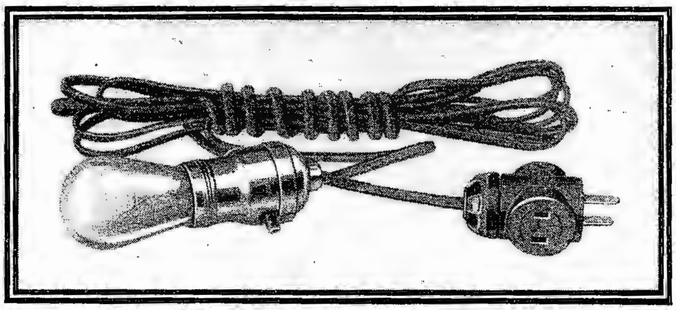
Above. Dry contact rectifiers work better and last longer when the temperature of the unit is kept as low as possible. One way of doing that in the case of the a. c. operated dynamic speakers is to bore three or four large holes in the bottom of the cabinet, preferably under the fins of the rectifier. Then air may circulate from below the cabinet, past the fins and out through the grille. If no feet are used on the bottom of the cabinet, four rubber feet should be employed to keep the cabinet off the surface on which it is resting

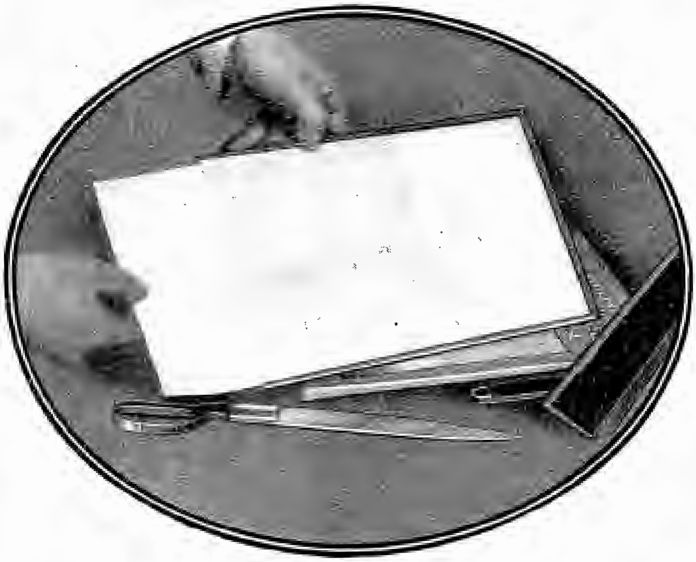


Above. Elusive a. c. hum in radio sets may often be in the speaker instead of the radio set. One way to prove this is to leave the set and speaker operating, remove the cord tips of the speaker and short them together. If there is a very slight increase in hum the speaker is not at fault. However, if the hum jumps perceptibly when the cord tips are shorted, it indicates insufficient filtration in the rectifier of the dynamic, or else a poor rectifier, regardless of type

Service Man Can Easily Make Up Handy Trouble Lamp

Right. A handy trouble lamp for use by the service man, which can be included in his repair kit, is illustrated at the right. It consists of a lamp socket, a 15-foot length of lamp cord, a triple male plug, and a single male plug. The socket is of the type equipped with a side push button. Black paint may be put on one side of the glass on the 10 watt lamp to keep the light out of the worker's eyes





Keep Your Radio Log Under Sheet of Celluloid

Left. Radio listeners who have much occasion to consult a frequency chart, or log of broadcasting hours, may find it advisable to fix up a stiff cardboard with a celluloid front, beneath which the frequency chart or log may be slipped. This will keep the log clean and flat. The cardboard and the celluloid should be of the same size, and approximately a half inch wider than the log or paper which is to be inserted. The edges of the cardboard and of the celluloid may be secured firmly with art tape such as is used around edges of photograph negatives

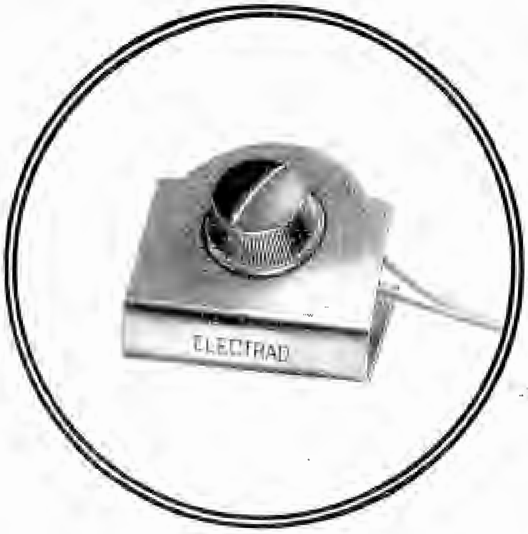
Loose Wall Plug May Cause Flutter in Radio Set

White Paint Mark Used to Indicate Polarity

Above. In the absence of a polarity plug the radio enthusiast may make a very simple substitute which can be used either on a d.c. or a.c. line If it is found an a.c. set hums a bit more when the plug is in one direction it may be reversed and the hum reduced. After finding the proper polarity, a dash of white paint may be put on the male plug at the pole desired, and another dot of white paint placed on the wall receptacle in which the plug is to be inserted. The two paint marks should meet, thus indicating the plug is in the right direction. If a d.c. line is used it may be desired to indicate the positive line, which can be done as above

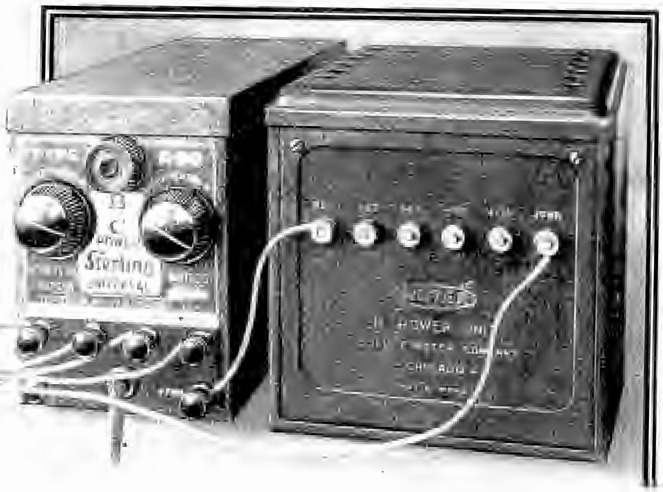
Above. Crackling or fluttering in a radio set has been known to be caused by a loose plug in the wall receptacle. If this is the case it may be remedied by putting a slight outward bend on one prong of the plug with a pair of pliers. However, in doing this be sure that too much pressure is not exerted on the prong or else the prong will be torn loose from its mooring in the compound from which the plug is made

Remote Volume Control Is Ideal for the Lazy



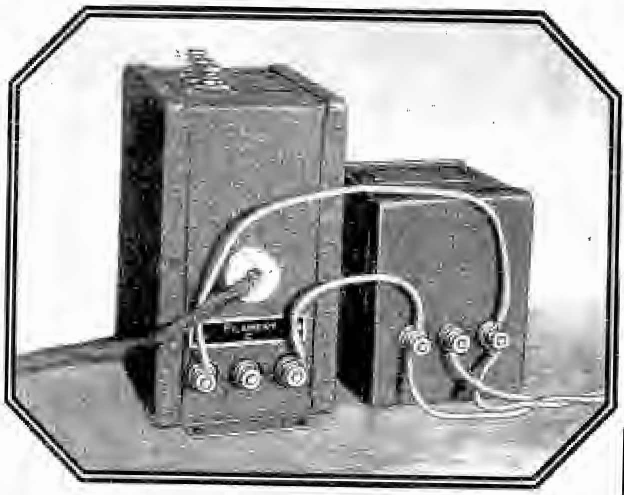
Above. If you are "too-o-o-o-o tired" to get up and turn off your radio set when the cooking expert gets to describing a favorite recipe for dill pickles, you may eliminate the pickles without leaving your chair if you fix up a variable resistance across the antenna and ground and run the two wires over to your chair

Hook Two Eliminators in Series and Get Higher Voltages



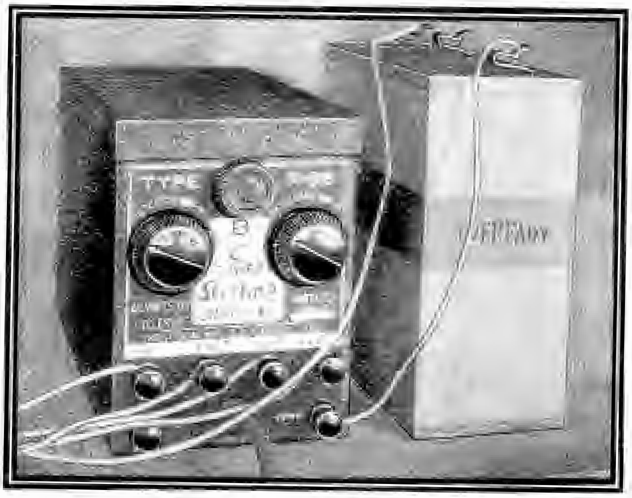
Above. Many a radio fan has a couple of old B eliminators kicking around the garret, and yet may be pining for a high voltage supply. Such a supply can easily be made by placing two B eliminators in series, the total voltage being the sum of the separate units. In this case the positive terminal of one B eliminator goes to the negative of the next. The high voltage is then taken from the two extremities

Filament Transformers May Be Paralleled If Desired



Left. In some superheterodyne circuits the experimenter finds he does not have sufficient filament current for the operation of 227 tubes. If he has an extra filament transformer, it may be paralleled with the first to give greater current. However, in paralleling use a small 3 volt flashlight bulb across the output of the two transformers when paralleled. If the lamp lights when both the 110 volt line plugs are put in a receptacle, it indicates the secondaries are poled properly. If the lamp doesn't light, one of the 110 volt line plugs will have to be reversed. When proper polarity is found, the two single supply lines should be wired together permanently

Eliminator and Battery in Series for Increased Voltage



Right. In converting a number of the old time sets to modern power tubes, it is found the eliminator only delivers 135 volts. This is not sufficient for a 171 tube. Consequently if you do not wish to buy a new eliminator, you may insert a 45 volt B battery in series with the B eliminator to get a total of 180 volts. As shown in the picture, the B power tap on the eliminator goes to the negative of the battery added, its positive terminal then becomes the plus power of the hookup. Of course you will have to renew this added battery from time to time

Photo C shows an actual photograph of a cloud-to-ground flash of lightning taken recently by Oregon State College scientists at a research station established in the Cascade mountains to study the effects of electrical storms. This picture was made in the vicinity of Mt. McLaughlin, a rock peak 9493 feet high in the Crater National Forest. P. & A. Photo

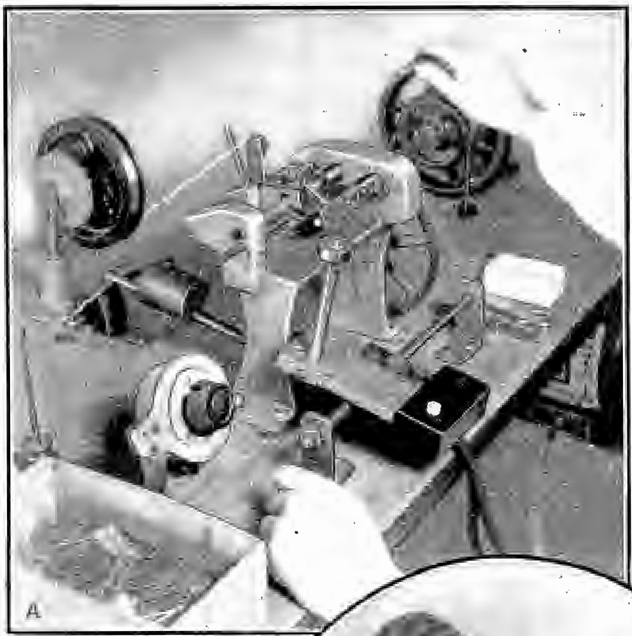
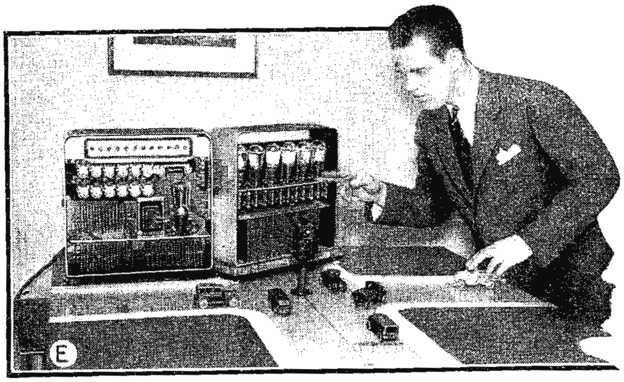


Photo A. One of the automatic grid making machines in the Duovac plant which automatically and precisely winds and welds the grids

Photo B. Guard your thoughts in the presence of this machine, for this device can register your nerve and thought impulses according to its inventor, Prof. Milton Metfessel of the University of Southern California. Miss Sarah J. Hendee, co-ed at the institution, is seen above assisting in the demonstration. P. & A. Photo.

Photo D. According to government officials, radio telephoning of weather news will shortly be extended to Seattle, Wash., and eleven Pacific coast cities will also soon be radiocasting directional beams to guide airplanes. The U. S. Airway radio station at Oakland, Calif., receives reports of weather conditions by telephone typewriters of The Pacific Telephone and Telegraph Co., from stations hundreds of miles distant and broadcasts them by radio telephone. Planes within a radius of 200 miles pick up the messages from the air. Photo shows C. W. Larson of the U. S. Airway radio station at Oakland, Calif., radio telephoning weather news to airplanes in flight.—P. & A. Photo

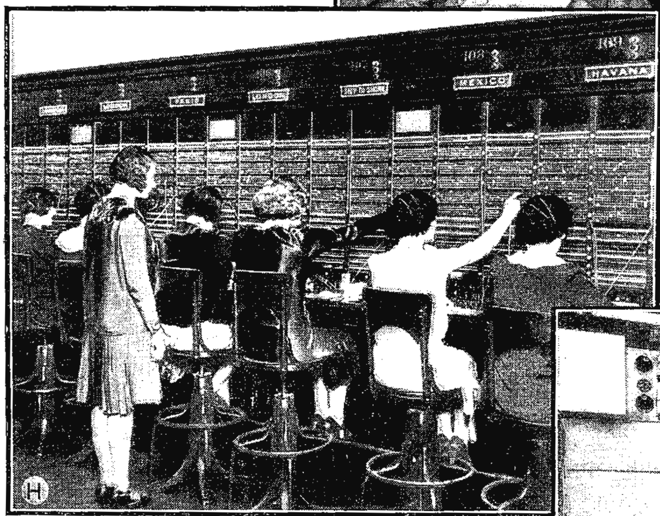


Traffic control has been brought under the control of the Robot, as Photo E of a miniature layout demonstrated at the Hotel Roosevelt shows. Detectors, wired to the Robot, are placed in the highways. Autos going over these send "messages" to the Robot's "brain" which manipulates lights. The heavier the traffic, the more time it is given to pass, while that from the other direction is held up. Shown above is Eugene D. Stirlen, president of the Automatic Signal Corp. of New Haven, who helped perfect the apparatus. Wide World Photo

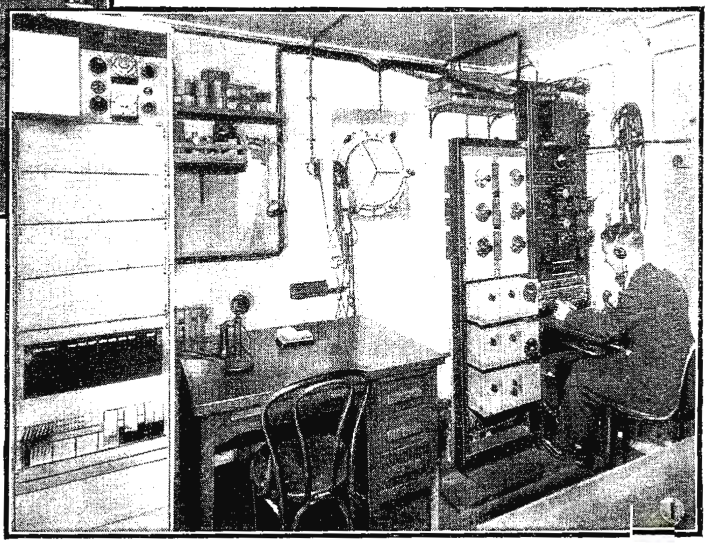
Photo F. By the skill of engineers of the Sonora Products Corp. of Chicago, the first amateur talking pictures are made possible. The 16mm motion picture film is used in connection with a blank phonograph record and by means of a combination hook-up the picture is synchronized in sound. In projection the record is placed on an ordinary phonograph timed with the projector and the results are—home talking movies. Photo shows Miss Doris Sass operating a home "talkie" movie. Wide World Photo

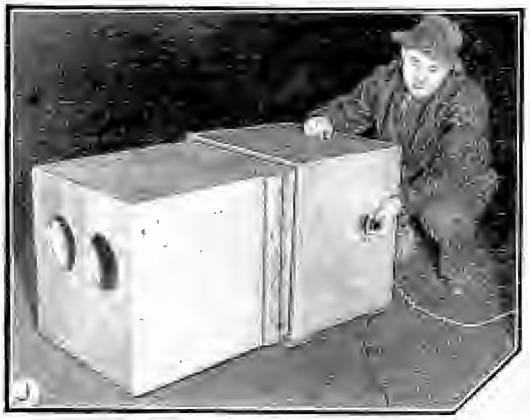
Photo G. When Col. Lindbergh and the scientists of the Carnegie Institute of Washington were over the jungles of Yucatan on their recent Maya exploration trip, they were in constant touch with the outside world by way of the only two-way high frequency radio communications system in use on aircraft in the world, the system devised, developed, constructed and installed entirely by the Communications Department of the Pan-American Airways, Inc., for use on all Pan-American planes in co-operation with the necessary ground stations. A new set with refinements is on view in the office of H. C. Leuteritz, communications chief of the Pan-American Airways, Inc. Photo shows H. C. Leuteritz, communications chief of the Pan-American Airways, Inc., using a two-way high frequency radio set used on their air-liners. Wide World Photo

The ship-to-shore telephone service connecting the S.S. Leviathan with the telephones of the Bell system was inaugurated recently. Photo H shows the foreign service section of switchboard in the offices at Walker Street, New York City. Voices going to or from radio telephone stations at Deal and Forked River, N. J., pass through this switchboard for routing to their destinations. Wide World Photo.



The ship-to-shore telephone service connecting the S.S. Leviathan with the telephones of the Bell System was inaugurated recently. Photo I shows an interior view of the deck house on the Leviathan, which houses the short wave radio telephone equipment. To the right is the receiving set where voices from shore telephones are received by radio from the Deal, N. J., station. Wide World Photo





Holland tunnel connecting New York and New Jersey is now experimentally employing a detector which records the presence of carbon monoxide, haze and dust. This so-called "electric eye" through the medium of a photo-electric cell charts microscopic motes too minute for the human eye to notice. Photo J shows the reflector of visibility meter. P. & A. Photo

A new high frequency crucible furnace which generates heat by induction from the ordinary alternating current supply of 110 volts at 60 cycles is now on display at the Museum of Peaceful Arts on West 40th Street, New York. A finger may be placed in the crucible and no heat will be felt, but if the visitor places his finger inside the same furnace with ring on it, he will instantly feel the ring become unbearably hot, as the metal starts the heat production. Photo K shows Miss Marjorie Lytell demonstrating the crucible. — Wide World Photo

The "lie detector" may not be accepted in some courts but criminologists stand by it, insisting that thousands of tests have proven that it never fails. A band is placed about the arm and another about the waist of the subject and connected to an apparatus in a small case. A pencil records a line on a moving drum. If the line is unbroken and straight the truth is being told. If it wavers or jumps an untruth is being stated, according to the experts. Photo M shows, left to right, Leonard Keeler, designer of instrument shown, Prof. August Vollmer of U. of Chicago criminology department and Marjorie Crighton, co-ed, testing the lie detector. P. & A. Photo

Photo L. Persons with defective hearing can follow the divine services in this new Protestant church in Berlin, Germany, easily with the aid of radio receivers attached to the backs of the pews. This edifice is one of the many in Germany designed along lines of modern architecture. P. & A. Photo

The first television broadcast in England was recently inaugurated in London by Sir Ambrose Fleming, deputising for Philip Snowden, English chancellor of the Exchequer. Photo O shows a view of the televisor, the reception device. P. & A. Photo

With the erection of the giant radio broadcast station, the "Deutschlandsender," at Seesen, Germany, bids fair to rank with the radio centers of the universe. The one at Seesen is of world-wide proportions. Photo N shows the water-cooled type of transmitting tubes used. P. & A. Photo

Radio Has Contributed Many Aids for Safety in Air Navigation

Just as Ship at Sea Is Protected So Radio Turns to Aviation to Safeguard Life and Property

RADIO has for some time past been contributing to the safety of air navigation in the same degree with which this science has provided safeguards for life and property at sea in the thirty or more years that have elapsed since Marconi first flashed the historic letter "S" across the Atlantic by wireless.

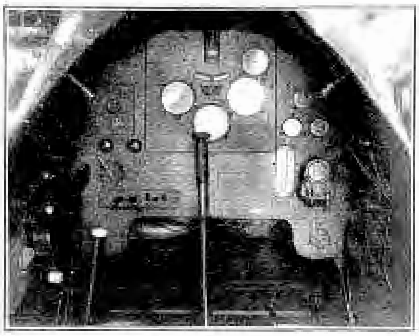
To those who have been in the radio business for twenty or more years it becomes increasingly apparent that the pace of development of radio appliances for air navigation is much more rapid than the rate of development on safeguards for ocean navigation. This may be partly attributed to the fact that many more people are involved in the operation of airplanes either for passenger or express purposes than those going to sea. Then again the commercial urge of radio development is much more intense in this day and age than it has been in the past.

What Has Been Done

What has been done for the safeguarding of mail and passenger planes in flight will be detailed in the article following. Only those devices having more or less of a radio origin will be described since our readers are not so interested in the mechanical aspects of aviation.

According to the National Air Transport, Inc., operator of the Cleveland, Chicago, New York and the Chicago, Kansas City, Dallas Airmail and Express Line, the first practical application of radio as a means of solving the problem of aviation's greatest foe, bad weather, was made by that company some time ago. Planes of this company flying the mail on the Cleveland-New York division are already equipped with directional and ground to plane receiving sets, while other ships of the company's extensive fleet are having the new equipment installed at the Chicago divisional repair shop as rapidly as possible.

The installation of the radio equipment is the culmination of a year and a half of intensive tests carried on by radio engineers of the National Air Transport Company and of the Department of Commerce which has resulted in the twin sciences of radio and aviation being definitely linked for the advancement of air transportation.



Wide World Photo

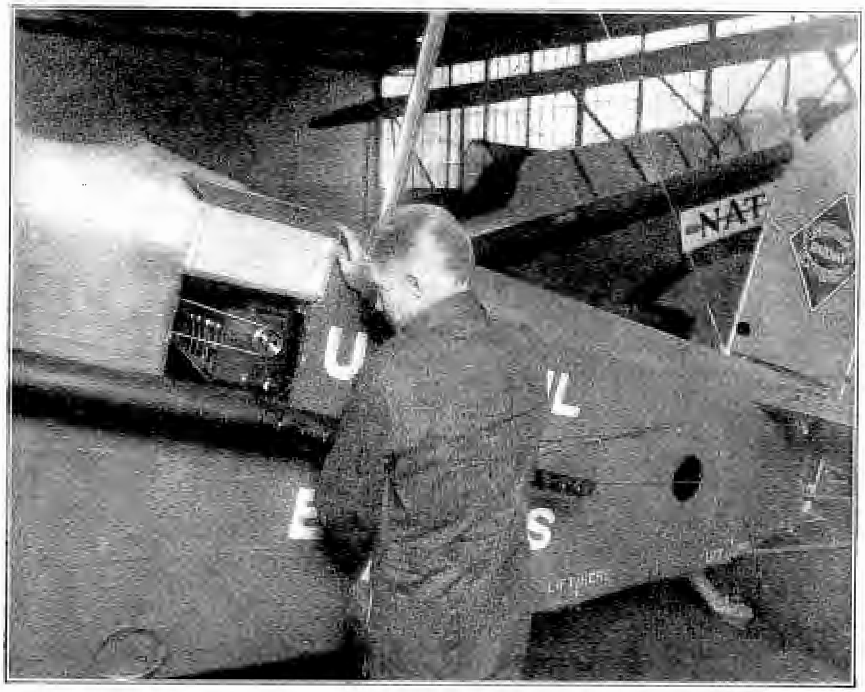
Fig. 1. Pilot's cockpit of a N. A. T. radio equipped mail and express plane. To the left at the side of the pilot is the control by which he tunes his radio so as to receive either the directional or voice waves. On the left of the instrument board is the switchboard where he plugs in his headphone connection. A volume control is also a part of this switchboard

Beacons Built By U. S.

The radio beacons at Cleveland, Bellefonte, Pa., and Hadley Field, N. J., have been erected and maintained by the Lighthouse Division of the Department of Commerce. Additional radio beacon stations will soon be in operation on the Chicago-Cleveland division of the transcontinental airways so that airmen can be guided by radio over the entire distance from New York to Chicago.

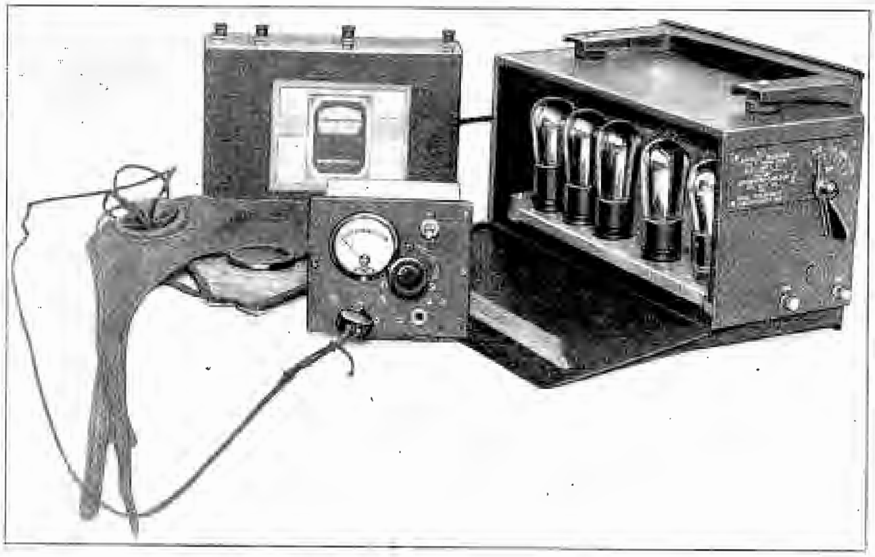
The radio beam along the eastern division is broadcast by transmitters known as equi-signal beacons. The principle upon which these transmitters work is the employment of two cross loops each radiating a characteristic signal. These signals interlock and form another signal along the bisector of the plane of the loop and when this signal is heard, the pilot in flight knows he is following his designated course.

For example, the pilot hears a dot and a dash and he knows that he is on the left of the course. He swings over and hears a dash and a dot and knows



Wide World Photo

Fig. 2. The remote controlled radio set used on the N. A. T. planes is shown in the compartment. The actual controls are in the cockpit, a pulley system extending from that point to the receiver itself



Wide World Photo

Fig. 3. Radio equipment for a N. A. T. mail and express plane. The pilot's helmet with earphones is shown to the left. In the foreground is the switchboard and volume control which is placed in front of the pilot on the instrument board of his plane. To the right is a receiving set, while in the background is the battery which combined with the ship's storage battery furnishes the energy for the apparatus

by that he is on the right of the course. He turns back to the left a little and when the dots and dashes blend into one dash he knows he is following the correct path of the airway.

Because the loop transmitters are used instead of the conventional type of vertical antenna system is the reason given by experts why the radio beacon waves can be concentrated in one direction along the course. The power generally used in transmission is 500 watts. The interior of the Cleveland airway radio station is illustrated in the photograph shown in Figure 7.

Radio Weather Reports

Weather reports are transmitted to the pilot through means of the voice transmitters from the ground stations to the plane. A different type of transmitting apparatus, tuned to a higher wave length, is used for this voice transmission which has been the subject of much intensive study and experimentation. Ordinarily the pilot is given hourly weather reports, but in event of the severe weather change ahead of him the radio beacon can be interrupted as a signal for him to tune into a higher wave length to receive voice transmission. This he can easily do by switching a remote tuning control in the cockpit which adjusts the receiving set placed in the small compartment just to the rear of his seat. The photograph in Figure 1 shows at the left the remote control tuning switchboard. The vertical mast antenna is attached to the fuselage about midway to the tail surfaces and it may be seen by inspecting the photograph in Figure 2, the vertical mast arising at the point near the mechanic's head in the picture and the aerial itself coming down at an angle to the right and being anchored at the front of the tail surface. Other equipment consisting of earphones, a volume control, an instrument board and batteries may be seen in the photograph in Figure 3.

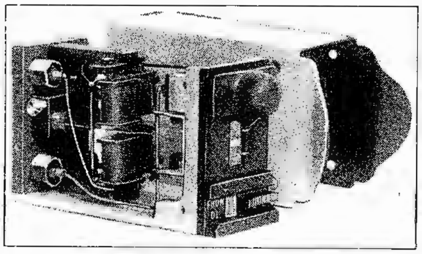


Fig. 4. This photograph shows the interior of the reed indicator described elsewhere as being the design of the Consolidated Instrument Company of America, Inc., through whose courtesy this view is supplied

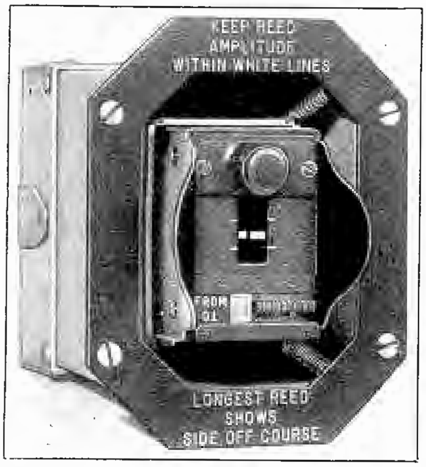


Fig. 5. Another view of the reed indicator made by the Consolidated Instrument Company of America, Inc., is shown in this photograph

Either code or voice is transmitted one way, from the ground to the plane at present, but a device is being perfected by which two-way communication will be possible. According to the N. A. T. all of their ships will eventually be equipped with this improvement.

Narrowing Beam Path

In thick weather the pilot can determine the proximity of an airport where a beacon is located by the narrowing path of the radio beam. The radio beam, like a beam of light, spreads sometimes to the width of two or more miles near the end of its effective path. Conversely it converges nearer its origin. Thus the pilot can tell when nearing a port by the intensity of the signals and the narrowing of the effective path of the beam. Further aid in locating a field in thick weather is given by what is known as a marker beacon which sends a strong signal that can be heard through the course signal and informs the pilot that he is above the field. This addition to the signal system is expected to be in general use shortly.

Between two airports equipped with the directional apparatus the pilot follows the course indicated by the one he has just left for about half the distance to the next, then the beacon located at the field toward which he is headed becomes effective and he follows its converging beam through his receiving set to his destination.

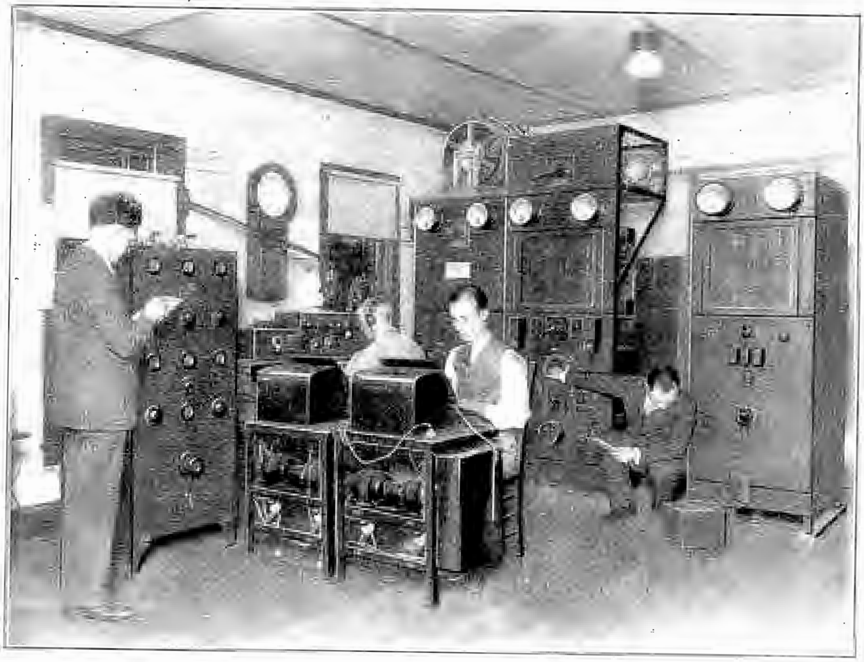
It is planned to have these directional

Fig. 6. Memory meter for depth sounding from aeroplanes which is part of the altimeter development of E. F. W. Alexanderson, consulting engineer of the General Electric Company. This memory meter intercepts the radio echo when it occurs, interprets it in altitude and preserves the result for observation by the pilot. Green, yellow and red lights give warnings corresponding to 250, 100 and 50 foot altitudes respectively. With Dr. Alexanderson in the picture is his assistant, S. P. Nixdorff at the left

beacons located at 200-mile intervals over all lines and thus take advantage of this new device to overcome any delay now caused by adverse weather conditions. Severe tests to which the directional and voice transmission apparatus has been subjected by National Air Transport pilots have proven their value and reliability as an aid to aerial navigation under all weather conditions.

Tuned Reed Indicator

Another interesting device which is used in aviation is known as the radio beacon tuned reed indicator, an instrument designed by experts of the radio section of the U. S. Bureau of Standards under the supervision of F. W. Dunmore, and is used to establish communication with a plane with radio beams sent out from stationary radio beacons. This instrument was publicly demonstrated by Lieutenant Dolittle at Mitchell Field on September 24 of the past year. By means of the communication established between the indicator and the land beacon it is possible for the plane to follow a definite track or boulevard of the air.



Wide World Photo

Fig. 7. The interior of the radio airway broadcasting station at the Cleveland airport is shown in this picture. Operators are receiving weather reports and other flying information over the teletype which in turn is broadcasting to the pilot in flight. Technicians are busy keeping the directional radio apparatus adjusted so that N. A. T. mail and express planes may follow a true course in all kinds of weather

The first models of this instrument were made by the U. S. Bureau of Standards and the contract to manufacture them for the Airways Division of the Department of Commerce of the Bureau of Standards has been placed with Julien T. Friez & Sons, Inc., Baltimore, manufacturing and research division of the Consolidated Instrument Company of America, Inc.

This method of radio communication by means of the reed or visual indicator is said to be superior to the aural beacon method of communication which necessitates the use of earphones. Interference from other sound signals and from static has made the aural beacon less desirable, whereas with the tuned reed indicator such interference does not occur. However with the tuned reed indicator no voice communication is possible unless headphones are used and the pilot warned to change to a higher wavelength for voice work.

Fig. 8. In this photograph at the right are the radio set which transmits a radio wave and preserves the echo, and the altimeter developed by E. F. W. Alexanderson, consulting engineer of the General Electric Company. Dr. Alexanderson is holding the memory meter on which the altitude is recorded. With him is his assistant, S. P. Nixdorff

This instrument is called a tuned reed indicator because reeds or thin strips of special metal built with extreme precision so as to vibrate each to but a single frequency are used to signal to the pilot that he is flying along the radio beam.

Two reeds of this instrument which are illustrated in Figures 4 and 5, with the flattened tips, seen behind the glass front, will vibrate with equal amplitude when the plane is flying its chosen course. When the front of the plane deviates from this course one reed will vibrate with a shorter amplitude and this shortening of reed vibration can readily be seen.

Hazard of Drift

The vibration of the faces of the reeds is visible behind the glass front as two short color bands of light. The shortening or lengthening of these bands of light is clearly visible. A direction for the pilot is written on the rim of the instrument case. It reads "longest reed shows off course." This is a perpetual

(*Continued on page* 98)

Hammarlund Hi-Q 30 D. C. Designed For Operation on Batteries

Alternating Current Model Chassis Serves for Both Jobs; Very Few Changes in Circuit

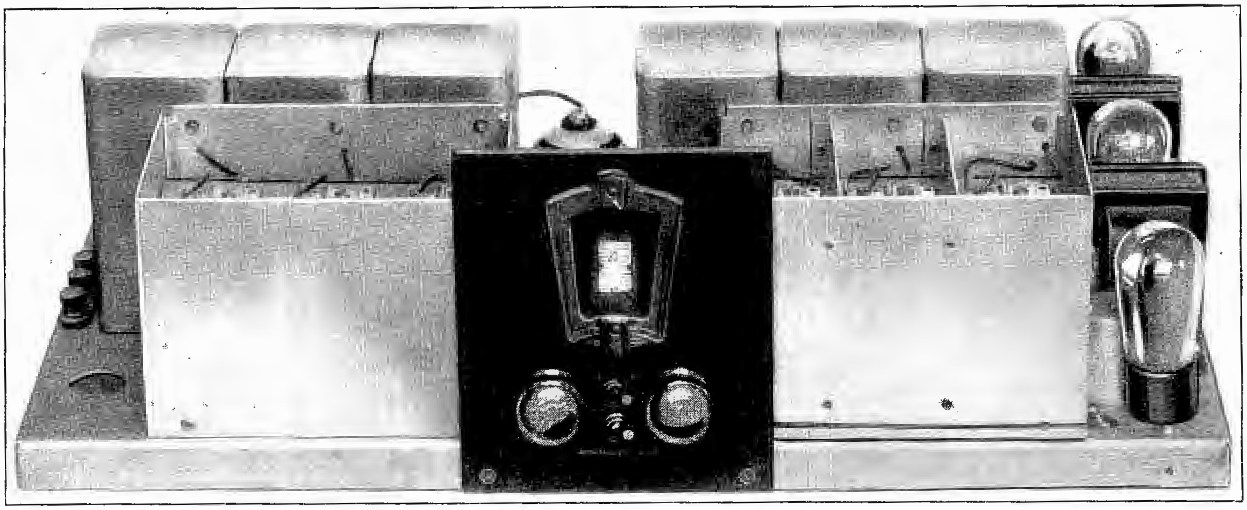


Fig. 1. A front view of the Hi-Q 30 as designed for battery operation is shown in this photograph

DESCRIBED originally on page 51 and 52 of our November, 1929, issue, the Hammarlund Hi-Q 30 a. c. receiver now has a twin for the battery operation districts, there being practically no circuit changes with the exception of resistance alterations in the filament circuit to accommodate the 222 d. c. screen grid tubes.

It will be noted by referring to the schematic diagram in Fig. 3 that the volume control which is a 50,000 ohm variable resistance used on the screens of the 222 tubes is across the plus 45 volt line and the ground all the time. While the current drain through this resistor is only about ⅞ of a mil nevertheless if the receiver is to be left idle for a long time it would be well to disconnect the negative B wire from the set so that this drain will not continue while the set is not being operated.

There have been so many requests from readers as to actual performance on receivers that our laboratory has secured a General Radio standard signal generator Model 403-C, and together with associated equipment made by the same company, is now taking response curves on the better known kits.

Three sets of measurements are made in accordance with standards laid down by the engineering committee of the R. M. A. These standards set forth as near as possible actual operating conditions. The signal generator simulates a broadcasting station with 30 per cent modulation, and the dummy antenna used simulates the average broadcast listener's aerial installation. The three measurements taken represent the measured performance of the receiver as regards its sensitivity, its selectivity and its fidelity.

How It's Measured

Since the Hi-Q 30 d. c. model was the first of the Hammarlund receivers to be measured in our laboratory we are giving briefly the method of measurement in accordance with the R. M. A. standard. The signal generator used is a 403-C, the audio oscillator is a 377, and the output meter is a 486, all being made by General Radio for measurement purposes. The dummy antenna used is one having an inductance of 20 microhenries, a capacity of 200 micro-microfarads, and a resistance of 25 ohms. It is also made by General Radio.

Sensitivity

The first measurement made is that of sensitivity. It is indicated in Fig. 4. The oscillator is set at a predetermined frequency and modulated by a 400 cycle note at 30 per cent modulation. The receiver is tuned to the r. f. signal with the volume control full on. The output meter is calibrated at .05 watts, which is the standard output for measurements. The output, or field strength of the oscillator is then advanced to a point which develops .05 watts in the output circuit. The voltage input from the oscillator is then noted in terms of microvolts which is equal to field strength.

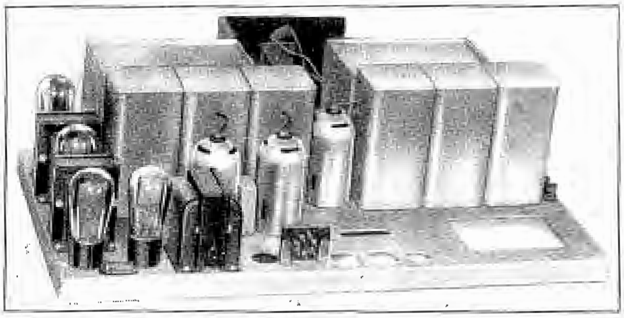


Fig. 2. As may be seen from this rear view the chassis is the same for the d. c. model as for the alternating current job described in our November, 1929 issue

The carrier frequency of the oscillator is then varied to another predetermined point and the receiver retuned to this frequency and the procedure of measurement repeated.

Inasmuch as the standardized effective antenna height has been selected as

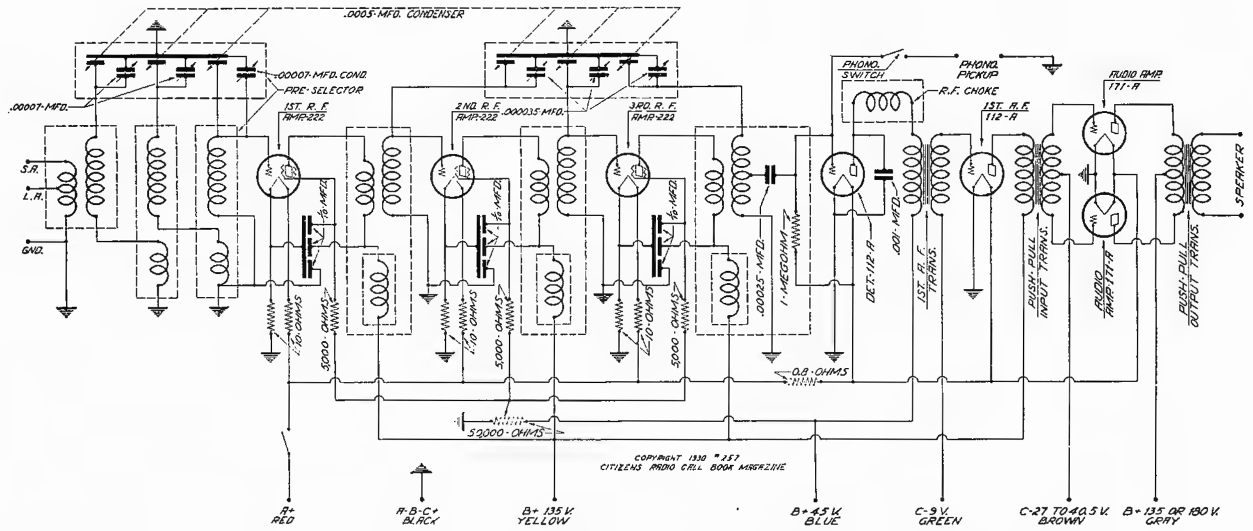


Fig. 3. The complete schematic circuit of the Hi-Q 30 d. c. is illustrated in this drawing

4 meters, the microvolts at the various frequencies required to develop .05 watts in the output circuit are divided by 4 to obtain the microvolts per meter which has been defined as the sensitivity of the receiver, and which also may be calculated as the overall gain of the receiver. From these various points are plotted the sensitivity of micro-volts per meter versus carrier frequency as illustrated in Fig. 4.

Selectivity

The next measurement is selectivity. From the sensitivity measurement is determined the point of least sensitivity and the base for measurements taken from this point so that the bottom of all curves will fall at the same point. The oscillator is adjusted to a predetermined frequency modulated by the 400 cycle, 30 per cent signal, and the receiver tuned to this frequency until resonance is obtained, and the oscillator output is turned up to a predetermined field strength. In case of the Hammarlund Hi-Q 30 d. c. this input was determined as 1000 microvolts. The volume control on the receiver was then adjusted so that 50 milliwatts was recorded in the output circuit. The receiver is then left untouched for the balance of the measurements at this carrier frequency. The field strength at resonance is then noted. The oscillator frequency is then varied either plus or minus a definite number of kilocycles off resonance. The oscillator output is then increased until 50 milliwatts is again recorded in the output circuit. This field strength being noted and the oscillator frequency again being varied a definite number of kilocycles, and the procedure repeated until either 50 kc. on either side of the resonance point has been reached, or 100 times the field strength at resonance has been attained. From these points a curve such as illustrated in Fig. 5 may be plotted. This same procedure is repeated at the other carrier frequencies selected. These three frequencies are 600, 1000 and 1400 kilocycles as illustrated in Fig. 5.

Fidelity

The last measurement is that of fidelity. The oscillator is tuned to a predetermined carrier frequency modulated by a 30 per cent 400 cycle note and the receiver balanced as in all preceding measurements. The volume control in this measurement may be set at any place desired for the conditions required by the oscillator output. The field strength necessary to develop .05 watts in the output at 400 cycles is then noted. The audio frequency is then varied from 90 to 10,000 cycles, always retaining 30 per cent modulation, and the oscillator output varied to maintain the standard output and these field strength readings recorded at all frequencies. From these readings of field strength the ratio of voltage inputs from a base of 400 cycles is figured, and the following formula used to evolve the decibel loss or gain from 400 cycles: $\text{Ratio}_{\log} \times 20 = \text{Db}$. These measurements are made on three standard carrier frequencies and a curve as illustrated in Fig. 6 is obtained.

What Curves Show

Analyzing the sensitivity curve we see a group of curves marked A, B, C and D.

Curve B was made with all condensers phased at 600 kc.

Curve C was made with all condensers phased at 1000 kc.

(*Continued on page* 105)

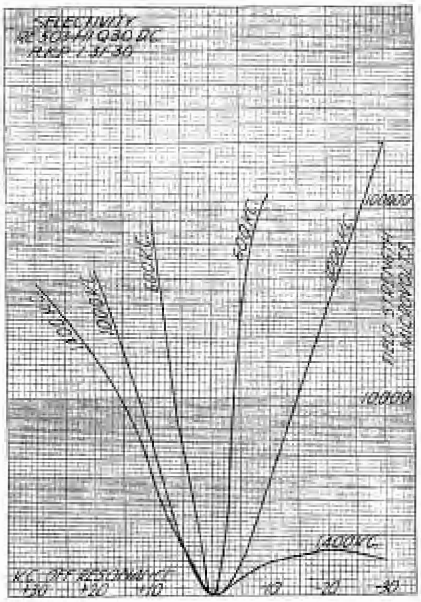


Fig. 5. Selectivity of the receiver as measured at 600, 1,000 and 1,400 kc. is shown graphically in this chart

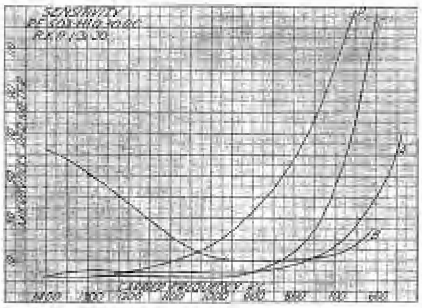


Fig. 4. The sensitivity curves as made in our laboratory are shown in this graph

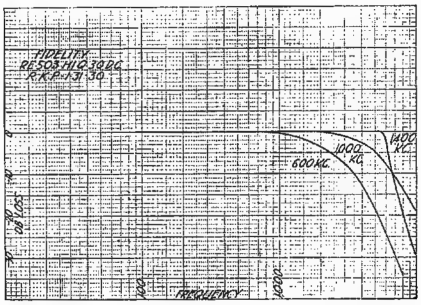


Fig. 6. Fidelity measurements made in the laboratory on the Hi-Q 30 may be seen in this graph

Amplifier With Universal Input and Output for Experimenters

Silver-Marshall 692 Designed For Improved Performance; Works Out of Low Impedance Pickup

TO meet the insistent demand of experimenters and amateurs for an amplifier with distinctly improved performance and a universal input and output circuit, the S-M 692 amplifier has been designed. Its designers state its frequency characteristic is flat within 2 DB from 60 to 12,000 cycles and to within 4 DB from 44 to 12,000 cycles. Due to the fact that the minimum perceptible difference in level at the extremes of the frequency range covered by this amplifier is about 3 DB at normal intensity, this amplifier is almost perfectly flat, as far as the ear is concerned, over the entire audio range.

The importance of the higher frequencies, which are so important to speech articulation, has become increasingly evident and the efforts of speaker manufacturers have been directed toward improving the upper register. At normal intensities, the ear can, on direct comparison, detect a difference of approximately ½ DB at 5,000 or 6,000 cycles that is at the frequency at which the usual amplifier begins to cut off. An inspection of the curve will show that the S-M 692 has a trifle more amplification at 8,000 than at 1,000 cycles. This means that an exceptionally good speaker with good high frequency response and a good source of input having these higher frequencies is necessary in order to make the difference distinctly evident. The excellence of the frequency characteristic is attested to by the fact that this amplifier has been used in a production speaker test set-up where a carefully equalized beat frequency oscillator is used to cover the entire audio band.

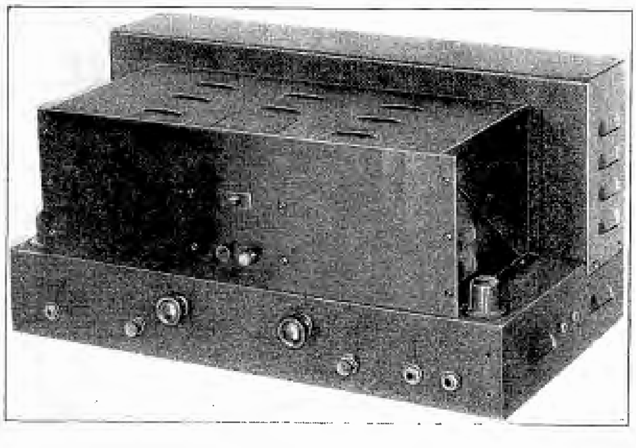


Fig. 2. A front view of the 692 is shown in this picture, the controls being shown on the rear of the chassis

High Amplification

Of special interest is the high amplification of 72 DB; that is, the total voltage amplification of 4,000. This means there is sufficient gain to operate directly out of a low impedance pickup without an impedance adjusting transformer. There is also sufficient output so that the amplifier can be used in experimental work with photo-electric cells having a low output. Where the maximum possible amplification is wanted, it may be secured by using an impedance adjusting transformer to work out of a low impedance source

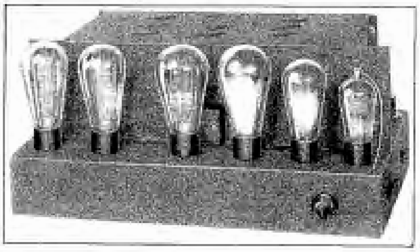


Fig. 1. The amplifier complete with tubes is illustrated in this photograph

into the 100,000 ohm input potentiometer. A table of the maximum amplification that may be secured with different types of input circuits is given below:

Input Impedance	Voltage Amplification	Gain DB
200	89,600	99
Mike	63,200	95.8
500	56,800	95
4,000	20,000	85.7
20,000	8,960	79
100,000	4,000	72

The table shows that without an input transformer the amplifier has approximately three times the voltage amplification of the usual three stage amplifier. When used with an external input transformer, out of a high impedance pickup, for example, the total voltage amplification is said to be 15 times that of the usual amplifier.

With an input transformer such as the S-M 225M, a total voltage amplification of 63,200 corresponding to a gain of 95.8 DB may be secured from a double button microphone which is sufficient for most "distant" pickup work. Where experimental work with extremely small inputs is to be done, when working out of a photo-electric cell, for example, which gives a very limited output, only a single 112A tube need be used as a pre-amplifier. If the P. E. cell is resistance coupled to a 112A tube and this in turn coupled through a 2¼ or 2½ to 1 ratio transformer to the 692, a total voltage amplification of 46,000 is available.

Potentiometer Input

Due to the use of a potentiometer input, this may be used as a volume control without affecting the frequency characteristic. In the conventional type of amplifier, where a transformer input is used and the volume is controlled externally, the volume control must either be of the "T" or special network type which is very expensive or, if it is of the straight potentiometer type, it will introduce both wave form distortion and frequency discrimination. The potentiometer type of input has the further advantage of permitting an external potentiometer to be used with the slider connected to the input of the 692 without introducing either form of distortion. In this case, the input potentiometer of the 692 is used as a gain limiting device.

Coupling Method

The amplifier uses a combination of resistance and transformer coupling which results in better performance than can be secured from either used alone. A 224 tube is used as the voltage amplifier. This gives a total voltage amplification of nearly 180 (45 DB). In special experimental models, considerably more amplification was secured

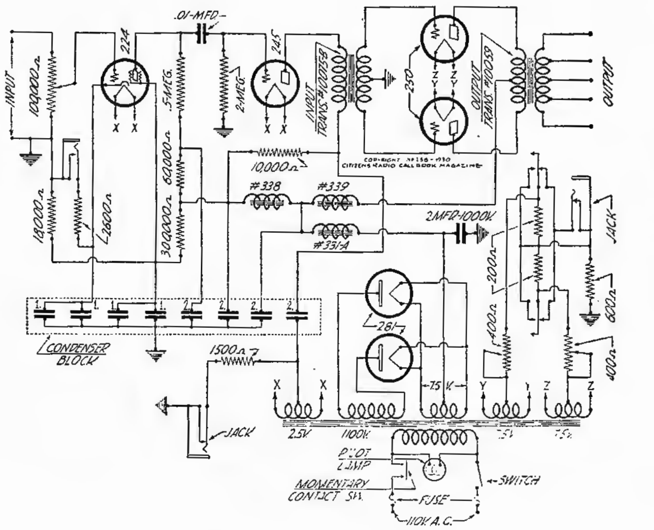


Fig. 3. This schematic diagram represents the circuit used in the S-M 692 described in the accompanying article

from this tube, but it was found that there was considerable loss of high frequencies due to the shunting effect of the input capacity of the following tube. This is particularly objectionable when working into a 250 tube direct due to its high input capacity. This effect may be minimized by lowering the resistance of the coupling element, but this lowers the effective amplification and vitiates the effect of using the screen grid tube. There is also a loss at both the low and high frequency end in the output transformer which cannot be compensated for in a straight resistance coupled amplifier. In order to hold up the low frequencies which are lost in the output transformer, and to improve the high frequencies which are lost both in the resistance coupled stage and in the output transformer, a coupling stage was introduced between the voltage and power stage. This was so designed that a resonance effect contributed to the bass reproduction and a special coil was used in the transformer which gives a very low distributed capacity and low leakage reactance so the peak which usually occurs at 6,000 or 7,000 cycles was moved up to 11,000 cycles. The effect of this compensation is clearly shown in the overall characteristic. It is important to remember in considering this that this is measured to the low impedance output circuit which works directly into the voice coil of a speaker and, therefore, under the worst possible conditions. Many amplifier curves are run giving the overall frequency characteristic to the plates of the 250 tubes and in this case the loss and frequency discrimination of the output transformer are not shown.

The use of this intermediate coupling stage using a 245 tube gets away from one other serious problem that is present when the 224 tube is coupled directly to the 250 tube. The manufacturers of the 250 type tubes have recommended that the input circuit to the tube contain a resistance of not more than 10,000 ohms. This is due to the fact that the input impedance of these tubes varies over wide limits and may be well below 100,000 ohms. While the 250 type tubes that are now being manufactured have been improved considerably over the earlier types. this is still a serious problem when working out of a high impedance circuit. This means that good performance can only be insured by using selected 250 tubes since a 250 tube having a low input impedance will lower the amplification and may introduce wave form distortion.

The output circuit is normally intended to work into a low impedance corresponding to the voice coils of one or more dynamic speakers or to a low impedance a. c. meter where measurements are to be made. The five taps on the secondary give sixteen output impedances ranging from 8 to 125 ohms. By using the output transformer as an autoformer, the speaker may be operated into impedances ranging from 900 to 8,000 ohms.

The practice of using an impedance adjusting transformer to get out of the usual 4,000 ohm output circuit and into a low impedance circuit has become quite common. By incorporating this transformer directly in the amplifier, the cost of this separate transformer or of the input transformers to the speakers is saved. Then, too, the loss of amplification and distortion introduced by the additional transformer are eliminated.

In spite of the high amplification of the S-M 692 amplifier, there is a peak hum voltage of less than one volt and the output contains a minimum of the higher harmonics of the power frequency to which the ear is sensitive. Because of the fact that an input resistance or potentiometer instead of an input transformer is used, the hum is almost independent of the volume control or gain setting.

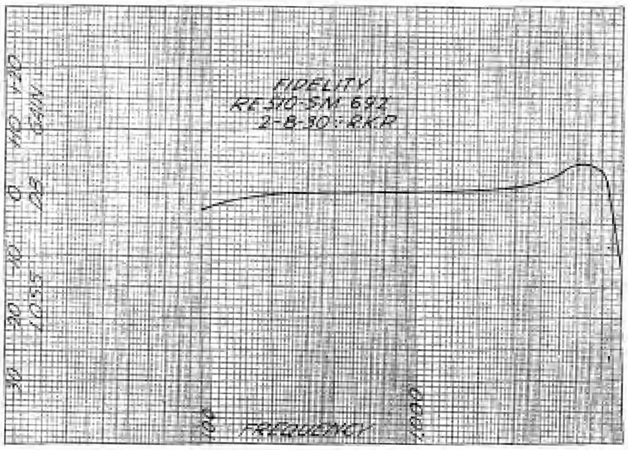
Made Foolproof

Mechanically and electrically, the unit has been made as foolproof as possible. The tubes are shielded both electrically and mechanically by a heavy gauge tube guard. All of the power equipment is mounted on the upper side of the chassis to minimize hum and other troubles from the power supply. All of the audio frequency circuits are isolated on the under side of the chassis. A false bottom covers all of the equipment on the under side of the chassis and a momentary contact switch which is actuated by a special tie rod prevents either the false bottom or the cover being removed without first breaking the 110-volt supply. This makes it impossible to receive a shock when either of these is removed.

When operating out of the normal low impedance output taps, either the input or the output may be short circuited or grounded without hurting the amplifier. To protect the amplifier against the only other probable source of trouble; namely, defective 281 or 250 tubes which could short circuit the power supply and burn up the power transformer, a special low current fuse has been placed in the power circuit. The power transformer has been designed for continuous operation and has a core rise of only 25 degrees C. The

(*Continued on page* 107)

Fig. 4. A graph of fidelity on the S-M 692 as recently measured in our laboratory. The input wiring capacity caused the sharp drop to 12 DB at 10,000 cycles, this on the hand sample measured. However, in production models the shielding of the first 224 input circuit has been altered to eliminate the high frequency cutoff



Radio Enthusiast May Put a Screen Grid Receiver in His Car

"Voice of the Road," Auto Set Recently Designed and is Fully Described for Builders

THE "Voice of the Road," a screen grid radio receiver kit suitable for installation in the average motor car has recently been designed by the Wireless Egert Engineering, Inc., for the Continental Wireless Supply Corp. The schematic diagram of the set is shown in Fig. 2 on this page, while the installation itself may be seen in the photograph in Fig. 1. At the right of the dashboard will be observed the tuning dial and two controls together with an on-off switch. The radio receiver itself is seen below and is connected to the dash by means of the flexible coupling. The battery wires for the receiver go from the chassis below the dash down to the battery itself. B batteries with a total of 180 volts may be utilized on this installation and if the current drain is not excessive renewals will not have to be made too frequently.

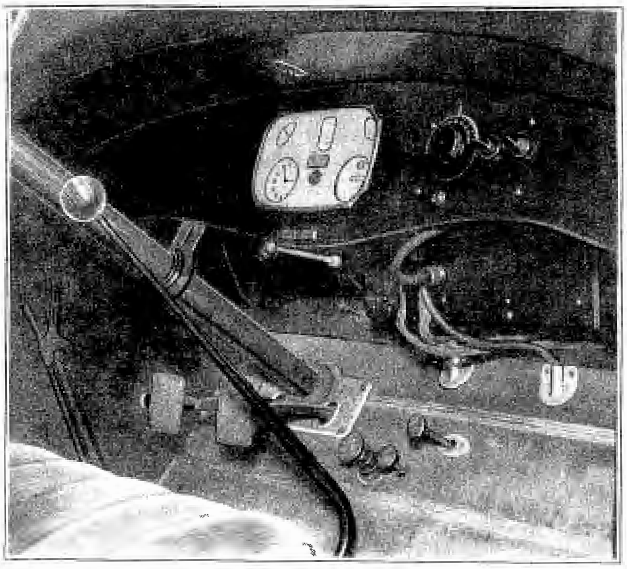


Fig. 1. In this photograph may be seen the "Voice of the Road" installed under the dash of an automobile, the controls being placed on the dash and operating through a shielded cable

According to the latest advices from the Continental Wireless Supply Corp., a different type of dial will be used in future models, probably one of the vernier type which will set in the center of the assembly on the dashboard a little higher than the two knobs shown in Fig. 1. One of these knobs will be filament and switch combined and the other will be the tuning control.

Completely Shielded

Considering the mechanical design of the receiver itself, it will be seen by examining Fig. 1 that the set is completely encased in a metal box. This may also be seen in Fig. 4 on page 102, where the remote control cable and knob is shown. This precaution was taken to prevent picking up dust and foreign substances while driving the car. All connections which must be made outside of the receiver protrude from the front of the metal box. There are pin jacks for the loud speaker connection and a pin jack for the antenna. There are cables for remote control and battery connections. These cables are completely shielded, the shielding factor being one of utmost importance for quiet operation. There is also a flexible shafting which extends to the tuning knob on the dashboard. This flexible shafting and the remote control portions are illustrated photographically in Fig. 6. Fig. 5 shows the bottom of the receiver, while Fig. 3 shows the rear of the receiver panel.

Simulates Factory Job

In the photograph, Fig. 3, the "Voice of the Road" receiver immediately gives the impression of being a factory made job. Every inch of available space is used, although the parts are individually placed to assure easy assembly and wiring. Each stage is fixed so that the coil, condenser and socket are advantageously placed to obtain the shortest wiring leads possible. Aside from this, one can easily see how well each stage follows the

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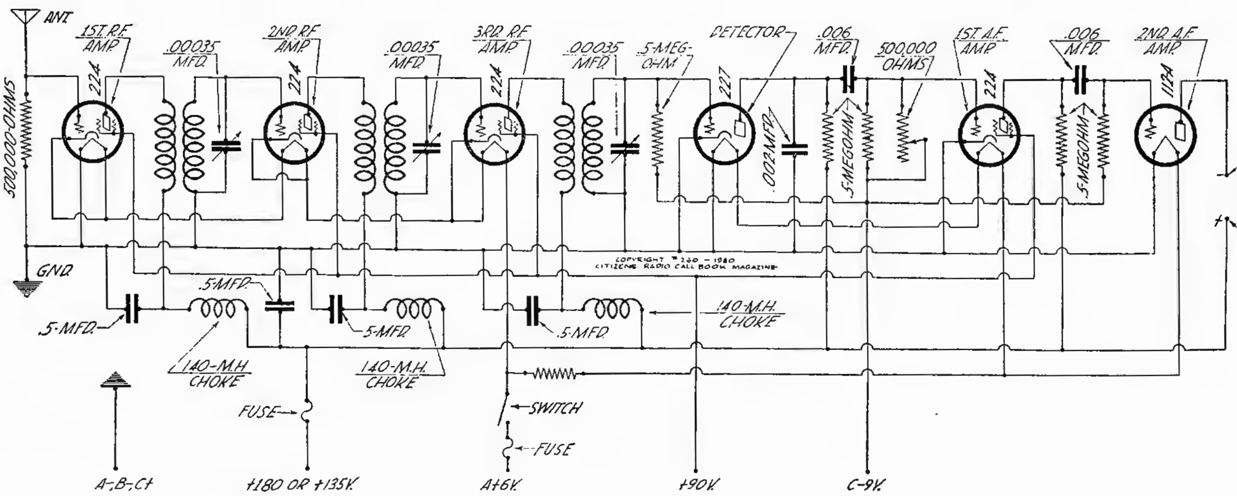

Fig. 2. A schematic diagram of the completed automobile radio set as recently designed is shown above

Scott Designs Remote Control for His Screen Grid Super

With New Device Custom Builders Find Wide Field for Sales of This Popular Receiver

THERE have been many remote control devices announced recently but all of them involve mechanical motions of the dials from a position at a distance from the receiver itself. In addition to that, all of the remote control tuning devices thus far made known are for use on tuned radio frequency receivers.

First For Super

The first remote control suitable for a superheterodyne has recently been announced by the Scott Transformer Company, a photograph of the unit being shown at the head of this article. The control is designed only for the Scott receivers and has been added to the Scott line in order to open up an entirely new and wider field for custom builders. With this remote control it is now possible to make sales of the Scott receivers to clubs, hotels, restaurants, rest rooms, and any place where the public gathers and yet where it is desired by the management that the actual control of the receiver be not in the hands of the public itself.

For example, in the past it has been found that many times when a receiver set is installed in a public place there is the tendency on the part of individuals to tune the receiver itself, some tuning it too loud and others tuning it too soft. Then again, while switching from station to station the volume control will probably be turned on too far and as a result there will be a crash of volume when running across a local.

However, with the remote control placed in the office of the organization, all of the tuning is done by the owner of the set and in that way greater satisfaction is derived by the listeners than if the machine were handled by several of their number.

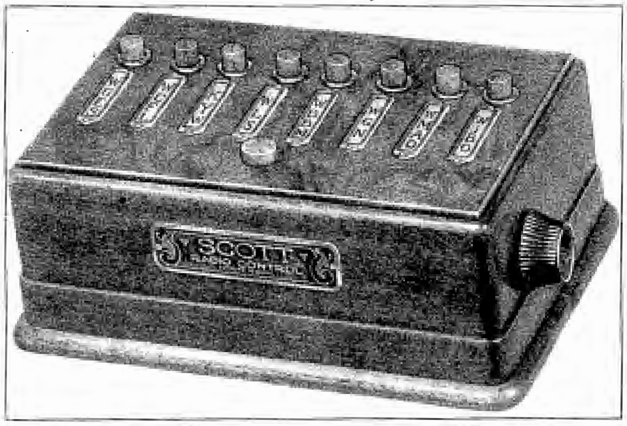

Fig. 1. This photograph is one of the recently announced Scott radio controls described in the accompanying article

No Movable Parts

In looking over the description of the remote control tuner we find that the remote control itself does the tuning. The condensers in the receiver do not move when the control is being used. There are no motors nor relays in the control. Instead the remote control might be likened to a remote controlled oscillator. The cord connecting the remote control to the receiver is no thicker than a lamp cord. On the other hand, the remote control does not interfere with the regular dial tuning of the receiver. Either the dial or the control may be operated at will by turning a switch one way or the other.

Ideal For Shut-Ins

Another one of the features of the use of the control is the fact that the bridge player, the bed-ridden, or the reader from his place of quiet can instantly control the receiver by the mere touch of a button. Thus the set itself may be in one corner of the room and the listener may be in another corner reading, with the remote control device at his side. By the same token the listener may also be in another room from where he may tune the receiver just as if he were alongside of it.

Enterprising custom builders can readily see the benefits of such a tuning device as applied to the sale of receivers in their own territory. As may be seen in the photograph shown in Figure 1, the device consists of a series of nine

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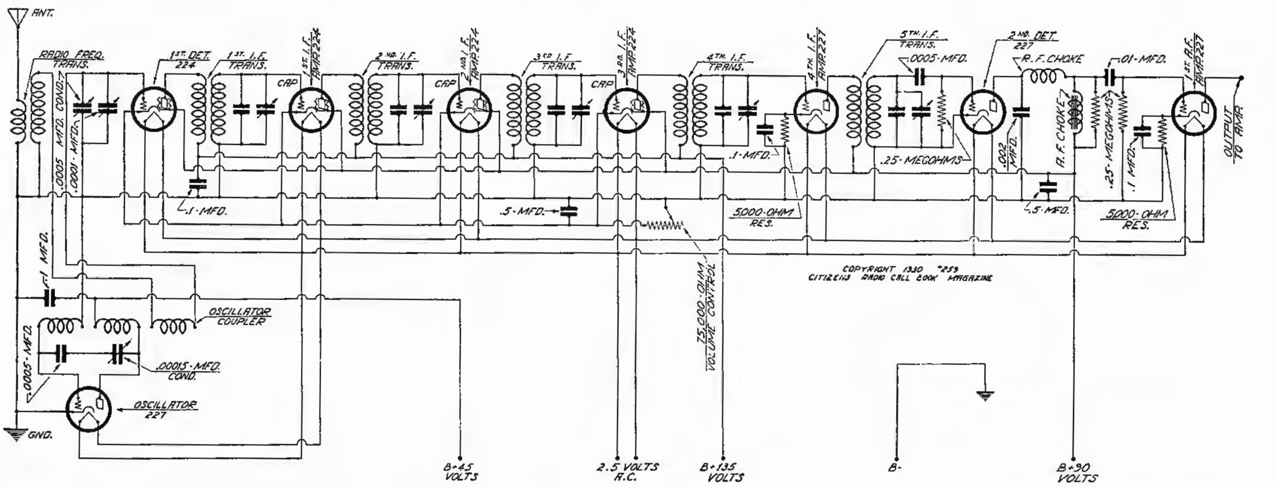

Fig. 2. The schematic diagram of the Scott a. c. shield grid 10 with recent changes is shown in this illustration

Amplification of Heart Voltages Is Used for Diagnostic Work

Vacuum Tube Permits Accurate Technique for Measuring Current from Contractions of Heart

ROMANTICISTS, poets and writers of love stories who in the past have dwelt upon the warmth of the heart may have to considerably alter their descriptions of that vital organ's attributes to include the characteristic voltage of the heart, if we are to be guided by the steps made by science in applying the principles of audio amplification to the compilation of heart voltage data being made by the medical world.

That the heart in its muscular contractions produce a current has been known for many years, but it has remained for the modest vacuum tube in an amplifier circuit to permit an accurate technique which may be used in diagnostic work. This work is known as "electrocardiography." A brief historical review of this subject has been interestingly presented by Pardee in his book "Clinical Aspects of the Electrocardiogram," from which the following is excerpted:

Heart Produces Current

"The clinical study of the electrical current accompanying the heart's contractions was made possible by Einthoven of Leyden in 1904 by the perfection of an instrument sufficiently sensitive and quick to follow the small, rapidly varying currents products by the heart. It had been known since 1856 that the contraction of the heart was accompanied by the production of an electrical current. In 1887 Waller demonstrated that this current could be led off from the surface of the body and recorded if only a proper contact were made between the wires from the galvanometer and any two areas of a body including the heart between them. At that time, however, the medical world was not prepared to consider seriously so complicated a diagnostic appliance. Even the physiologist had difficulty in making use of this knowledge, for the only instrument available was the capillary electrometer which was totally inadequate to record with any degree of accuracy the quickly varying currents of the heart beats. Einthoven's string galvanometer was first described in 1903, and in 1906 and 1908 he published the results of his first clinical study. The clinical use of the electrocardiograph since became general in the large clinics abroad and the first instruments were installed in this country between 1910 and 1913."

According to a booklet on the Victor electrocardiograph manufactured by the Victor X-Ray Corporation of Chicago, we learn the increasing importance of the electrocardiograph for clinical diagnosis and prognosis is recognized everywhere. Humanity is gratefully indebted

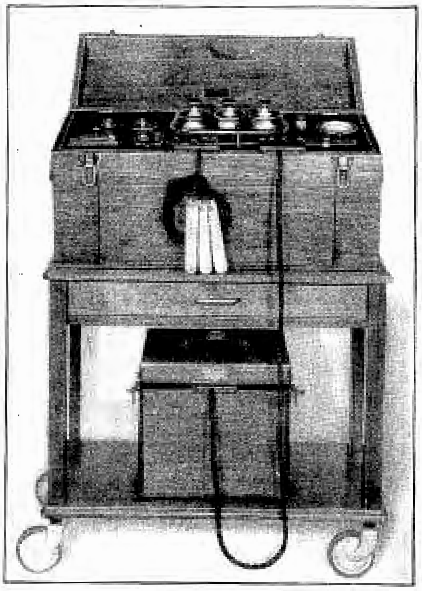

Fig. 1. This photograph shows one of the electrocardiograph mobile sets made by Victor and described in the accompanying article

to the medical scientists who have contributed to the vast fund of present-day knowledge of the clinical pathology of the heart, also to the physicists who have collaborated with medical men in the designing of delicate instruments with which electrocardiography becomes possible and a valuable aid to the medical sciences.

Several years ago the idea of an improvement over the then prevalent type of electrocardiograph was entertained by several members of the research laboratories of the General Electric Company in view of the intense interest in the study of diseases of the heart. A careful and extensive survey of the methods in vogue indicated that an instrument which would be more simple to operate, of greater ruggedness and at the same time in portable form without sacrifice in sensitiveness would prove a valuable aid to everyone in this field.

Experimental Models

From these angles the research laboratories approached the problems involved and after several years of laboratory investigation and experimental work were ready to announce a new type of electrocardiograph differing radically in principles of design from those used in the past. Several of these experimental models were completed and placed in the hands of heart specialists to prove the correctness of design from the standpoint of reliability and practicability. Application of the new instrument in hundreds of cases by these specialists showed a record of consistent performance that was most gratifying and so justified completion of a finished model. At this stage the original model was turned over to the engineers of the Victor X-Ray Corporation who completed the work by making certain changes in addition as would permit incorporation of certain requirements that suggested themselves during the periods of actual clinical use of these first models in the hands of specialists.

For the benefit of our readers we are giving a somewhat detailed explanation of the amplification of the heart voltages by thermionic amplifiers. Because of the extremely low voltage generated by the action of the heart instruments for its measurement have necessarily been extremely sensitive and required great skill and considerable experience to assure reliable records. The fragility of the usual galvanometer string of quartz is obviously due to the microscopically small diameter required in order that it may register the deflection caused by the infinitely small heart voltage. Every cardiologist is aware of the great care that must be exercised in manipulating such a delicate mechanism and the consequently ever-president possibility of variable performance which would affect directly the end results.

To eliminate the extreme delicateness of this very vital part of the instrument seemed therefore the first essential in

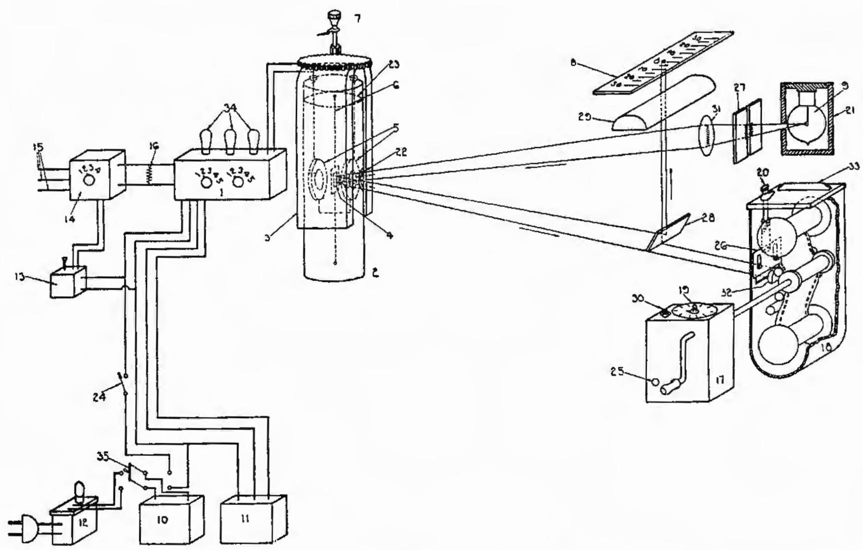

Fig. 2. This is a simplified schematic diagram of the electrocardiograph whose principles of operation are described in these columns

any new design and the research laboratories of the General Electric Company utilized their knowledge of the latest approved methods for measuring voltage as used in critical engineering work. The result proved extremely successful for cardiographic purposes, for with the introduction of modern amplification methods in the use of three special amplifying tubes it became possible to step up the imperceptibly low voltage of the heart action and to measure these increased voltages with a new and rugged type of galvanometer.

Beam is Recorded

The galvanometer consists of a small iron vane ruggedly suspended in a cell of a clear oil of appropriate viscosity and is situated in the field of a permanent magnet. To this vane is attached a small mirror. Movement of the vane is produced by means of two coils placed at right angles to the field of the permanent magnet, placed in such a way that the current of amplified voltage of the heart action passing through the coils modifies the magnetic field and causes the vane to alter its orientation. The corresponding movement of the small mirror is recorded by a beam of light which it reflects onto a film. The source of this beam of light is a special incandescent galvanometer lamp with a concentrated filament.

Special attention is directed to the fact that the galvanometer is immersed in oil. This is for the purpose of damping the movement so that overshooting is impossible. The speed of deflection is still extremely fast and comparable only with that obtained with certain instruments when used in the research laboratory. Furthermore, there is the fact that this deflection speed is consistent regardless of any and all operating conditions as the galvanometer is set permanently at the factory and sealed.

The new principles employed by means of which a pencil-like beam of light becomes the recording factor, offer very definite advantages. In the first place the small beam of light is very easily controlled, as it may be sharply focused and set permanently after focus, with the result that all films when developed show the path of this beam as sharp and distinct as though it were made with a pen. This is explained by the fact that the only portion of the film exposed is where this minute beam of light strikes it so that the balance of the film develops out to a perfect transparency.

Parts and Functions

In the schematic diagram shown in Figure 2 the following are the parts of the system with their respective reference numbers: 1. Amplification system; 2. Galvanometer; 3. Horseshoe magnet; 4. Galvanometer mirror; 5. Coils; 6. Metal ribbon; 7. Beam control; 8. Ground glass window with scale; 9. Special bulb; 10. Storage battery; 11. Dry "B" batteries; 12. Trickle charger; 13. Standardization switch and resistance; 14. Lead selector; 15. Leads from patient; 16. Resistance; 17. Spring motor with constant speed governor; 18. Camera; 19. Film footage scale; 20. Knob control to open and close camera shutter; 21. Special light-proof bulb case; 22. Window in galvanometer case; 23. Galvanometer oil level; 24. Main switch on panel; 25. Speed control governor adjustment; 26. Camera shutter; 27. Beam shutter; 28. Reflecting mirror; 29. Lens; 30. Motor control; 31. Lens; 32. Lens; 33. Light excluding shutter for loading camera; 34. Special vacuum tubes; 35. Storage battery charging switch.

One of the distinct advantages realized with the introduction of these new principles is that the factor of skin voltage does not have to be taken into consideration when using the instrument described in this article. If the skin voltage were considerably lower than the heart voltage it could possibly be

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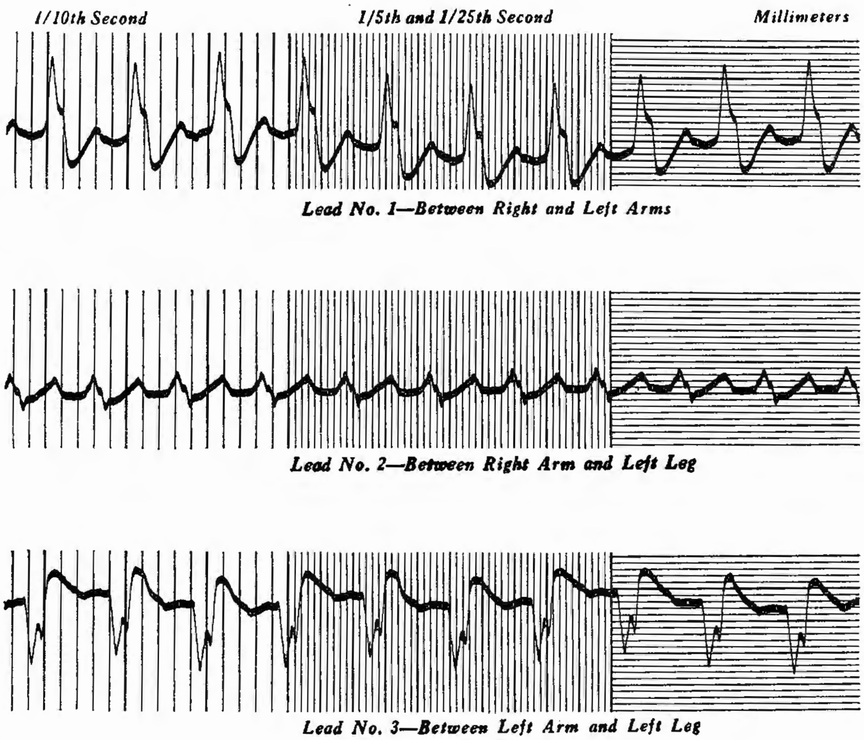

Fig. 3. Heart tracings as made by the amplifier are shown in the above illustration

Vacuum Tube Becomes Heart of New Elevator Control System

Based on Increase of Plate Current When Tube Changes From Oscillating to Non-Oscillating Condition

A NEW system of elevator control by means of which elevator cars are automatically brought to correct floor level, has recently been announced by the General Electric Company. This method is described as being unusually simple in operation and involving but few extra parts. It is predicated upon the use of a three element vacuum tube similar to those used in radio sets.

Used in R. R. Signals

The vacuum tube is known as a pliotron and has been used for a number of years on railroad locomotives for the purpose of transmitting block signals into the engineer's cab in visible form so that the engineer does not have to depend on watching the semaphor and light on the side of the track. While it is similar to the common vacuum tube it differs in the value of operating voltages which are used.

Controls By Relays

The use of the pliotron in the automatic leveling of elevator cars is based on the characteristic increase of plate current when the tube changes from an oscillating to a non-oscillating condition. A suitable number of these tubes are mounted on each elevator car and these tubes are normally in oscillation. By an arrangement of coils and vanes the motion of the car as it approaches a floor level is made to stop the oscillation of the tubes thus actuating relays. The relays govern control circuits which slow up the car and stop it at the correct position. The new method controls the car when running in either direction.

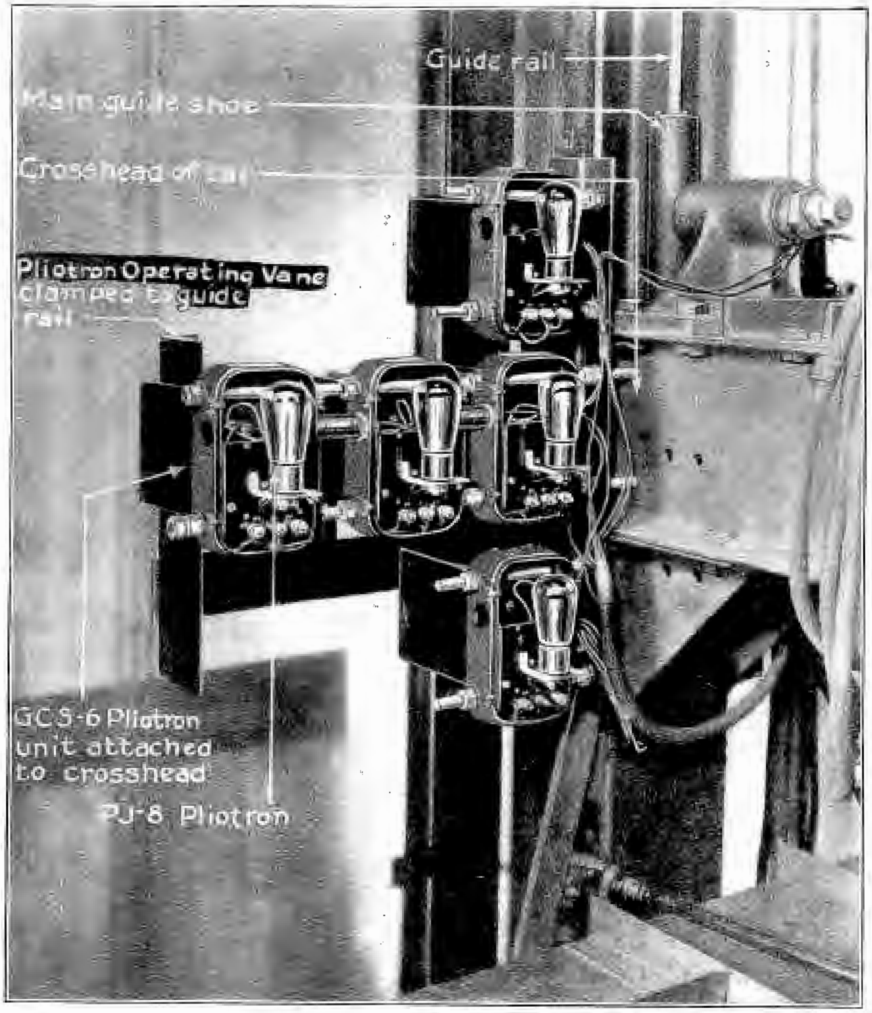

Fig. 1. This photograph illustrates a typical Pliotron installation on top of elevator car as described in the accompanying article

Stops at Floor Level

In operation the elevator operator throws his car switch to the off position as he approaches the floor at which it is desired to stop. On nearing the floor the relays are actuated by a combination of the coils and vanes, thus slowing the car up and bringing it to a stop at the floor level without any attention or work on the part of the operator. After discharging or receiving passengers the car is started in the usual manner and operation is continued as before.

Another application of the pliotron tube to elevator operation makes it unnecessary for the operator to watch his position in the hatchway. Devices similar to those used in automatic leveling are employed and in addition a signaling equipment consisting of suitable push-buttons, light and a bell is used.

Passengers Call Floors

When each passenger enters the car he calls out the number of the floor at which he wishes to get off, and the operator immediately presses a push-button corresponding to this floor. When all passengers are in the car the operator starts by the usual method. As he approaches the first floor at which a stop is to be made a signal light flashes and a bell rings notifying the operator that a stop is to be made. He then throws the car switch to the off position and the car continues at full speed to a pre-determined point in the hatchway where it is slowed up automatically and brought level with the next floor by the automatic leveling devices. Operation is continued in a similar manner until the trip is completed.

In addition to this arrangement push buttons are installed on each floor. A passenger waiting for a car presses a button which lights a signal and rings a bell in the first car approaching in

(*Continued on page* 97)

Curves Taken on H. F. L. Mastertone

IN Fig. 1 is the sensitivity curve of the Mastertone as measured in our laboratory. The average overall sensitivity of this receiver may be said to be very good, disregarding the irregularity as indicated at 800 kilocycles, about which more will be explained later in this article. The dotted portion of the curve between 925 and 1400 kilocycles is an estimated value as the equipment at hand will not measure with great accuracy below 1 microvolt per meter. As will be noticed the sensitivity on this dotted portion of the curve is between .35 and .5 microvolts per meter, this being exceptionally good sensitivity.

Selectivity

In Fig. 2 are the selectivity curves at the three standard frequencies, showing the uniformity of selectivity over the wave band with the exception of the 1400 kilocycle curve. The deviation of this curve from the other two frequencies may be accounted for, as will be mentioned later. The overall selectivity of the receiver is quite satisfactory.

Fidelity

In Fig. 3 may be seen the fidelity curves of the Mastertone which when studied are almost a counterpart of the selectivity curves. The 600 and 1000 kilocycle curves follow each other almost identically in accordance with the symmetrical rise of the same selectivity curves. The 1400 kilocycle curve has a sudden drop at 1200 cycles and begins to flatten out again at 2000 cycles, and again takes another drop at approximately 7000 cycles. This follows in accordance with the 1400 kilocycle selectivity curve, and the deviation of the same from the remainder of the curves. The loss of fidelity up to 7000 cycles is not great enough to cause an appreciable change in ear quality. The loss at the low frequency end while being slightly more than average will not be appreciable to the ear. From the study of these fidelity curves it is very

(*Continued on page* 106)

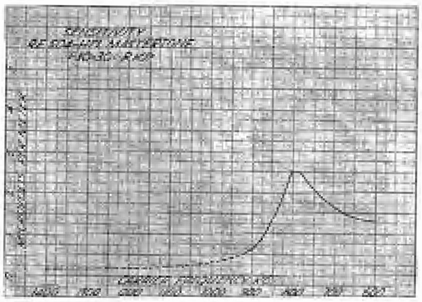

Fig. 1. This graph shows the sensitivity curves taken on the Mastertone receiver

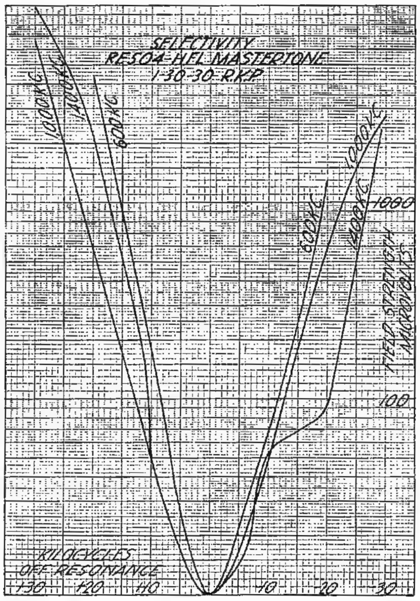

Fig. 2. The selectivity of the Mastertone as measured in our laboratory is shown in the curves plotted in this graph

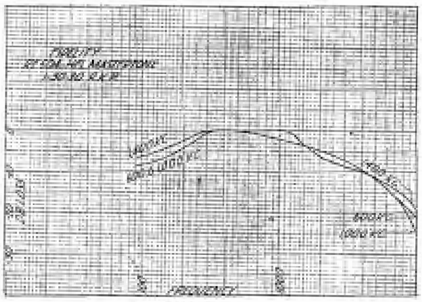

Fig. 3. The fidelity curves of the Mastertone receiver are given in the graph plotted above

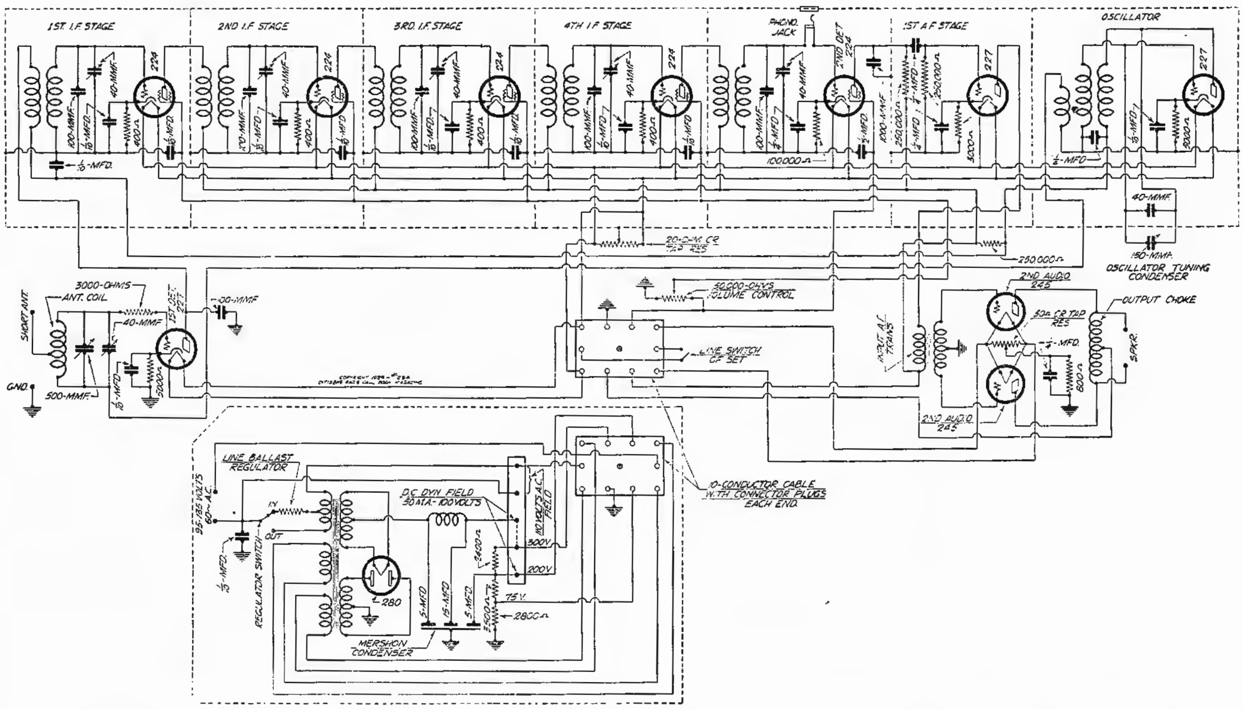

Fig. 4. The schematic diagram of the receiver is shown here. Constants are those of the receiver we tested. The manufacturer reserves the right to alter constants as dictated by production and efficiency needs

Details Now Available for Practical Radiovision Reception

Operating Notes Given for Those Wishing to Pioneer in the Next and Greatest Step in Radio

By D. E. REPLOGLE*

NO better proof of the advent of practical radio television, or radiovision, can be presented than actual operating notes on how to tune in radiovision programs. Hence the following paper which outlines in the simplest manner the necessary steps for obtaining satisfactory radiovision reception from existing television stations.

So much has been claimed and contradicted with regard to radio television that it is well to point out the two viewpoints from which conclusions may be drawn. The first viewpoint is that of the layman, who is quite unfamiliar with the difficulties involved and is interested solely in television for its entertainment value. From this viewpoint, radiovision is admittedly crude, yet nevertheless is gaining ground day by day in the matter of program possibilities. The second viewpoint is that of the radio experimenter, who is interested in the television technique rather than in the program. From this viewpoint, radio television is of surpassing interest at present, for it brings back all the thrills and joys of the early broadcast days. Once more, the experimenter is faced with the novelty, the possibilities and the opportunities of pioneering. Indeed, rather television is broadcasting history all over again, and by many is considered the brightest spot on the horizon of the radio industry. From the second viewpoint, therefore, must the present discussion be considered.

Photo B shows the Jenkins model 100 radiovisor with the special Jenkins television receiver being operated by H. G. Miller, who designed the receiver

Who Broadcasts?

Throughout the country there are experimental television stations in operation. There is hardly a section not covered in an experimental manner, at least. Most radiovision signals are of the 48-line category, although some broadcast 60-line pictures and others 24-line pictures. For the present, the 48-line pictures are the most widely used. Somewhat better detail is possible with 60 lines. The detail is too crude in 24-line pictures to favor that category.

Two stations are broadcasting radio-

(*Continued on page* 108)

*Jenkins Television Corporation.

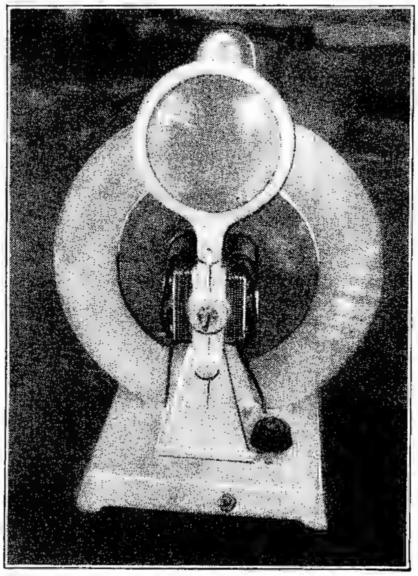

Photo F shows a view of the small radiovisor for experimenters, details of which appear in this article

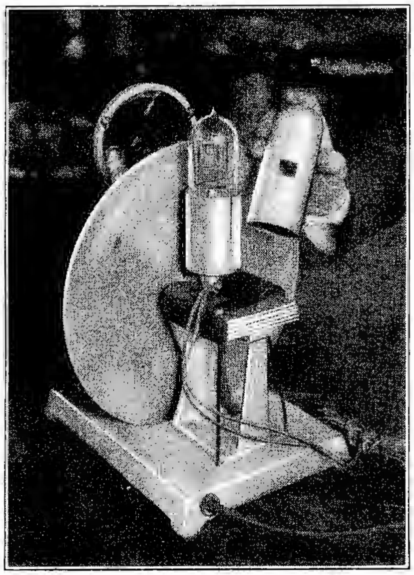

Photo G shows a rear view of radiovisor with lamp house cover removed to show television lamp

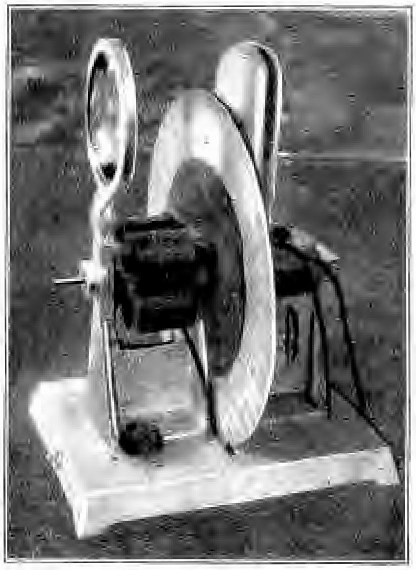

Photo H shows a side view of the Jenkins small radiovisor, showing the six electromagnets

Loftin-White Direct Coupled Amplifier Now Available in Kit Form

Electrad Designs One Specifically for Use as a Phonograph Amplifier; Can Use Tuner with It

ANTICIPATING the great amount of interest shown in the Loftin-White direct coupled amplifier for use as a phonograph amplifier, and also useful to a limited degree for amplification of radio signals when tuned with a simple inductance and capacity tuning means, Electrad has placed the first kit on the market for the benefit of experimenters and builders.

Early Model Seen

The kit very closely follows the original design shown the Editor of this publication by Electrad at the I. R. E. engineering convention held in Rochester, N. Y., last November. Only a few changes have been made in the job from the production standpoint. One of the visitors who heard the amplifier perform said, perhaps facetiously, "That's the most wallop I ever heard from fifteen cents worth of resistors."

Our own laboratory has done a good deal of work on the Loftin-White as indicated in a study described in the Radio Engineering section of the January issue of this magazine, and further developments which are detailed in the engineering section of this issue. And after having seen several experimental versions of the L-W amplifier it would appear that the facetious gentleman at Rochester was not so far wrong after all.

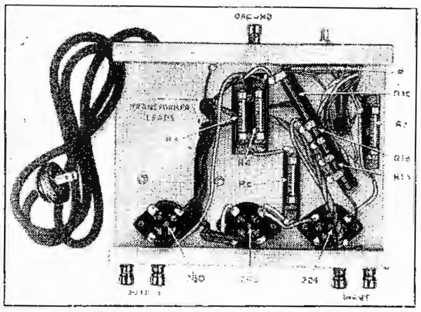

Fig. 2. The bottom of the sub-base may be seen in this picture with all of the wiring in place

Three Features

Simplicity, economy and efficiency are perhaps the three features of the amplifier system using direct coupling as popularized by Loftin and White. The photographs accompanying this article illustrate the simplicity and economy. The efficiency of the amplifier when properly operated is excellent.

Use Tuner Ahead

Due to an interesting characteristic of this circuit a simple receiver can be constructed by coupling the input terminals to an antenna and ground through the conventional tuning coil and variable condenser. Under these conditions the receiver will have a range approximating a good crystal set and will give excellent speaker reproduction. The degree of selectivity will depend upon the characteristics of the coil used.

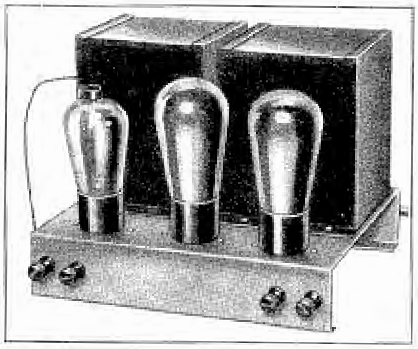

Fig. 1. The completely wired and assembled amplifier is shown in this photograph

Output Impedance Value

No output device is included in this kit because it is assumed a dynamic speaker will be employed in which event its regular input transformer will be hooked to the output binding posts of the amplifier. If other devices are used instead of the dynamic input transformer such devices should have an impedance of at least 2500 ohms.

For coupling to a receiver the input binding posts should be connected to the output of the detector tube through an audio frequency transformer. The secondary of the audio transformer should be shunted with a 500,000 ohm variable resistance such as the Electrad Royalty type L. This resistance can then be adjusted for suitable volume with minimum hum.

Short Leads

It should be remembered that the control grid lead should be as short as possible, and the resistance should be as close to the transformer as possible. Also the amplifier must be grounded through a bypass condenser of at least ½ mfd.

Parts Used

The parts used in the Electrad amplifier described are shown below:—

1—Power transformer
1—Choke and condenser bank mounted in can
1—Electrad type P 200 ohm potentiometer
1—Electrad type V-586, D-20 tapped divider resistor
1—Electrad R5 25000 ohm metallic leak
1—Electrad R3 50000 ohm metallic leak
1—Electrad R6 100,000 ohm metallic leak
1—Electrad Rc 500,000 ohm metallic leak
1—Ground binding post
2—Input binding posts
2—Output binding posts
1—224 socket
1—245 socket

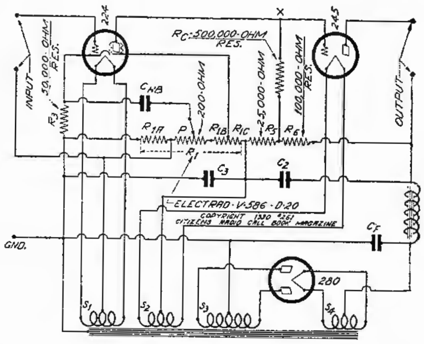

Fig. 3. The schematic diagram of the circuit may be traced from the drawing shown here

1—280 socket
2—Single resistor mounts
1—Double resistor mount
1—224 clip
18—6/32 screws
23—Lock washers
14—Metal washers
4—Fiber washers
2—Feet black Celatsite wire.

Response Curves on Hi-Q A. C. Set

IN the November, 1929, issue of this magazine was described the Hammarlund Hi-Q a. c. receiver, on which curves have since been taken by our laboratory. Since many readers have requested curves on the kit receivers the laboratory has taken up this work and several curves are shown in this issue.

After looking at these curves the reader should consult the curves of the d. c. receiver which is described in this issue. Since both receivers are made by the same concern and since both curves are given it may be of more than passing interest to contrast the family of curves of one set against those of the other. Some of the data shown in connection with the d. c. job described in this issue might be applied to the a. c. version which has been measured and is here described.

From the laboratory we secure the analysis of the three curves shown on this page.

Sensitivity

In Fig. 1 we have the sensitivity of the Hi-Q 30 a. c. The condensers during this measurement were all phased at 1000 kilocycles, and the volume control was only five-eighths of the way on. Therefore this curve is only relative. With the volume control completely on, the maximum sensitivity at 900 kc. would probably be considerably less than 1 microvolt per meter. The shape of this curve is not desirable and is due mainly to the effective inductance of the antenna coil changing with frequency tuned by virtue of the variation of antenna load with frequency. If the antenna condenser were trimmed at all frequencies the curve would flatten out and would very probably follow that of Curve A of the Hi-Q 30 d. c. as illustrated in Fig. 4 on page 53 of this same issue. When this condition is satisfied the receiver will have considerably greater sensitivity and therefore more satisfactory operation.

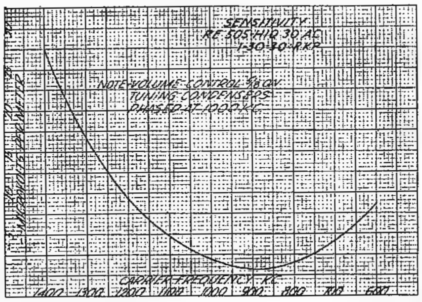

Fig. 1. This curve represents the sensitivity of the receiver under measurement

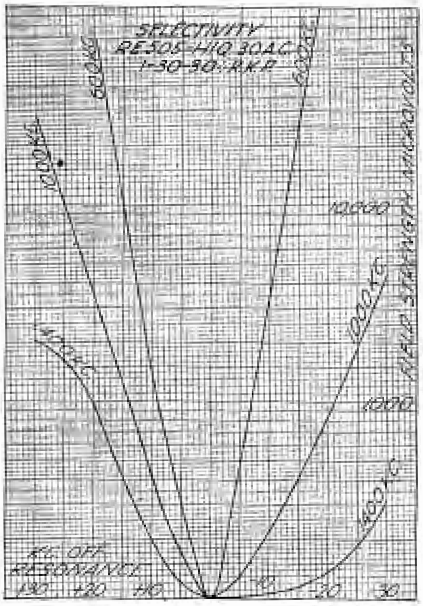

Fig. 2. The selectivity of the Hi-Q 30 a. c. is shown in this graph

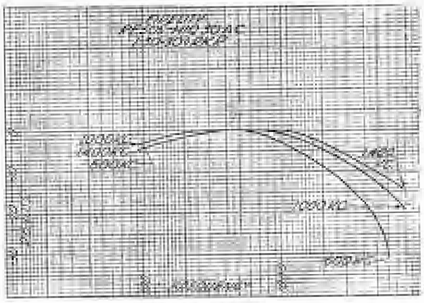

Fig. 3. Measured fidelity of the receiver is disclosed in these curves taken in our laboratory

Selectivity

Figure 2 is the selectivity graph. The selectivity of the a. c. job is not as great

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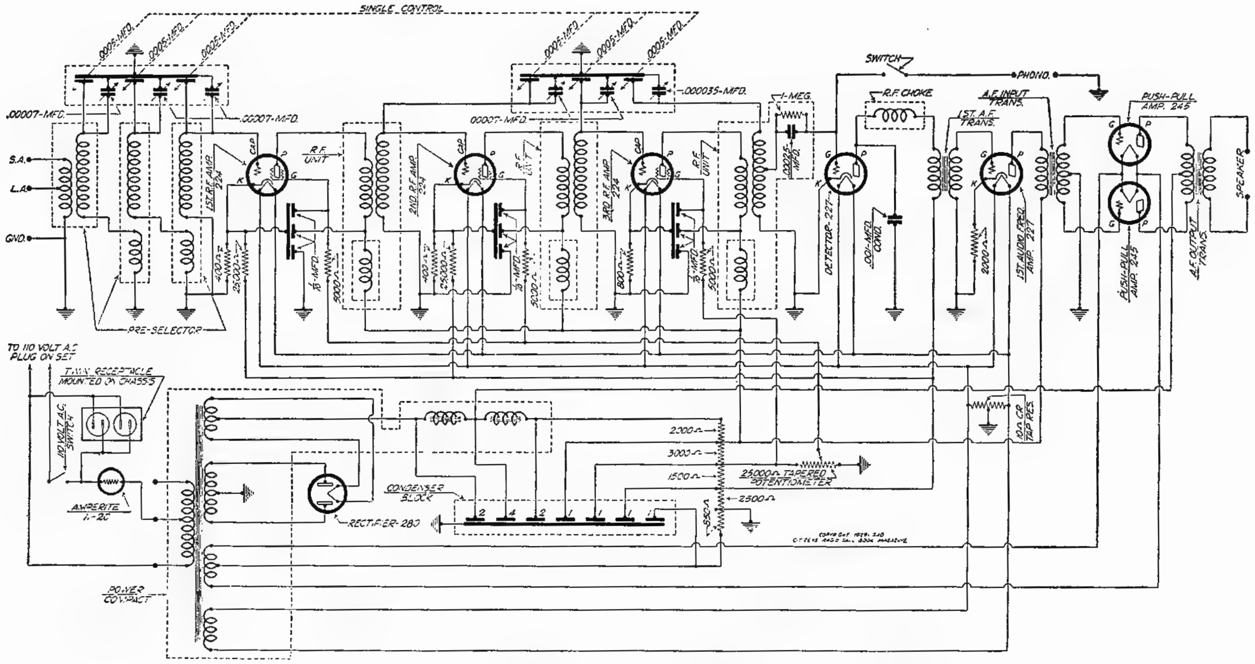

Fig. 4. The electrical constants of the receiver are shown in this drawing

Lincoln DeLuxe 10 Response Curves

IN keeping with our policy of measuring receiver kits and wired receivers we are describing on this page the sensitivity, selectivity and fidelity measurements recently made in our laboratory on the Lincoln DeLuxe 10 which was originally described in our January, 1930, issue, pages 52 and 53.

The three sets of curves taken from these measurements are shown in Figs. 1, 2 and 3; the power supply schematic is Fig. 4 and the receiver schematic is shown in Fig. 5.

Measurement of the receiver was made with a dummy antenna with no inductance, a capacity of 200 mmf and a resistance of 25 ohms. This particular type of dummy antenna is employed when measuring superheterodynes and other receivers utilizing an extremely short energy collector. General Radio standard signal generator 403-C, audio oscillator type 377 and output meter type 486 were the standards used in the measurements.

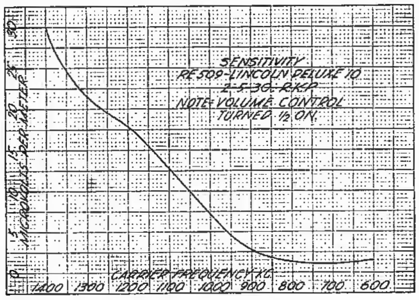

Fig. 1. The sensitivity of the Lincoln 10 receiver as measured in our laboratory is shown above

Sensitivity

An analysis of the sensitivity curve shown in Fig. 1 would indicate that the most sensitive portion of the band in the receiver's operation is around 850 kilocycles, where the sensitivity runs about an average of 1.25 microvolt per meter, then rising as the frequency increases until it reaches about 30 microvolts per meter at 1400 kilocycles. It should be noted that when these measurements were taken the volume control was only turned half on, so that the sensitivity measurement is relative only.

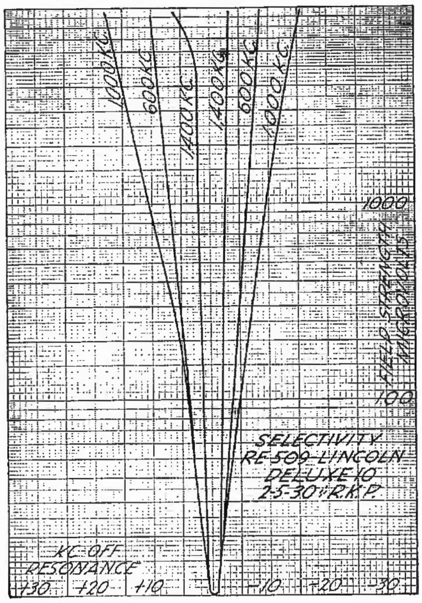

Fig. 2. These selectivity curves were obtained upon measurements made on the Lincoln 10

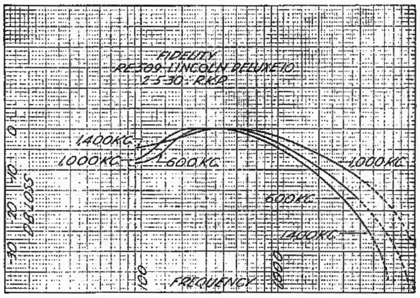

Fig. 3. The fidelity curves of the receiver are shown in the above illustration

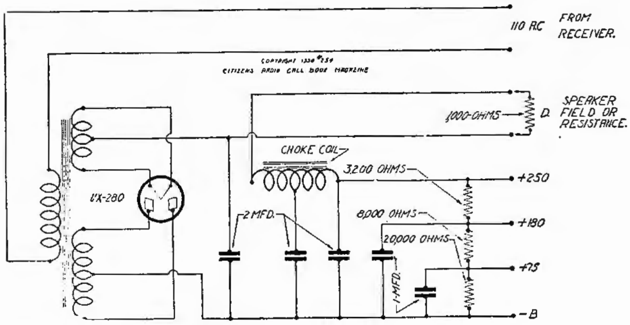

Fig. 4. The power supply used with the Lincoln DeLuxe 10 is here diagrammed schematically

Selectivity

It is quite probable that engineers would disagree as to the merits or demerits of the selectivity curves shown in Fig. 2. In one respect it may be said the selectivity is too great to have uniform quality. On the other hand, it might be argued that the distance hunters are not primarily interested in quality so much as selectivity and distance. It will be noted that the 1400 kilocycle curve in Fig. 2 resembles a hairpin. Its counterpart in fidelity may be seen by referring to the 1400 kc. curve in Fig. 3. It will also be noticed that the position of the three frequency curves is juxtaposed as contrasted to factory receivers in which the majority have the 1400 kc. curve on the outside, the 1000 kc. curve next inside and the 600 kc. curve in the center. This might in part be attributed to the fact that since the sensitivity at 1400 kc. in Fig. 1

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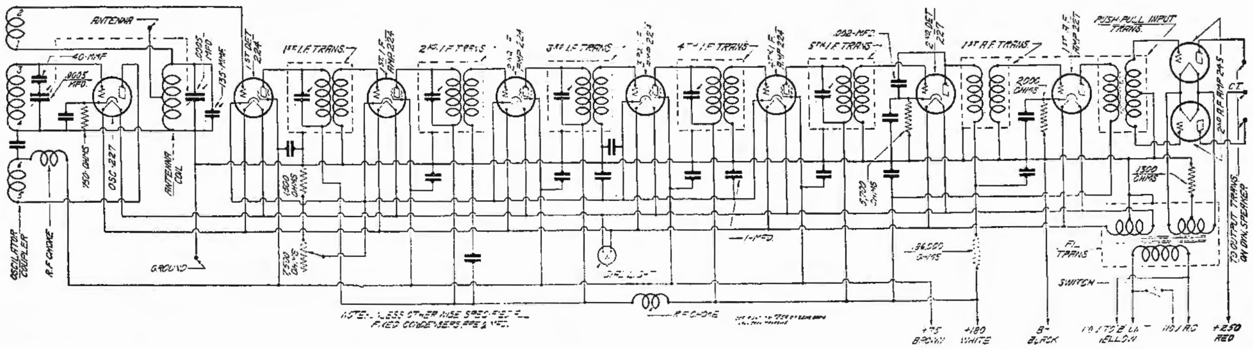


Fig. 5. This illustration is the schematic of the receiver itself as described in the January issue of this magazine

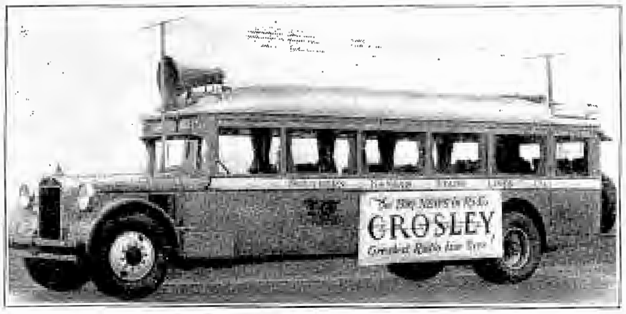
What's Your Idea?

(Readers of this department who have any suggestions for ideas to be described, or handy service shop links to be published, will confer a favor on the editorial department if they will make known their suggestions and ideas. If there is any special type of material that is desired by readers the department will be glad to know of it so that such data may be presented in forthcoming issues of this publication.—Editor.)

Radio Equipped Buses

A HUGE motor bus roaring along in the dead of night at a speed of forty miles an hour, with strains of dance music issuing from an enormous loud speaker mounted on the top of the machine, is becoming familiar in southern Kansas. W. E. Titus, president of the Radio Corporation of Kansas, has equipped several buses with Crosley radio sets for the entertainment of passengers.

In his latest experiment, Titus did not use a battery set, but installed a 41-S screen grid receiver of the same construction as that sold for use in electrically equipped homes. A small aerial was mounted on top of the bus and without a ground. The dynamotor used was a 32-volt d. c. motor driving a 110-volt 60-cycle a. c. dynamo. Six special resistors, or suppressors, connected to the spark plugs of the bus motor, successfully eliminated interference from the engine's ignition system. Passengers report that broadcast programs from stations as far distant as Memphis, Tenn., can be heard plainly even when the bus is traveling at top speed.



This Kansas bus is equipped with a regular a. c. set driven from a 32-volt d. c. motor driving a 110-volt a. c. generator

Don't Short Line Ballast

MOST of the more advanced radio sets of today, provided with a line ballast socket, do not come with the line ballast cartridge. It is left to the dealer or the ultimate owner to supply that cartridge for the proper operation of the radio set. Consequently, and unfortunately, the socket is often shorted, eliminating one of the most essential features for uniform and satisfactory operation.

If the line ballast socket has been included in the assembly, states Charles Golenpaul, of the Clarostat Manufacturing Company, Brooklyn, N. Y., it is because of the necessity of uniform voltages throughout the critical receiver, irrespective of fluctuating line voltages. Usually the power transformer of such a receiver is arranged for a low-voltage input, with the line ballast introducing more or less resistance in series for a uniform input voltage. To short out the line ballast is to apply excessive voltage on the power transformer and consequently on the radio tubes, filter condensers, chokes and other components, resulting in costly replacements. Even when there is a switching arrangement which compensates for the elimination of the line ballast, the set operator fails to secure the marked advantage of uniform operation.

The line ballast cartridge or clarostat is a relatively minor item in the original cost of the set. It costs no more than the average radio tube. Yet this device will save hundreds of hours of tube life, paying for itself many times over in a short space of time.

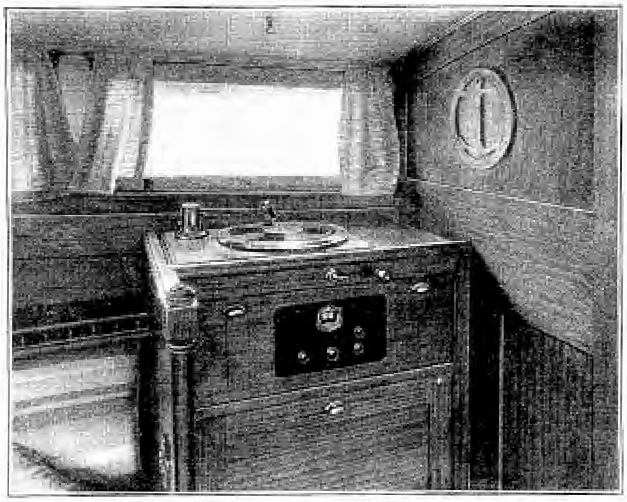
Radio Equipped Yachts

AMERICA'S radio audience probably will be increased by many thousands of listeners during 1930 as a result of successful installation of screen grid battery radio receivers on yachts and motor boats. With the perfection of the modern receiving set, broadcast programs may be enjoyed on the water as well as on shore. Yachting publications estimate there are a quarter of a million prospects for radio sets in the boating industry.

The radio-equipped motor boat comes on the heels of the radio-equipped automobile. At the annual Motor Boat Show held in New York, yachtsmen evinced keen interest in three types of craft equipped with a screen grid battery radio receiver perfected by the Crosley Radio Corporation, of Cincinnati, O. These boats were the Fairform Flyer, the Chris-Craft, and the Furness Coaster.

The Fairform Flyer, a standardized sea-going cruiser built by the Huckins Yacht Corporation of Jacksonville, Fla., was the first make of yacht to be equipped with radio and phonograph pick-up as a standardized equipment. The Huckins Corporation selected the Crosley screen grid battery receiver as part of the equipment of every Fairform Flyer.

The first of the 1930 Fairform models was launched recently and taken on a seventy-five mile trial trip, starting from Jacksonville, Fla. The radio performed surprisingly well, Frank P. Huckins reported in a letter to the Crosley cor-



Here is a typical radio installation in a cabin cruiser or yacht. The set used on this job is a Crosley d. c. screen grid. The installation is described in an article on this page

poration. Reception was as clear and natural as on shore, he said.

The screen grid battery chassis was installed in a built-in cabinet in the main cabin. About twenty feet of antenna was used. The top of the cabinet serves as a writing desk. The desk top raises to give access to the phonograph, making a unique installation for those who desire to reproduce their phonograph records through the radio system. The phonograph is mounted on a raised panel. The radio chassis is mounted in a drawer normally kept locked. This drawer is suspended in such a manner that even if spray should come in an open window, it cannot reach the drawer or radio set.

In perfecting receivers for marine use, radio engineers were aided by the development of screen grid tubes and circuits, which greatly reduce static interference and permit almost detailed selectivity of programs. With a screen grid set, a short antenna can be used.

Battery sets equipped with screen grid tubes and circuits also possess an advantage of economy, the battery drain being estimated by Crosley engineers at 25 per cent less than was the case with the old type of battery receiver. The engineers have been able to build the power, selectivity and sensitivity of larger screen grid sets into the compact battery model, which was designed to fit in small spaces.

The boat owner who desires to install a receiver on his craft may erect a simple aerial by stretching a wire between two insulators attached to the masts, or to other supports seven feet or more above the deck. The ground wire may be attached to any bright metal parts (unpainted brass, copper, or galvanized iron) below the water line. Otherwise the receiver is installed exactly as in a private home. The aerial and ground wires are connected, the battery cable attached to the proper terminals of the batteries, the Dynacone speaker plugged in and tubes inserted. Dry "B" and "C" batteries are required, but many yachts have six-volt storage batteries for lighting which may be used as the "A" battery. In such cases it is not necessary to provide a special storage battery for this purpose, as required in home installations.

Radio transmission is more effective over water than over land, the water range being estimated roughly as twice the land range. There are no power lines, leaky transformers, etc., to interfere with one's reception on a boat.

"Seagoing" radio sets afford protection as well as entertainment to owners of motor boats. When storm warnings are broadcast from shore, small craft can scurry for shelter in time to escape the fury of the elements.

Radio for small craft has been an intensely interesting subject to all boat owners for years. The perfection of radio equipment for cruisers, as demonstrated in Southern waters, comes at a time when boat owners and prospective boat owners in the North are planning to equip their craft with the latest innovations.

DIARY OF A SERVICE MAN

FEELING that some of our service men readers may profit by the example of an expert service man in his daily service calls, we are beginning in this issue "The diary of a service man" from which we hope that our readers will be able to get an idea as to possible causes of trouble on receivers and the remedies therefore.

For obvious reasons the addresses of the individuals upon whom the service man calls are not given. The data from which this diary is prepared is kept in a daily record form and the particular service man whose efforts we are watching makes a point of keeping a history

Duovac Tube Characteristics

Type Number	Filament Terminal Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
DX 199	3.3	.06	2-9	----	----	90	4.5	----	----	----	----	2.5	15,000	425	6.6	7	Det. & Amp.
DX 120	3.3	.132	----	----	----	135	22.5	----	----	----	----	7.0	6,600	500	3.3	110	Power
DX 201A	5.0	.25	2-9	----	----	90	4.5	----	----	----	----	2.5	11,000	725	8.0	15	Det. & Amp.
			----	----	----	135	9.0	----	----	----	----	3.0	10,000	800	8.0	55	Det. & Amp.
DX 226	1.5	1.05	----	----	----	180	13.5	----	----	----	----	7.5	7,000	1,170	8.2	70	Amplifier
DX 227	2.5	1.75	2-9	----	----	180	13.5	----	----	----	----	6.0	9,000	1,000	9.0	164	Det. & Amp.
DX 224	2.5	1.75	----	----	----	180	1.5	400	75	1.	----	4.0	400,000	1,050	420	----	Det. & Amp.
DX 112A	5.0	.25	----	----	----	180	13.5	----	----	----	----	9.5	4,700	1,700	8.0	275	Power
DX 171A	5.0	.25	----	----	----	180	43	2,025	----	----	----	20.0	2,000	1,500	3.0	700	Power
DX 245	2.5	1.5	----	----	----	250	50	1,560	----	----	----	32.0	1,900	1,850	3.5	1,600	Power
DX 210	7.5	1.25	----	----	----	425	39	2,170	----	----	----	18.0	5,000	1,600	8.0	2,500	Power
DX 250	7.5	1.25	----	----	----	450	84	1,530	----	----	----	55.0	1,800	2,100	3.8	4,650	Power

of every service call so that if in the future he has to return to a particular job he has an accurate description of the previous condition of the set and what changes were made by him.—Editor.

October 22

October 22, J. D. Morris. Receiver Splitdorf. The trouble was a burnt out 280 and the remainder of the tubes slightly low in emission. The cause was that applied filament voltage of 280 tube was 5.5. Line voltage 115, adjustment 105.

The remedy was a new 280 and an adjustment of the line voltage set at 115 volts. After adjustment the 280 filament voltage was 5 volts. In addition the set was completely tested. Charges $4.68.

November 11

Call was made under date of November 11, customer C. E. Walton. Receiver make was a Sparton. The trouble was poor quality, raspy, and r. f. oscillation.

The cause was a 171-A power tube which was low in emission and the r. f. stages out of neutralization. The remedy was the replacement of the power tube and the re-neutralization of the r. f. stages. While on the ground the set was completely tested. Charges $5.25.

November 11

Another call made on November 11th to the residence of Chas. A. Foss. The make of the receiver is not given here for obvious reasons. The trouble was poor quality and broad tuning. The cause was the dynamic speaker input transformer in the speaker and the output transformer in the chassis were not matched. The customer would not spend money to do the job right. Power tubes were low, the detector low, the r. f. out of phase and no bypass on the grid bias resistances.

The remedy was power tube replaced and detector replaced. The radio frequency was phased. A bypass was placed on the power grid bias resistor. Quality improved but the output must be changed in order to operate properly. Charges $11.00.

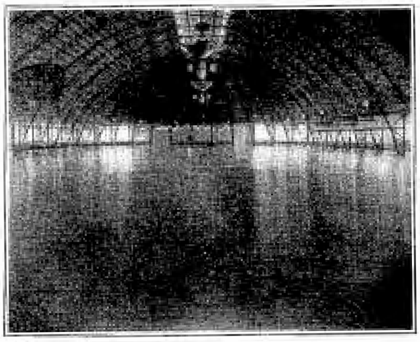


Fig. 1. Thousands of people trip the light fantastic at the great Saltair resort near Salt Lake City to the tune of dance music played by a public address system recently installed by the Amplion Corp. of America. This photograph shows the interior of the dance pavilion

November 13

On November 13 a call was made at the home of Anthony Batek who had a Kolster 6J model, serial 31623. The trouble was the fact that both tubes had been in service for 18 months. The remedy was the replacement of the 280 and the power tube. Complete inspection was also made. Charges $8.25.

November 15

On November 15 the service man visited Edward Leonard. His receiver was a Nelson N-30, serial 11653. The trouble was noisy set and broad tuning. The cause of the difficulty was a gassy tube and the selector out of phase. The remedy was the phasing of the selector and the replacement of the gassy tube by the customer. Charges $4.00.

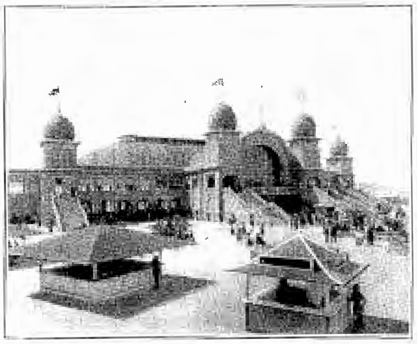


Fig. 2. In this picture may be seen the exterior of the huge dance pavilon around which as many as 12,000 people congregate when bathing girl revues are held to listen to the announcements of the judges in selecting the winners

November 17

R. L. Lucas was the next customer called on on November 17. The receiver was a Philco. Trouble was no distance and poor quality.

The cause was power tubes low, two r. f. tubes low and all tubes ten months old. The remedy was the power tubes and the two r. f. tubes replaced. The set was completely tested. Charges $11.50.

November 20

On November 20 the home of Michael Warnimont was visited. This customer had a Scott a. c. 10. The trouble was in oscillation, and inability to obtain correct balancing of intermediate transformers. The cause was the balancing condenser on the fifth intermediate stage shorted to the shield. The remedy was the insulation of the balancing condenser. After this the set performed properly. Charges $10.00.

November 21

On November 21 J. W. Conroy owning a Bremer-Tully custom built Counterphase model receiver reported trouble. It was found on inspection that the "B" batteries were dead and the second r. f. transformer was open. The remedy was the use of new "B" batteries. But the customer did not wish to spend money to replace the r. f. transformer. Total charges $12.50.

November 22

The home of George Brown was the next one visited. This visit was made on November 22. The customer has a Scott a. c. 10. It was found that the trouble was due to an antenna primary burned out. This was caused by the antenna plug used in the light socket, the condenser in the plug being shorted and grounding the light line through the primary. The remedy, of course, was a new antenna transformer. Total charges $9.00.

November 24

On November 24 the home of William Edwards was visited. This customer has a Radiola 18, serial 21765. Trouble was encountered from squeals. The cause was found to be r. f. oscillation. The remedy was the reduction of regeneration in the receiver by means of the regeneration control. Charges $3.00.

November 29

At one of the jobber stores a visit was made to service an Atwater-Kent model 32 receiver, on November 29. This receiver had been placed on the d. c. line and the switch contacts were burned out. The remedy was the replacement of the switch. Complete inspection was also made. Charges $3.75.

January 3

January 3 the customer was the Supreme Auto Service. Trouble in old Garod a. c. receiver was found to be that the 199 detector did not light. (This job used 3 112's operated from raw a. c. with a 210 output, the 199 detector obtaining its filament voltage from a portion of the C bias resistor of the 210 tube.) The cause was the 281 rectifier being low, filter condensers open, resulting in lowering the filter output voltage so low that the 210 would not draw sufficient plate current to light the 199.

The remedy was a new rectifier tube. A 4 mfd 1000 volt filter condenser was placed across the second filter choke. The r. f. stages were also neutralized. Total charges $8.50.

January 4

On January 4 a call was made on Harold Daniels. The receiver was a Sonora d. c. model. The trouble was the fact that no filament voltage was shown. The cause was the fact that the fluid in the Abox A eliminator was low, also three of the tubes were low.

The remedy was the filling of the Abox with water and the replacement of two tubes. The Abox and the B eliminator were adjusted for correct load voltages. A complete inspection was also made. Total charges $7.75.

Dialing Interference

INTERFERENCE caused by automatic telephone exchanges, and its elimination, is related by W. P. Banning, assistant vice-president of the American Telephone and Telegraph Co. in response to a recent letter from the editor of this publication. Radio dealers of North Haverhill, N. H., had complained of radio interference. According to Mr. Banning investigation showed telephone service at North Haverhill is given by a local company which has connection with the New England Telephone and Telegraph Company. Service in the town of North Haverhill is given by a dial system installed by the Automatic Electric Company.

The interference with radio arose from the operation of the dialing equipment both at the station and at the central office. Mr. Banning states it was cleared by the use of small condensers of a small fraction of a microfarad with resistance in series, supplemented by small radio choke coils. These, he is advised, have been installed at the telephone stations and on the central office equipment. Grounding the selector frame in the office was also found to reduce disturbances from the central office equipment.

It has been found in the past the telephone companies are willing to prevent interference where it is shown their apparatus is at fault.

Salaries Increasing

THAT the radio service man is contributing in no small measure to the security of the radio industry is evident from real action as well as words of praise. According to a recent survey, the average salary of the capable service man is from $40.00 to $60.00 in most sections of the country, particularly in the smaller towns, as contrasted with $18.00 to $25.00 formerly paid to service men.

"The importance of good service men is being generally appreciated today," states Rudolph L. Duncan, President of RCA Institutes, New York City. "While all-electric radio sets appear to be simpler than ever, this is only an optical illusion, due to external simplicity. Actually, present-day radio sets are quite complicated. There is little or no chance to tinker. The service man must know his job. The radio industry is exerting every effort to have faulty radio sets serviced out in the field, rather than have them returned to the jobber and even the factory for servicing. In this manner the industry is saving millions of dollars per year, a fair portion of which is being paid the service man for the savings he effects."

Correction

Owing to a typographical error in the article on the Lincoln DeLuxe 10 on page 52 of our January, 1930, issue, it was stated the wavelength range of that receiver was from below 220 meters to 550 meters.

Actually what was intended was "from below 200 meters," since the model tested covered from 180 meters to 550 meters.—Editor.

Salt Lake P. A. Job

TWENTY-five miles west of Salt Lake City is located the Great Salt Lake, after which the city was named. This great lake has become known through the world as a great pleasure resort, due to the waters of this lake being so salty and containing in soluble form many chemicals, all of which are said to be desirable in a medicinal form for bathing. As a result, thousands of people patronize the Great Saltair resort daily.

This resort is built one mile out from the shore of the lake. It is supported by 1700 piles and on them is placed the huge famous dance hall known to be the largest in the world built over water. Also, a huge bathing pavilion is constructed, besides a bull fighting arena, a large roller skating rink, a huge ship cafe, roller coasters and all the other many concessions that are usually found at such resorts.

Music for Dancers

On June 5, 1929, the Amplion Corporation of America installed a huge public address system, wherein phonograph music was played for the benefit of matinee dancers in the huge dance hall. This dance hall is shown in photograph Fig. 1. At a distant end of the hall, one ten-foot Amplion exponential horn was located, and in conjunction with the Amplion giant dynamic horn unit, a three stage power amplifier and the Amplion turntable metal cabinet—phonograph music was reproduced at a volume sufficient to duplicate a standard orchestra for the accommodation of the people dancing on said floor.

That following evening, a bathing girl revue was held outside in front of the huge dance pavilion, which is shown in photograph Fig. 2. The girls paraded up the stairs on one side, across the balcony, and down the stairs on the other side. Three Amplion six-foot trumpet horns working in conjunction with an Amplion giant dynamic horn unit on each trumpet, and driven by the power amplifier, and Amplion microphone and its microphone input amplifier, were located on said balcony beside the orchestra. With this apparatus it was possible for the judges of said bathing parade to announce to the twelve thousand people congregated outside of the pavilion watching said parade, the names of the winners in the parade. The orchestra music was also picked up and amplified so that the twelve thousand people could hear the music as clearly as if they were in an auditorium.

The reaction of the people was very favorable upon the performance of this apparatus, due to the fact that even the people in bathing one-quarter of a mile away from these speakers heard all that was going on. This, of course, was due to the fact that a high standard of quality was realized through this apparatus producing a fine definition of sound.

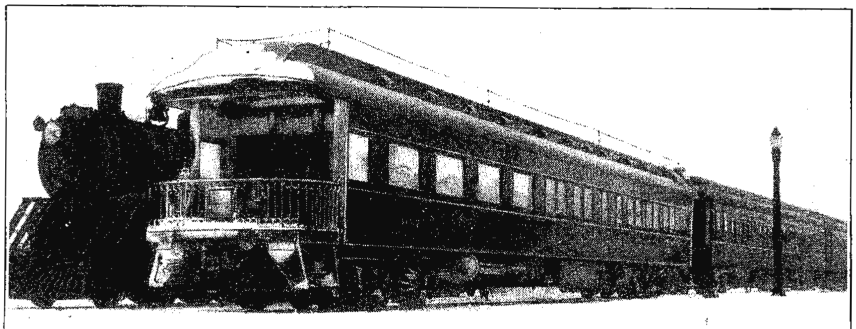


Fig. 3. Aerial construction on radio equipped cars of the Canadian National Railways. Ground is to car trucks

DeForest 422-A Audion

WITH the requirements of a successful portable radio set as well as a rural radio set in mind, the DeForest engineering staff has developed a new dry-battery type of d. c. screen-grid tube. The DeForest Radio Company of Passaic, N. J., has just introduced this tube, which is known as the DeForest 422-A Audion.

Perryman Tube Characteristics

Type Number	Filament Terminal Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
RH-199	3.3	.063	2-5	45		67.5	3.0					1.7	17,000	380	6.6	....	Det. & Amp.
						90	4.5					2.5	14,000	425	6.6	7	Det. & Amp.
PD-200A	5.0	.25	2	45	1.5										20	....	Detector
RH-201A	5.0	.25	2-5	45		90	4.5					2.5	10,500	725	8.5	15	Det. & Amp.
						135	9.0					3.0	9,500	800	8.0	55	Det. & Amp.
PA-240	5.0	.25	2-5	135	.3	135	1.5					.2	150,000	200	30	....	Det. & Amp.
				180	.4	180	3.0					.2	150,000	200	30	....	Det. & Amp.
PA-226	1.5	1.05				90	6	1,620				3.7	9.400	875	8.2	20	Amplifier
						135	9	1,500				6.0	7,400	1,100	8.2	70	Amplifier
						180	13.5	1,800				7.5	7,000	1,170	8.2	160	Amplifier
PA-227	2.5	1.75	2-5	45	2.0	90	6	2,000				3.0	10,000	900	9.0	....	Det. & Amp.
						135	9	1.800				5.0	9,000	1,000	9.0	....	Det. & Amp.
						180	13.5	2,250				6.0	9,000	1,000	9.0	....	Det. & Amp.
PAC-224	2.5	1.75				180	1.5	400	25			4.0	400.000	1,050	420	....	Det. & Amp.
PA-120	3.3	.132				90	16.5					3.2	7,700	428	3.2	....	Det. & Amp.
						135	22.5					7.0	6.600	500	3.3	110	Power
PA-171A	5.0	.25				90	19	1,900				10	2,500	1.200	3.0	130	Power
						135	29.5	1,840				16	2.200	1,360	3.0	330	Power
						157	35.5	1,970				18	2.150	1.400	3.0	500	Power
						180	40.5	2,025				20	2.000	1,500	3.0	710	Power
PA-245	2.5	1.5				180	33	1,270				26	1.950	1.800	3.5	....	Power
						250	50	1,565				32	1.900	1,850	3.5	1,600	Power
PA-210	7.5	1.25				180	12	1,715				7	7.000	1,100	8.0	145	Power
						250	22	2,200				10	6,000	1,330	8.0	340	Power
						350	31	1,940				16	5,150	1,550	8.0	925	Power
						425	35	1.750				20	5,000	1,500	8.0	1.540	Power
PA-250	7.5	1.25				300	54	1.540				35	2,000	1,900	3.8	1.500	Power
						350	63	1,400				45	1,900	2.000	3.8	2,350	Power
						400	70	1,270				55	1.800	2,100	3.8	3.250	Power
						450	84	1.525				55	1,800	2,100	3.8	4,650	Power
PAC-401	3.0	1.2		45		90	3					4	15,725	1,250	12.5	....	Det. & Amp.

Instead of the thoriated tungsten filament employed in the usual —22 d. c. screen-grid tube, the 422-A employs an oxide-coated filament of approximately three times the usual cross-sectional area. While the usual filament emission for the —22 type is rated at 15 milliamperes as the passing mark, the 422-A has an emission averaging 50 milliamperes, with a passing mark of 25. The filament draws only 60 milliamperes at 3.3 volts, as compared with 132 milliamperes for the usual —22 type. The heavy filament, with its oxide coating, makes for a practically non-microphonic tube, and one with positive and ample emission during a long period of service. The other characteristics of the 422-A are plate voltage, 135; screen-grid voltage, 45; control grid, —3; mutual conductance, 465 microhomos.

RESISTOR CHANGE

THOSE who have built, or contemplate building the Citizens unit audio amplifier illustrated on pages 105 and 106 of the January, 1930, issue of this magazine should observe the value of resistance for the power tube bias as indicated in the schematic, Fig. 4, page 106, and the graphic diagram should read 850 ohms instead of 8,500 ohms. This same change should also be made in the list of parts in the power supply data in the third column on that page. For example, the Electrad resistor should be a type 8.5, 850-ohm fixed resistor instead of an 8,500-ohm one as indicated. Obviously with that large a resistance value in the bias circuit on the power tube the grid voltage would be entirely too high and the circuit would not function at its best.—Editor.

Tailor-Made Sound Reproducing Systems for Theatres

By LUDWIG ARNSON
(Vice-President, Radio Receptor Co.)

BACK in the early days of radio reception, when adventurous radio fans were forsaking the crystal for the vacuum-tube detector, selection was a comparatively simple matter. The proud purchaser would simply say, "Give me a vacuum tube," and after six or seven dollars had changed hands, would walk out with that Aladdin's Lamp representing the acme of radio perfection. And the writer fears this condition or frame of mind exists even today in the matter of talking movie theater equipment.

The average moving picture theater owner seems to believe that it is simply a matter of "Send me up a sound outfit," and his troubles are over. Far from it—they are just beginning.

Need Adjustments

It is an actual fact that of all the theaters, auditoriums and other public places in existence, only about 20 per cent are really ready for the immediate installation of a sound-reproducing system without adjustments of any sort. The remaining 80 per cent hold in store just about every acoustic problem imaginable. And each one of these problems requires special treatment of its own. In other words, just as much care is necessary to "tailor" the installation to fit the theater, as is required to tailor the goods to fit the "stylish stout."

We were recently called upon to assist a figurative "stylish stout" in upper New York state, whose requirements were delicate in the extreme. This particular theater was afflicted with dead spots or areas, not necessarily far from the sound source, where practically nothing could be heard. Farther back in the theater, reception was excellent, as it was to the front and sides. The trouble was diagnosed in this case as conflicting sound waves. A train of sound waves coming directly from the stage, encountered another train of waves deflected straight down from the ceiling. Where the two met, they counteracted or neutralized each other to such an extent that practically nothing could be distinguished. The remedy in this case was found in the medium of distribution, that is to say, in the use of directional speakers. The usual cone speakers were discarded and a number of specially designed horns were substituted. These horns, equipped with the best obtainable reproducer units, were placed at different angles and their relative positions varied until the ideal degree of reproduction was achieved. In this way we actually made the sound waves behave, directing them the way we wanted, to overcome the natural defects of the theater. The results of this tailoring are readily apparent today in the quality of reproduction enjoyed in this theater—a quality that would lead one to believe that the theaters had been built just for this purpose.

Too Much Volume

Another effect encountered in some theaters is not so much a problem as an advantage, although it may cost the owner just as much in the long run. We know, and the informed manager knows, approximately what quantity of apparatus is necessary for a given space to be covered. It sometimes happens that the manager, without consulting the installation specialist, orders what would seem to be the necessary equipment, and finds to his disgust that his reproduction is too powerful. The reason is that some theaters are so acoustically perfect that only 50 per cent of the energy is necessary to fill them as would be required for a theater of the same size that was not acoustically sound. The aforementioned manager finds that the size of his installation far exceeds the demands of the theater, and he is consequently obliged to operate at greatly reduced power. This means that he has spent twice as much as was necessary on the original installation, and is probably wasting 50 per cent of his power bill in unnecessary upkeep. A little tailoring here would have saved a good deal of cloth.

Fig. 5. The latest in radio broadcast receiving equipment on railway trains as installed in a compartment-observation-library car of the Canadian National Railways. The receiver is a standard all-electric ten tube set with phonograph combination and dynamic speaker. Alternating current for the operation of the receiver is supplied by a motor generator set which takes direct current from the car lighting system at 32 volts and converts it into alternating current at 110 volts 60 cycles

It should not be deducted from this that theater owners are "boneheads" Far from it. If there are certain little details that you do not thoroughly approve of in your neighborhood movie house, do not jump to the conclusion that the manager or owner has been guilty of criminal negligence in not calling in a doctor soon enough. There still remain, unfortunately, certain elemental factors that cannot be overcome with ease. There is, for instance, what may appear to be a lack of synchronism between screen subject and sound; that is to say, the ear may subconsciously detect a fraction of a second difference between the movement of the actor's lips and the reception of his voice. This is not a technical defect but a perfectly natural law that governs the difference between the speed of light and the speed of sound. Now light is practically instantaneous, so that the man sitting in the farther-most row of one of our great theaters, actually sees the image on the screen at the exact instant that it appears on this screen, while the sound, coming the entire length of the theater, strikes his ear a fraction of a second later. The natural reaction to this is to wonder why loud-speakers could not be placed in all the different parts of the theater. However, a careful analysis of this sug-

Van Horne Tube Characteristics

Type Number	Filament Terminal Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
199	3	.06	——	——	——	90	—4½	1,800	——	——	——	2.5	16,500	380	6.25	7	Det. & Amp.
201-A	5	.25	——	——	——	135	—9	3,600	——	——	——	2.5	11,000	725	8.0	55	Det. & Amp.
200-A	5	.25	——	45	——	——	——	——	——	——	——	1.5	——	——	——	——	Detector
120	3	.125	——	——	——	135	—22½	3,461	——	——	——	6.5	6,600	500	3.3	110	Power
112-A	5	.25	——	——	——	157½	—10½	1,312	——	——	——	8.0	4,800	1,670	8.0	195	Power
171-A	5	.25	——	——	——	180	—40½	2,025	——	——	——	20.0	2,000	1,500	3.0	700	Power
210	7.5	1.25	——	——	——	425	—35	1,545	——	——	——	22.0	5,000	1,550	7.7	1,540	Power
245	2.5	1.50	——	——	——	250	—51½	1,609	——	——	——	32.0	1,900	1,850	3.5	1,600	Power
250	7.5	1.25	——	——	——	400	—70½	1,282	——	——	——	55.0	1,650	2,300	3.8	3,250	Power
226	1.5	1.05	——	——	——	180	—13½	1,800	——	——	——	7.5	7,000	1,170	8.2	160	Amplifier
227	2.5	1.75	——	——	——	180	—13½	2,250	——	——	——	6.0	9,400	870	8.2	140	Det. & Amp.
222	3.3	.132	——	——	——	135	—1.3	——	45	——	——	——	——	——	——	——	Det. & Amp.
224	2.25	1.75	——	——	——	135	—1.5	——	45	——	——	——	——	——	——	——	Det. & Amp.

CeCo Tube Characteristics

Type Number	Filament Terminal Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
B-BX-C	3.0	.06	....	45	....	90	4.5	1,610	....	....	....	2.8	16,000	400	6.4	....	Det. & Amp.
H	5.0	.25	....	80	3.0	....	....	....	....	....	....	....	14,000	1,030	14.4	....	Hard Detector
O1-A	5.0	.25	....	45	....	90	4.5	1,450	....	....	....	3.1	9,500	900	8.5	....	Det. & Amp.
G	5.0	.25	....	90	....	60	....	....	....	....	....	0.8	25,000	800	20.0	....	Res. Amplifiers
K	5.0	.25	....	....	....	80	0	.	....	....	....	4.8	11,000	1,130	12.5	....	R. F.
RF22	3.3	.132	....	....	....	135	1.5	....	45	....	....	1.5	800,000	350	290	....	Det. & Amp.
M26	1.5	1.05	....	....	....	90	6.0	1,620	....	....	....	3.7	9,400	875	8.2	....	Amplifier
N27	2.5	1.75	....	45	....	90	6.0	2,000	....	....	....	3.0	11,300	725	8.2	....	Det. & Amp.
AC24	2.5	1.75	....	....	.	180	1.5	....	75	....	....	4.0	400,000	1,050	420	....	Det. & Amp.
E	3.0	.12	....	....	....	90	16.5	410	....	....	....	4.0	7,500	440	3.3	....	Power
F	5.0	.50	....	....	....	90	4.5	940	....	....	....	4.8	5,000	1,600	8.0	....	Power
F12A	5.0	.25	....	....	....	90	4.5	940	....	....	....	4.8	5,000	1,600	8.0	....	Power
J71	5.0	.50	....	....	....	90	16.5	1,830	....	....	....	9.0	2,500	1,200	3.0	....	Power
J71-A	5.0	.375	....	....	....	90	16.5	1,830	....	....	....	9.0	2,500	1,200	3.0	....	Power
L45	2.5	1.5	....	....	....	250	—50	1.560	....	....	....	32.0	1,900	1,845	3.5	....	Power
L10	7.5	1.25	....	....	.	180	12	1.715	....	....	....	7.0	7,000	1,100	7.8	....	Power
L50	7.5	1.25	....	....	....	250	45	1,610	....	....	....	28.0	2.100	1,800	3.8	....	Power

gestion will make the drawbacks self-explanatory. A cure of this kind would be worse than the original ill, due just to this very time lag. The spectator in the far row would hear the sound at exactly the same time that he would see the image, it is true, but, a fraction of a second later he would hear this same sound coming up from one of the speakers located in the front of the house. The result would be a fuzzy or blurred sound to every one in the house, as the spectator down front would also hear the response from the speaker located at the back of the house, as well as the speaker nearby.

So it should be taken into consideration that some of these minor details are really beyond the control of the owner who, after all, is far more anxious to please you than you are to be pleased. If, however, your ears are strained, or assaulted, the chances are that the owner was over-confident, or perhaps he did not want to admit that he was a "stylish stout."

Servicing Power Packs

DUE to the relatively few component parts the detection of defective apparatus in a power pack is not a hard problem. The possible causes of trouble may be roughly classified as defective power transformer, rectifier tube, chokes, resistors and condensers. The simplest form of volt meter—battery test will serve to disclose whether there is a burn-out or short circuit in any of the previously mentioned components. The replacement of any of these pieces of apparatus is likewise a simple matter, with the exception of the filter condenser. Here the greatest delicacy of touch is required.

A broken down filter condenser is easily discovered. Generally this condition is indicated by the plates of the rectifier becoming excessively hot. The condenser should be disconnected from

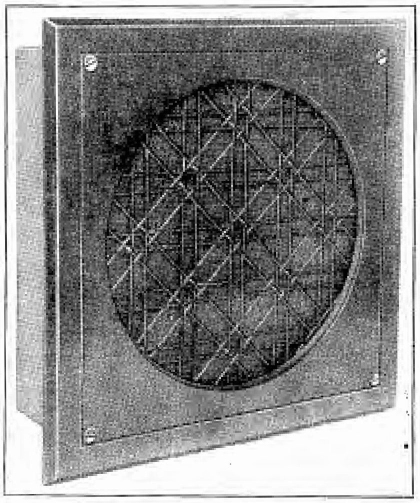


Fig. 6. A recently announced flush wall type speaker made by Best is illustrated in this photograph. It is designed for use with centralized installations in hotels, clubs, schools and other institutions. The outside dimensions of the grille panel are 10½ by 10½ and the depth is 3 inches. The speaker is equipped with a magnetic unit

the circuit and a battery voltage applied. The condenser terminals should be short circuited immediately after the charge is applied and a small spark should result. If the spark does not materialize the condenser is defective and requires replacement. Great care should be taken in testing power packs as high voltages are developed across the condensers and unless these charges are dissipated before testing a bad shock will be received.

Replacement Is Delicate

According to Harry W. Houck, chief engineer of the Dubillier Condenser Corporation, the testing and replacement of condenser blocks is the most delicate operation in the servicing of a power pack, and should not be undertaken unless the smallest of soldering irons and the steadiest of hands are possessed. Faulty soldering will destroy or at least weaken a paper condenser quicker than any other factor aside from excessive voltage or electrical train, declares Mr. Houck.

For the soldering of condenser sections, small soldering irons should be used and these must be kept clean and bright. Rosin should be used to clean the parts and just enough applied to do the job in a minimum of time, for if the soldering iron is applied too long at a time the heat causes the impregnating compound of the condenser to melt. The solder may even work its way down into the tightly wrapped paper and tinfoil, causing a short circuit or weak spot. Acid soldering flux or paste should never be used for while it is easier to apply than solder, the slightest trace of acid may result in chemical action, deterioration, weak spots, and even an open connection chewed away by the acid. No acid soldering flux is permitted in the Dubillier plant and none should be employed outside.

Despite the greatest care taken in manufacture and assembly of condenser sections, there is always the danger of improper soldering by the service man or individual making repairs. To avoid this trouble condensers should be so constructed that the terminals are quite removed from the actual condenser section so as to prevent the conduction of heat from the soldering iron to the delicate condenser itself. In this respect the latest condenser blocks with flexible leads or pig-tails represent not only greater convenience in wiring, but also eliminate to a large extent the danger of spoiling the condenser in soldering.

Plate Current Misleading

A HIGH plate current in a tube is often taken by the layman, as well as by many so called experts, as an indication of a good tube. This is generally misleading, according to George Lewis, tube engineer and vice-president of the Arcturus Radio Tube Company of Newark, New Jersey, which organization has devoted considerable research to the problems of radio tube servicing.

"Dealers and service men are often satisfied if a tube shows a high emission or plate current" declares Mr. Lewis. "But this does not necessarily mean that the tube is a good one. On the contrary, if the tube emission is above normal it generally means a gassy tube which is quite as bad as a tube characterized by a low plate current. A gassy tube almost invariably introduces distortion and is responsible for several radio ills. A tube before being placed in the customer's set should be carefully tested in a well designed set tester and the client should determine by simple observation and questioning that the tube he is buying falls neither above nor below the normal tolerances."

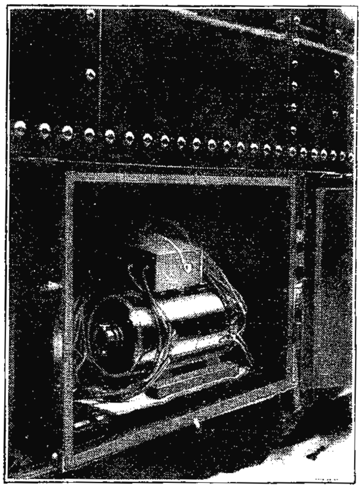


Fig. 4. Motor generator set for supplying alternating current for operation of combined radio receiver and phonograph on radio-equipped cars of the Canadian National Railways. Motor generator is located under the car floor and supplies alternating current at 110 volts, 60 cycles. The motor takes power from the car lighting system, which is 32 volts d. c.

Speakers in Hotels

THAT centralized radio or the practice of a common radio receiver supplying a number of scattered loud speakers in a building is rapidly gaining in favor is becoming increasingly apparent. A case in point is the announcement that the Piedmont Hotel in Atlanta, Georgia, an old landmark of the South, is being remodeled to include a centralized radio installation.

The Farrand Manufacturing Company of Long Island City, New York, announces that it has received an order for 450 speakers for installation in that hotel. The speakers will be built into the wall of each room to provide a variety of radio entertainment for the guests. The Alexander Sewald Company which is remodeling the hotel is making provision for a centralized radio installation to supply the inductor dynamic speakers which combine the tone and volume of the dynamic with the simplicity of the magnetic type.

Bond Tube Characteristics

Type Number	Filament Terminal Voltage	Filament Current (Amperes)	Detector Bias (Megohms)	Detector "B" Voltage	Detector Plate Current (M. A.)	Amplifier "B" Voltage	Amplifier "C" Voltage	Amplifier "C" Bias Resistor (Ohms)	Screen Grid "B" Voltage	Screen Grid Current (M. A.)	Plate Resistor (Ohms)	Amplifier Plate Current (M. A.)	A. C. Plate Resistance (Ohms)	Mutual Conductance (Micromhos)	Voltage Amplification Factor	Maximum Undistorted Output (Milliwatts)	Purpose
BX-199	3.0	.06	2-9	45	1	90	4.5	....	....	....	....	2.5	15,500	425	6.6	7	Det. & Amp.
BX-200A	5.0	.25	2-3	45	1.5	....	....	....	....	....	.	....	30,000	666	20	....	Detector
BX-201A	5.0	.25	2-9	45	1.5	90	4.5	....	....	....	....	2.5	11,000	725	8	15	Det. & Amp.
	....	....		....	....	135	9.0	....	....	....	....	3.0	10,000	800	8	55	Det. & Amp.
BX-222	3.3	.132	....	....	....	135	1.5	....	.	....	....	1.5	850,000	350	300	..	Amplifier
BX-226	1.5	1.05	....	....	....	90	6	....	....	....	....	3.5	9,400	875	8.2	20	Amplifier
	....	....	....	....	....	135	9	....	....	....	....	6.0	7,400	1.100	8.2	70	Amplifier
	....	....		....	....	180	13.5	....	....	....	....	7.5	7.000	1,170	8.2	160	Amplifier
BY-227	2.5	1.75	2-9	45	2	These Characteristics apply for				....	....	....	10.000	800	8	....	Det. & Amp.
	....	....	¼-1	90	7	detection only				....	....	....	8.000	1.000	8	....	Det. & Amp.
BY-224	2.5	1.75	....	....	....	180	1.5	....	....	....	....	....	400.000	1.000	420	....	Det. & Amp.
BX-120	3.0	.125	....	....	....	135	22.5	3,460	....	....	....	6.5	6.300	525	3.3	110	Power
BX-112A	5.0	.25	....	....	....	135	9	....	....	....	....	7.0	5.000	1.600	8	120	Power
	....	....	....	....	....	157.5	10.5	....	....	....	....	9.5	4.700	1.700	8	195	Power
BX-171A	5.0	.25	....	....	....	90	16.5	1,625	....	....	....	10	2.500	1.200	3	130	Power
	....	....	....	....	....	135	27	1,685	....	....	....	16	2.200	1.360	3	330	Power
	....	....	....	....	....	180	40.5	2,025	....	....	....	20	2.000	1.500	3	700	Power
BX-245	2.5	1.5	....	....	....	180	33	1.265	....	....	....	26	1.950	1.800	3.5	750	Power
	....	....	....	....	....	250	50	1,560	....	....	....	32	1,900	1.800	3.5	1,600	Power
BX-210	7.5	1.25	....	....	....	250	18	1,060	....	....	....	17	6.000	1.330	8	340	Power
	....	....	....	....	....	300	22.5	1,250	....	....	....	18	5.600	1.450	8	600	Power
	....	....	....	....	....	350	27	1.350	....	....	....	20	5.150	1.550	8	925	Power
	....	....	....	....	....	400	31.5	1.370	....	....	....	23	5.000	1.600	8	1.325	Power
	....	....	....	....	....	425	35	1.510	....	....	....	23	5.000	1.600	8	1.540	Power
BX-250	7.5	1.25	....	....	....	250	45	1,610	....	....	....	28	2,100	1,800	3.8	900	Power
	....	....	....	....	....	to	to	to	....	....	....	to	to	to	3.8	to	Power
	....	....	....	....	....	450	84	1,530	....	....	....	55	1.800	2,100	3.8	4.650	Power

Temple Receiver Nos. 8-60, 8-80, 8-90

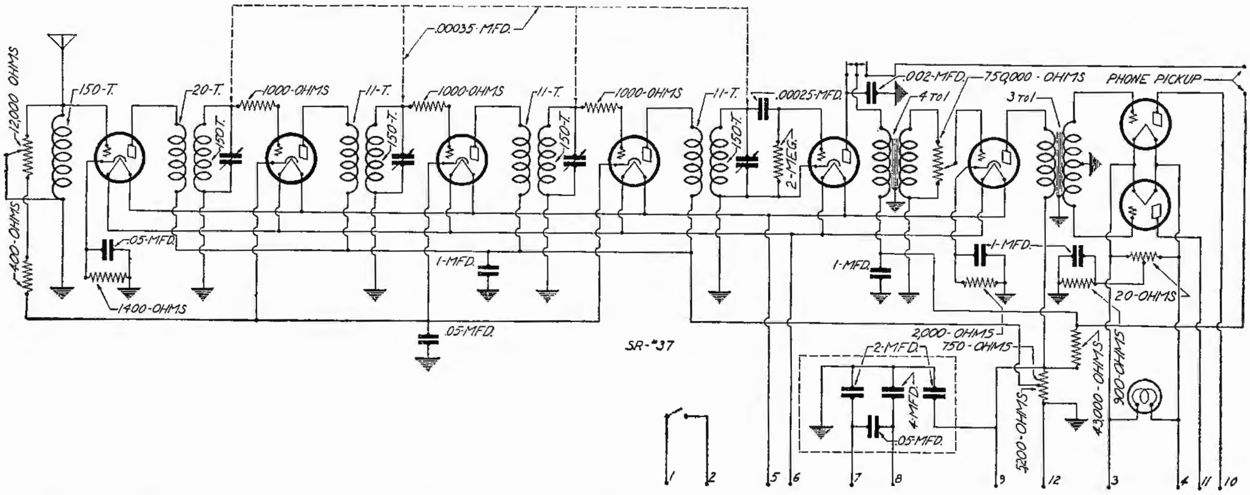


Fig. 1. The schematic of the Temple receiver models 8-60, 8-80 and 8-90 is shown in the above illustration

As will be seen from an examination of the schematic diagram accompanying this article the radio frequency circuit in the Temple receiver is a conventional r. f. circuit using grid suppressors. All of the radio frequency and the detector stages employ 227 heater tubes while the power stages are handled with the 245 in push pull. The rectifier is a 280.

Temple Model 8-60, 8-80, 8-90

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
227	1 R.F.	2.05	100	5	+5	----	3.8	5.5	1.7
227	2 R.F.	2.05	100	5	+5	----	4.0	6.0	2.0
227	3 R.F.	2.05	100	5	+5	----	4.2	6.0	1.8
227	Det.	2.05	35	----	----	----	2.4	2.5	.1
227	1 A.F.	2.1	115	7	+7	----	4.2	5.7	1.5
245	Pwr.	2.4	190	38	----	----	27.5	30.	2.5
245	Pwr.	2.4	190	38	----	----	27.5	30.	2.5
280	Rect.	4.8	----	----	----	----	40	----	----

Line voltage, 109. Volume control at maximum.

Fig. 2. A typical analysis of the tubes in this receiver as made with a Weston set tester is shown in the above table

Dynamic Field Choke

It will be noted that the field coil of the dynamic speaker is in series with the high voltage secondary acting as a second choke coil in the filter system. The first choke is contained in the power pack carrying on top of it fuse connections for the 110 volt primary. This 110 volt primary is tapped for a 110 and 125 line voltage, this change being made by reversing the position of the two ampere protective fuse.

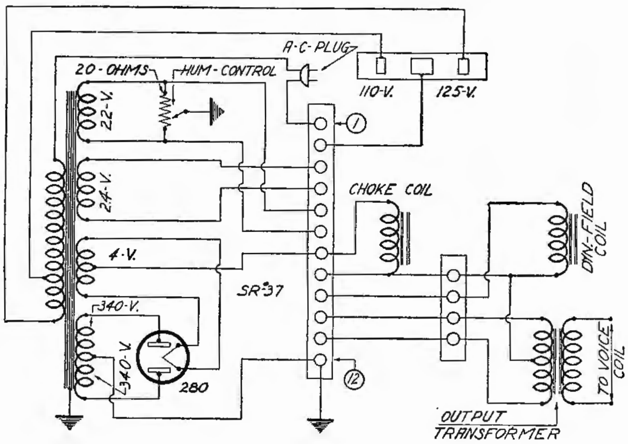
Service Hints

According to service hints given in the bulletin issued by the Temple Corporation no C voltage on the 227 tubes indicates either defective resistors in the cathode return or shorted resistor bypass condenser. No C voltage on the 245 indicates a defective resistor in the filament to ground circuit of the 245 or a shorted bypass condenser across the 900 ohm portion of the large resistor. Any great deviation in plate voltages from those found in the chart denotes either a poor rectifier tube or a defective power pack. Great deviation in milliammeter readings indicates unsatisfactory tubes.

Watch Antenna Plug

Be sure that the antenna and ground leads are connected properly. Burned out antenna chokes could be caused either by a shorted antenna plug or a tube placed in the first r. f. socket which has a direct plate to grid short. If by any chance one side of the a. c. line of the power pack was grounded and you reversed the antenna ground leads to the set this would result in a burned out antenna choke.

Fig. 3. The schematic diagram of the power supply used in connection with the models illustrated on this page is given here



Colin B. Kennedy S. G. Model 20 Set

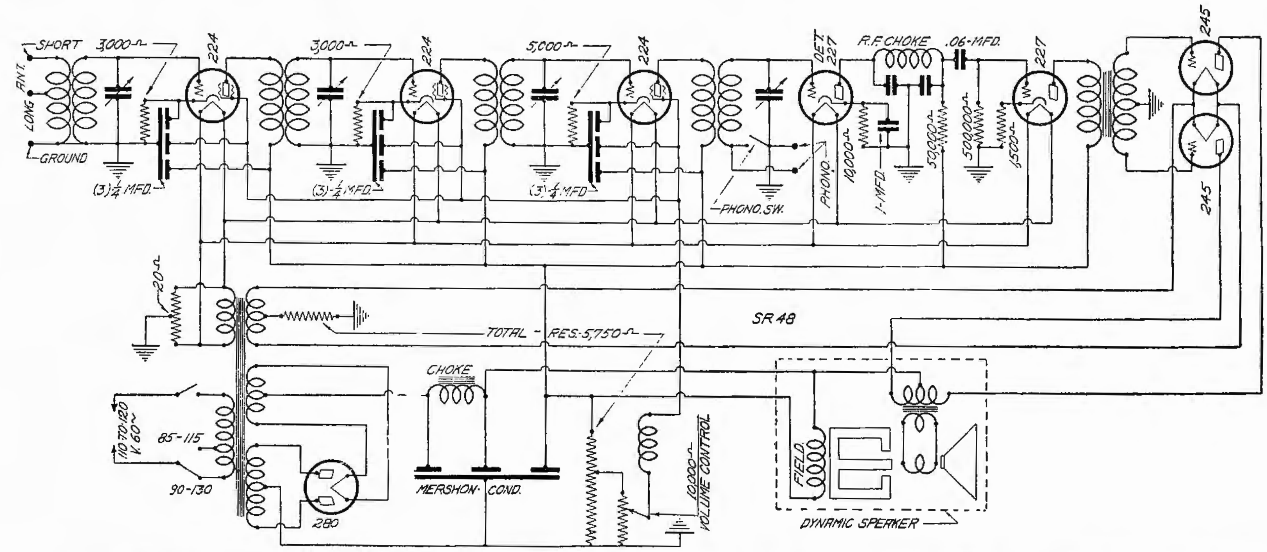


Fig. 1. The schematic of the receiver and its power supply as used in the Kennedy model 20 receiver is illustrated above

KENNEDY'S screen grid model 20, illustrated on this page in schematic form, is constructed on a base similar to the model 10 but with additions and changes in the method and amount of shielding. A portion of the amplification from screen grid tubes is used to provide additional selectivity instead of increasing the audio volume. The first audio stage in the 20 uses resistance coupling as compared to transformer coupling in the model 10.

General instructions for locating trouble that may occur, faulty reception of various kinds and unusual conditions, are similar to the general instruction on the model 10.

Use Set Analyzer

Modern makes of tube testing devices and set analyzer kits are equipped to check screen grid tubes and to test out circuits designed for their use. In case of trouble tubes should be tested, and if no tester is available for checking the screen grid tubes, these tubes should be replaced, one by one, with tubes known to be good. Set voltages may be checked with an analyzer, or by removing the base plate, and reading with a voltmeter and test leads. The chassis is removed from the cabinet by removing connections from rear terminal panel, clearing the a. c. cord and removing the two bakelite knobs, after taking out the four hold-down bolts in the corners of the chassis.

Voltage Measurements

Screen voltages are measured from cathode terminal to screen terminal of each r. f. socket. Screen is postive. Bias voltages are measured from cathode terminal to ground of each r. f. socket and detector, cathode positive. Other voltages are measured as in the model 10.

Coils may be tested with a battery, meter and pair of leads. Test from ground (entire chassis is grounded) to the grid terminals of the r. f. and detector sockets. Note that the grid terminals of the screen grid tubes are the flexible leads to the tops of the tubes.

Radio-Phono Changes

The model 20 phono-radio switch and its connections are entirely different from the model 10. Two phosphor-bronze contact springs are mounted behind the switch lever, near the front center of the chassis, and make contact when the switch is thrown to radio. When thrown to phono the pickup is hooked in series with the detector coil. The wire from the detector coil ground terminal to the ground lug is broken and the two ends attached to the two phosphor-bronze contact springs.

Keep Speaker in Circuit

When operating set or testing it, a speaker should be connected at all times as the field of the dynamic forms a part of the filter circuit. Many sets with the electrolytic filter will be found to hum considerably when turned on their sides, or upside down. This is a normal condition however. Because of the method of testing at the factory few receivers should be found that tend to oscillate. A tap on the voltage divider resistance is provided to lower screen voltages if found necessary to do so in case of oscillation tendency.

Colin B. Kennedy Model 20

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	170	3.5	3	65	1	4	3
224	2 R.F.	2.35	170	3.0	3	65	1	4	3
224	3 R.F.	2.35	170	3.0	3	65	1.6	4	2.4
227	Det.	2.35	130	—18.	+18.	----	1.8	3.	1.2
227	1 A.F.	2.35	160	—10.	+10.	----	7.4	9.	1.6
245	Pwr.	2.36	230	45	----	----	26	30	4.
245	Pwr.	2.36	230	45	----	----	26	30	4.
280	Rect.	4.8	----	----	----	----	80	----	----

Line voltage 112, set on 120 tap.

Fig. 2. With a Jewell set analyzer the typical tube voltages on the receiver would be approximately as indicated in this table

U. S. Radio and Television Model 37

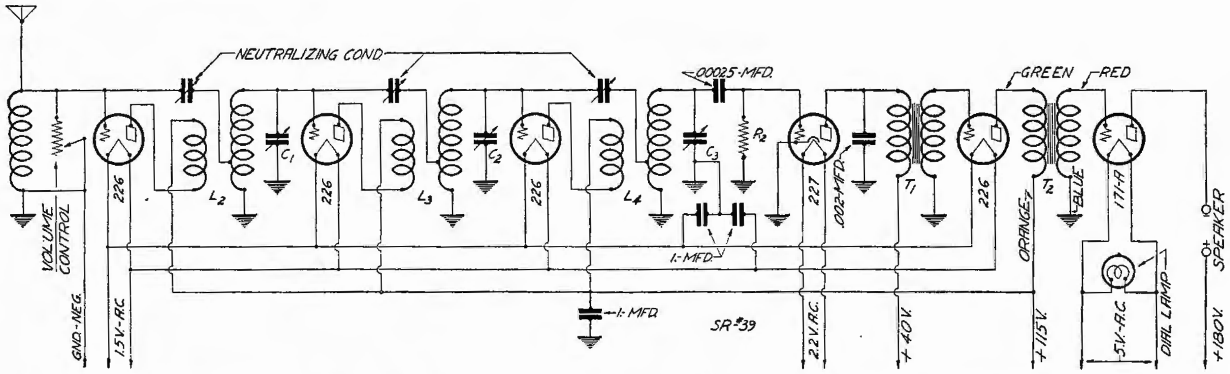


Fig. 1. In this illustration may be seen the schematic diagram of the U. S. Radio and Television model 37 chassis

SCHEMATIC diagrams of the power supply and the receiver itself on the model 37 made by the U. S. Radio and Television Company are shown on this page. A table of typical tube voltages is shown in Figure 2.

The simplest test for determining whether the audio amplifier is operating properly is to place the finger firmly on the grid lug of the detector socket. If this produces a loud steady noise in the speaker the a. f. amplifier is O. K. Another method is to tap the 227 tube lightly, which will produce a ringing sound in the speaker if the audio end is O. K. In the event trouble is located in the audio a careful reading of the voltage from plate to filament by means of a set tester or a thousand-ohm-per-volt voltmeter will indicate an open, short or ground in the primaries of the audio transformers or the speaker winding. The voltage reading between filament and grid is an indication of the C bias. Failure to get a reading means an open secondary in the audio transformer. When the audio amplifier is O. K. from tests as described the r. f. amplifier may be tested by the following method:

Touch the incoming end of the antenna wires of the solder lead of the third variable condenser (reading from right to left facing front of receiver) which tunes the detector stage. If this stage is functioning properly, strong local signals (or the oscillator if one is being used) will be heard, which can be broadly tuned by rotating variable condensers. If the signal is heard over the entire dial with the same strength the coil in this circuit has an open secondary which should be replaced. In the case of no signal the coil secondary has shorted turns or tuning condensers shorted.

With coil removed test variable condenser with battery and voltmeter and examine for plate touching at any point during rotation over the entire dial scale. If condenser is O. K. install new coil. Touch antenna to plate of third r. f. and if signal is still heard it is an indication that the primary is O. K. If the signal disappears, primary is defective and coil should be replaced. Proceed as above indicated to check second and first stage of r. f.

For neutralization procure a 226 tube of average character and cut off one of the filament prongs close to the base. Tune in a loud local signal not higher than 400 meters and insert the specially prepared 226 tube in the first socket (reading from right to left facing front of receiver) and with a fiber screw driver adjust the first neutralizing condenser to minimum volume. The three neutralizers are mounted on the under side of the chassis and are adjusted through openings near coil shields. Do likewise with second and third stages.

U. S. Radio & Television Model 37

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
226	1 R.F.	1.49	115	—9	----	----	5.5	9.0	3.5
226	2 R.F.	1.49	115	—9	----	----	5.5	9.0	3.5
226	3 R.F.	1.49	115	—9	----	----	5.5	9.0	3.5
227	Det.	2.2	26	----	----	----	1.5	1.8	.3
226	1 A.F.	1.49	105	—9	----	----	5.0	8.5	3.5
171A	2 A.F.	4.9	182	—37	----	----	20.	23.	3.
171A	2 A.F.	4.9	182	—37	----	----	20.	23.	3.
280	Rect.	4.9	----	----	----	----	25	----	---

Line voltage 115. Speaker tipjacks shorted.

Fig. 2. A typical voltage analysis on the tubes employed in this receiver may be found in the above table

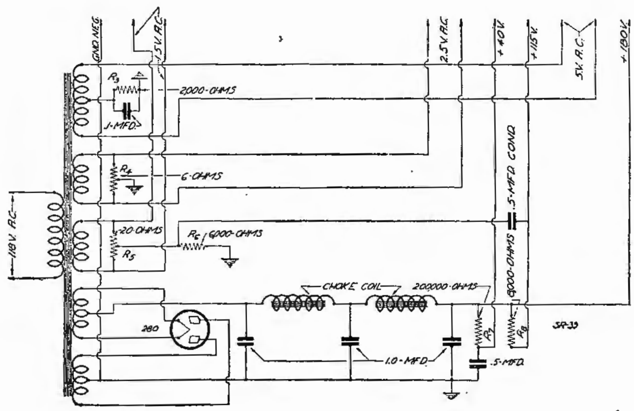


Fig. 3. The power supply used in connection with the model 37 receiver described on this page is shown in the schematic illustration at the right

Gulbransen 9 in Line Model Receiver

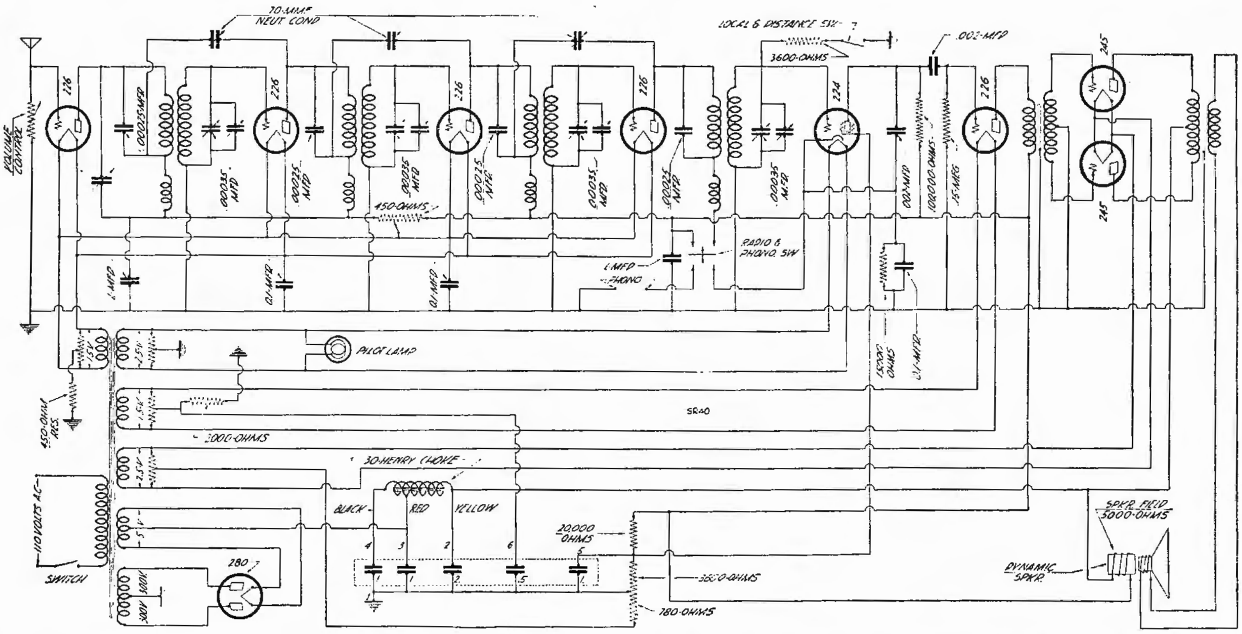


***Fig. 1.** In this schematic diagram of the Gulbransen receiver may be seen the electrical constants of the set and its power supply*

KNOWN as the Nine in Line model, the receiver made by the Gulbransen Co., of Chicago, Ill., is illustrated schematically in Figure 1, the schematic representing the receiver and its power supply. A table of typical tube voltages is shown in Figure 2.

Tuned R. F. Set

As will be seen by inspecting the diagram, the receiver is a nine tube tuned r. f. set including the 280 rectifier tube. It consists of four 226 tubes in the radio frequency end, a 224 screen grid detector, a 226 in the first audio and two 245 tubes arranged in push-pull in the output end.

Untuned Antenna

The antenna stage is not tuned, a high resistance volume control being inserted between antenna and ground.

Reneutralizing

Generally the only reason for reneutralizing is a change either in tube or circuit capacity. On this receiver the neutralization tolerance is quite wide. When necessary to reneutralize, use a good 226 tube from which one filament prong has been severed, close to the base. To neutralize, tune in a strong local, adjust receiver to maximum volume, getting the station right on the head. Remove the fourth r. f. tube and insert the specially prepared 226. The station should still be heard, but weakly. If it cannot be heard in the speaker, put on a pair of headphones.

Work at 25 Degrees

Adjust the fourth r. f. neutralizing condenser until volume is at a minimum. Continue this procedure with the third and second r. f. tubes, replacing the good tube back in its socket after each stage is neutralized. Neutralization should be done at about 25 degrees on the dial. Be sure to use an insulated screwdriver or tool for adjusting the neutralizing condenser.

Gulbransen Model 9 in Line

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
226	1 R.F.	1.35	116	8.5	----	----	4.7	8.7	4.
226	2 R.F.	1.35	116	8.5	----	----	4.7	8.7	4.
226	3 R.F.	1.35	116	8.5	----	----	4.7	8.7	4.
226	4 R.F.	1.35	116	8.5	----	----	4.7	8.7	4.
224	Det.	2.2	80	1.3	----	15	----	----	----
226	1 A.F.	1.4	110	1.0	----	----	4.0	5.0	1.
245	2 A.F.	2.2	232	42.	----	----	27.	32.	5.
245	2 A.F.	2.2	232	42.	----	----	27.	32.	5.
280	Rect.	4.6	----	----	----	----	84	----	----

Line voltage 115. Volume control.

***Fig. 2.** A table of the typical tube voltages as taken with a standard set tester is illustrated above for the benefit of service men*

Another Substitute

Occasionally the service man may be called on to neutralize the set and he may not have the specially prepared 226 tube with him. In this case a simple method is to obtain a straw such as is used at soda fountains. Clip off about one inch of the straw and slip the short piece over one of the filament prongs of the tube. Replace the tube in the socket, being careful that the straw is not torn in so doing. This will allow the tube to go into the socket without lighting the filament, and the set can thus be balanced for the tubes actually used. However, this method requires much more patience than the previous method, especially since the repairman must be careful not to tear the straw while inserting the tube in the socket.

Crosley Jewelbox No. 704-B Receiver

ILLUSTRATED on this page is the schematic diagram of the Crosley 704-B a. c. receiver and its power supply. The model is known as the Jewelbox and is but one of the several models manufactured by the Crosley Radio Corporation. A table of typical tube analysis is shown in Figure 1.

This set incorporates three stages of neutrodyned, radio frequency amplification, the latter two of which are tuned; a non-regenerative detector and two stages of audio amplification, the output stage being of the push-pull type. The power supply system is an integral part of the circuit.

Small auxiliary condensers, called "acuminators," are shunted across the first and second tuning condensers. They serve as means of sharpening the tuning when greatest selectivity is required. A small auxiliary variable condenser shunted across the detector tuning condenser serves as a means of aligning the tuning condensers so they will track over the scale.

The power transformer has five secondaries, four of which supply filament current for lighting the tubes, and the fifth of which supplies current to the plates of the 280 rectifier. The high voltage secondary is tapped at the center, the ground lead or low line being taken from this tap.

From the midpoint of the transformer secondary connected to the 280 filament, the high line lead is taken for the plate supply. This lead runs to a filter circuit consisting of a Mershon condenser and a choke coil.

From the filter circuit the high line lead runs directly to the plate circuit of the push-pull output stage. The plate supply for the other stages is reduced to the proper voltages by resistances from the plate circuits to the high line lead of the filter. A 10,000-ohm resistance is used for the first audio, 3,250 ohms for the r. f. stages, and a 60,000-ohm resistor in series with the previously mentioned 3,250-ohm unit for the plate circuit of the detector.

Crosley Model 704-B

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
226	1 R.F.	1.35	155	12	----	----	5.2	----	----
226	2 R.F.	1.35	155	11	----	----	5.6	----	----
226	3 R.F.	1.35	155	11	----	----	5.6	----	----
227	Det.	1.9	40	11	+11	----	2.25	----	----
226	1 A.F.	1.3	150	10	----	----	5.5	----	----
171A	2 A.F.	4.7	172	38	----	----	17.5	----	----
171A	2 A.F.	4.7	172	38	----	----	17.5	----	----
280	Rect.	4.2	----	----	----	----	25	----	----

Line voltage 110. Volume control maximum.

Fig. 1. This is a table of typical tube analysis made by the service man with a Weston set tester

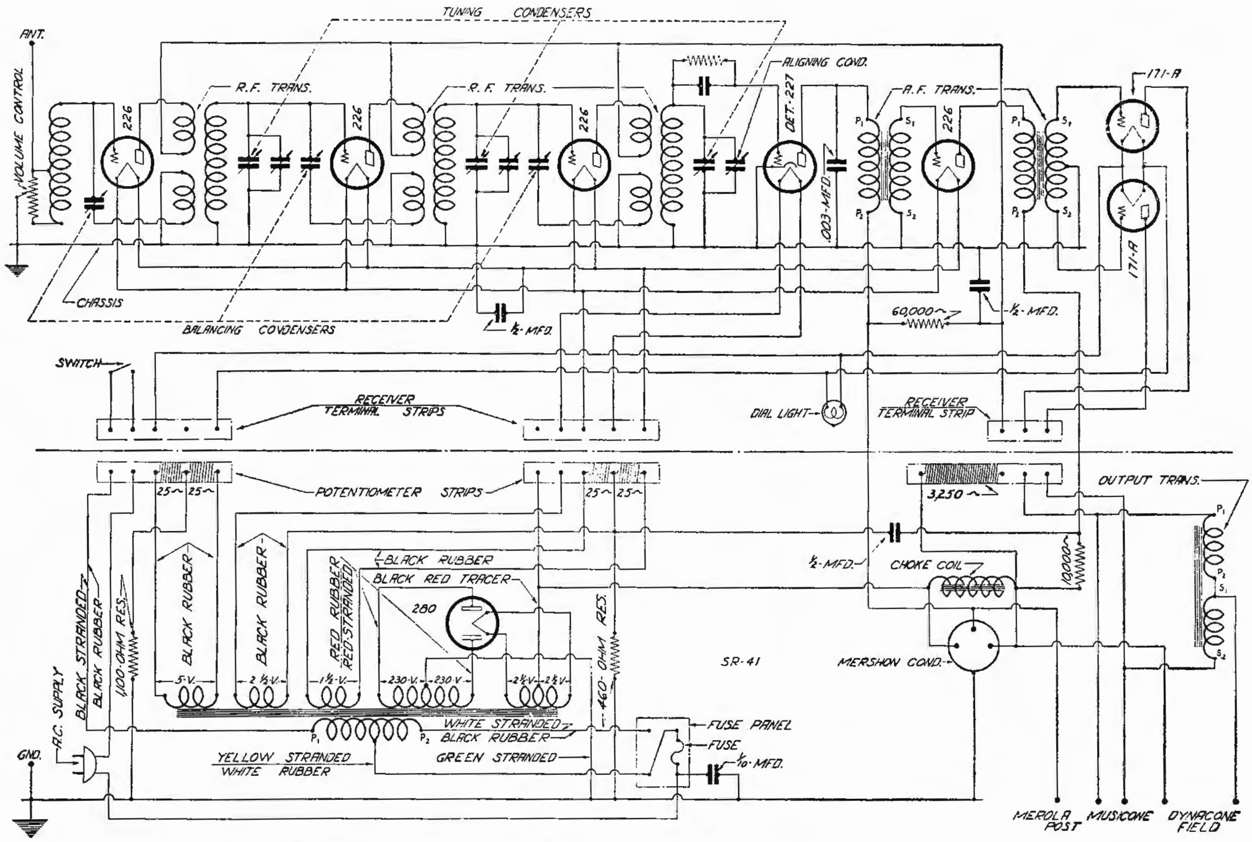


Fig. 2. The schematic diagram of the Crosley 704-B a. c. set is shown in this illustration

Graybar Model 600 Superheterodyne

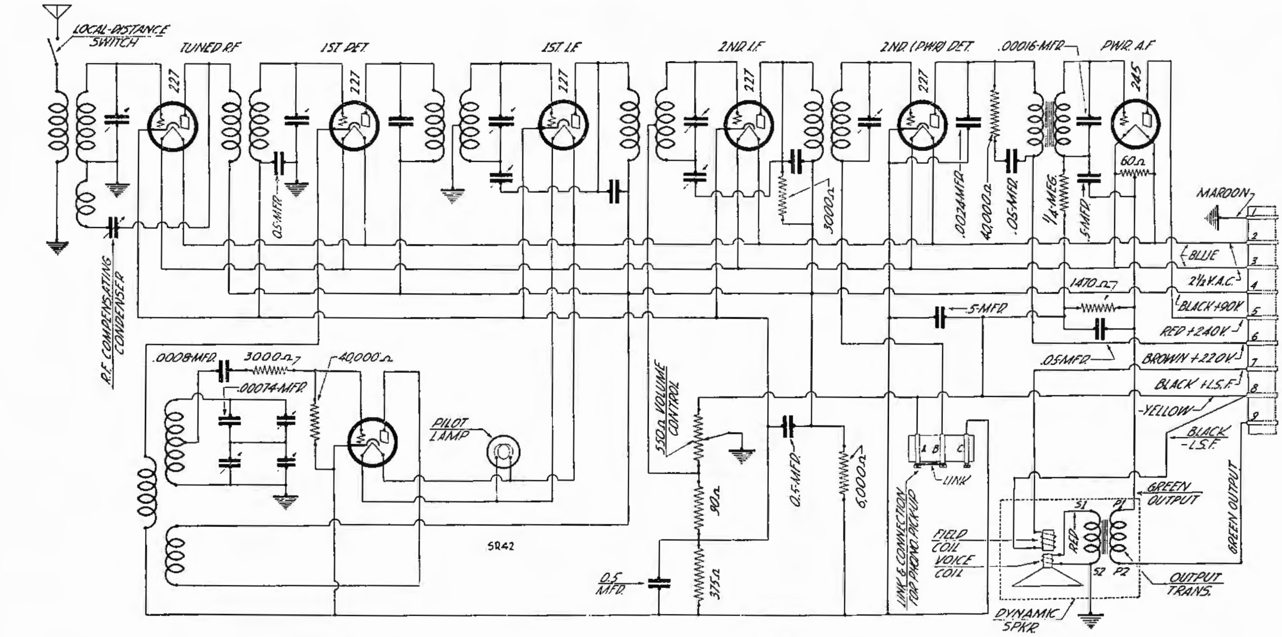


Fig. 1. The receiver portion of the Graybar model 600 is shown in this schematic

THE Graybar No. 600 receiver is a seven tube socket powered console cabinet model receiver using the superheterodyne circuit. It employs six 227 tubes and a 245 in the power output stage. A 280 is used in the socket power unit for supplying all plate, grid and cathode voltages, as well as supplying high voltage d. c. for the dynamic field.

Power detection is used in the second detector, where 235 volts is shown for plate circuit rectification with proper grid bias, which is about minus 29 volts.

With respect to tubes, the tuned r. f. stage (tube 1) is most critical for selection of tubes. For this position the tube giving loudest signal without oscillation should be employed. In the event any tube oscillates it may be necessary to reduce the setting of the r. f. compensating condenser so that no oscillation will take place over the entire tuning scale.

Other stages somewhat critical are the oscillator and the second detector, sockets 5 and 6 respectively. The remaining tubes should be interchanged until a tube is found for the oscillator that gives loudest signal for a given station. The second detector tube should be selected for its ability to handle large volume. Select the tube for this position that will permit the volume control to be advanced and give the greatest undistorted output without overloading.

Tubes 3 and 4, representing the intermediate frequency stages, should have tubes chosen for best amplification. When changing tubes it is advisable to change only one at a time in order to prevent unnecessary voltage unbalancing. When changing the 280 rectifier turn the switch off.

The volume control regulates the bias on the tuned r. f. stage and the first intermediate. A local-distance switch is incorporated. A high impedance semi-tuned antenna primary in the r. f. stage allows varying lengths of aerial without materially affecting the receiver tuning.

Graybar Model 600

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
227	1 R.F.	2.35	+100	—20	—26	....	0	....	....
227	2 1 Det.	2.35	+95	—9	—17	....	1.6	....	....
227	3 1 I.F.	2.35	+100	—20	—26	....	0	....	....
227	4 2 I.F.	2.35	+100	—3	—26	....	7.3	....	....
227	5 Osc.	2.35	+90	0	--16	....	8.7	....	....
227	6 2 Det.	2.35	+235	—29	—17	....	0.7	....	....
245	7 Pwr.	2.40	+225	—16	....	....	31.	....	....
280	Rect.	4.8	....	....	....	....	19	....	....

Line voltage 120, tap on 120 connection. Volume control at zero.

Fig. 2. Based on measurements shown in the Graybar manual the above table of typical tube analysis will be approximately correct

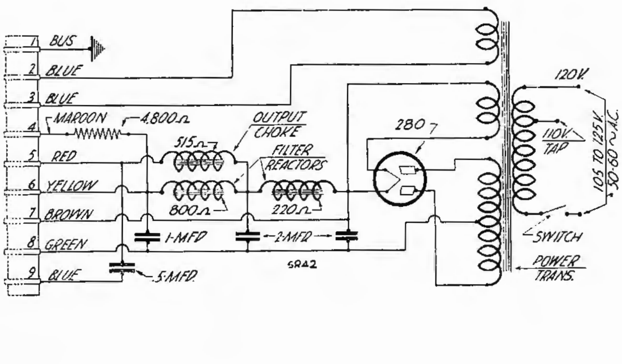


Fig. 3. The power supply, using a 280 rectifier, is shown in the diagram to the left. The resistor network at the left matches that at the right in the schematic shown in Fig. 1

Zenith Model Nos. 52, 53, 522, 523

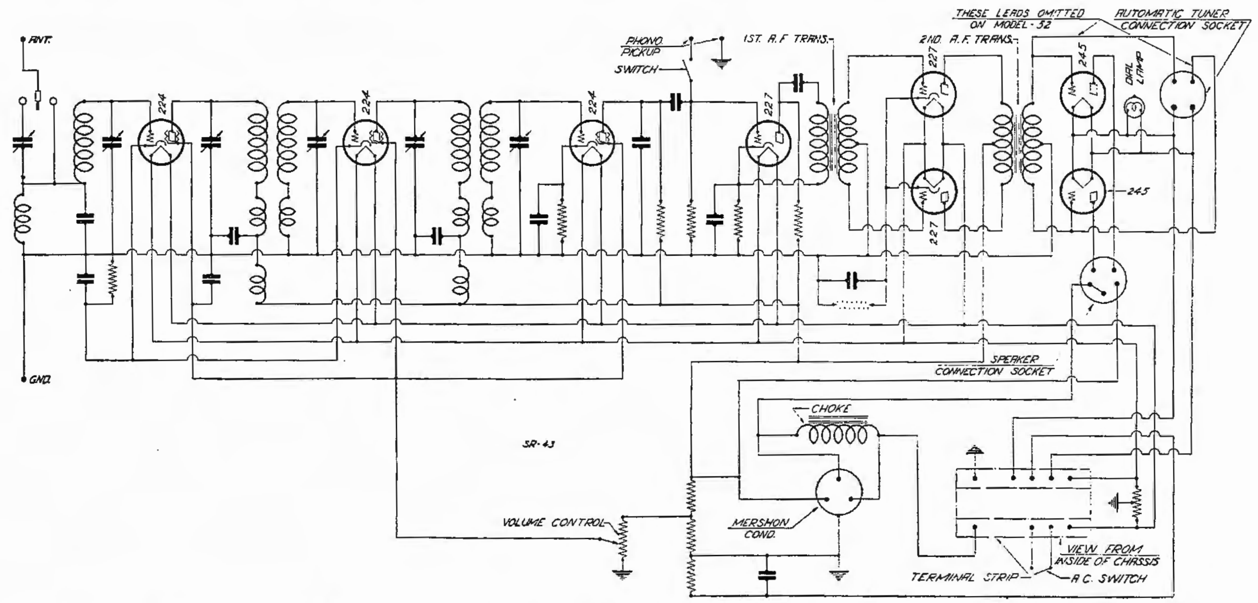


Fig. 1. This drawing is the schematic diagram of the models 52, 53, 522 and 523 receivers made by Zenith. The power pack is shown in Fig. 3

On this page may be seen the schematic diagram of the Zenith models 52, 53, 522 and 523 together with the power supply drawing and a table of typical tube voltages.

One departure from the conventional may be noted in the fact that two 227 tubes are used in push-pull in the first audio stage, followed by two 245 tubes in push-pull for the power output.

Instead of the usual grid leak and condenser linear detection is used in the 224 detector, a 50,000 ohm resistor and a .2 mfd. condenser being placed between cathode and ground. According to the tube analysis chart the grid voltage is 5 volts. The coupling from the plate circuit of the detector to the grid circuit of the 227 first audio is by resistance and capacity.

The circuit diagram of Models 52, 53, 522 and 523 is shown in Fig. 1. Models 54 and 542 use exactly the same diagram except there is a two point switch in the grid circuit of the first tube which disconnects the industance coil from the circuit and connects one side of the loop aerial to the grid of the first tube. The other side of the loop is grounded to the chassis. The power supply used on the models mentioned above is shown in Fig. 3.

Balancing of the receiver at the factory is done with an oscillator tuned to 203 meters. Since the set has been accurately balanced at the factory it is seldom rebalancing will be required. In the event such a step is necessary, tune in a station (preferably a distant one) about 200 to 250 meters (in the absence of an oscillator). After tuning in the station accurately and leaving the tuning dial alone, start turning the balancing nuts (beginning with the one at the left) until maximum signal is secured. Turning these hexagonal nuts (in the rear of the condenser shield) governs the trimmer capacities. Adjusting may be done with a Spintite No. 5.

Zenith Models 52, 53, 522, 523

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.	2.4	175	1	2	50	1.6	2.8	1.2
224	2 R.F.	2.4	175	1	2	50	1.6	4.0	2.4
224	Det.	2.4	90	5	5	50*	0	0	0
227	1 A.F.	2.4	55	2	2	----	1	1.2	.2
227	2 A.F.	2.4	143	14	14	----	4.3	5.7	1.4
227	2 A.F.	2.4	143	14	14	----	4.3	5.7	1.4
245	3 A.F.	2.2	248	45	----	----	24	28	4.0
245	3 A.F.	2.2	248	45	----	----	24	28	4.0
280	Rect.	4.7	.	. .	----	----	100	----	----

Line voltage 115, set on 120 tap. Volume control maximum.
*Actually 50 volts, but electrostatic voltmeter needed to show true reading.

Fig. 2. A table of typical tube analysis chart as made with a Jewell set analyzer is shown above

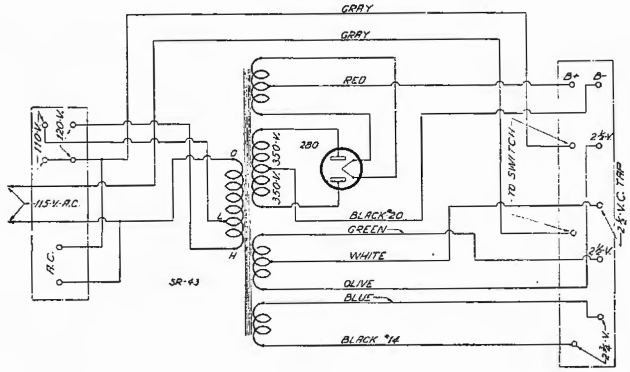


Fig. 3. The power pack used for the 52, 53, 522 and 523 Zenith models is illustrated in the diagram at the left

Amrad Model 81, Bel Canto Series

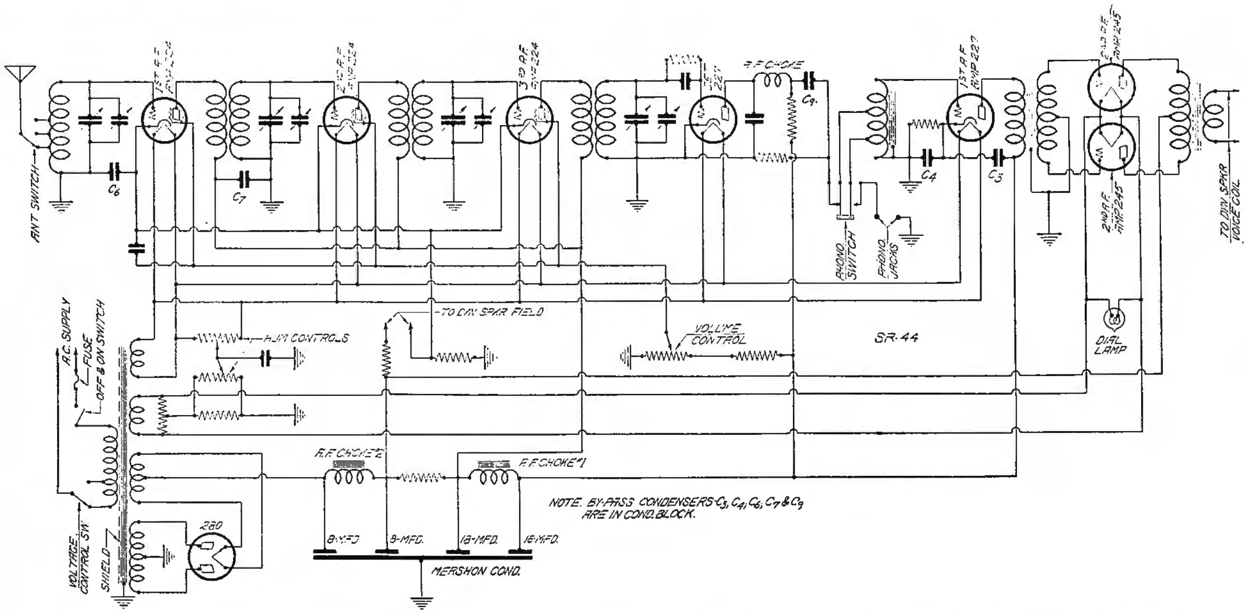


***Fig. 1.** The schematic diagram of the receiver and the power supply used in the Amrad model 81 is shown in the above drawing*

MADE by the Amrad Corporation, Medford Hillside, Mass., the model 81 receiver of the Bel Canto series is illustrated in this page. The receiver and power supply schematic is shown in Fig. 1 while a table of typical tube voltages is shown in Fig. 2. The model 70 Amrad was shown schematically on page 92 of the November, 1929 issue of this magazine.

The receiver uses three 224 screen grid tubes in the radio frequency stages followed by a 227 detector with grid condenser and leak detection. Coupling into the first audio stage is a resistive combination, arrangements being made for the inclusion of a phonograph pick-up in this circuit by means ot a switch shown in the schematic. The power output stage consists of two 245 tubes arranged in push-pull.

The antenna circuit of the first tube has a tapped inductance with a short, long and medium antenna tapoff. A switch is provided for selecting either of the three types of antenna.

Screen Volume Control

The volume control on the receiver is a variable resistance between the high line and ground, the arm of the resistance at the ground end going to the screen grids of the three 224 tubes, altering the potential placed on these screen grids.

The dynamic speaker field is included as a part of the resistance network between the center of the filter chokes and the ground. Hum control on the receiver is afforded by means of two hum controls, one of which is across the filament transformer secondary for the 224 tubes, and the other between ground and the center tap of the 2.5 volt secondary for the 245 tubes. A condenser goes from the two arms to ground.

The lower portion at the left of the schematic shows the condenser for filtering which is a Mershon. It has four sections, two sections of 8 mfd. apiece, one being placed at the entrance to the choke and the other at the output, while the two 18 mfd. sections are disposed around the input and output of the second filter choke. A resistive connection is employed between the output of the first choke and the input of the next.

Voltage Control Switch

The alternating current line is fused, and the primary of the 110 transformer is provided with a voltage control switch. An electrostatic shield is inserted between primary and secondaries on the power transformer and is grounded. Pilot lights are operated across the 2.5 volt secondary for the 245 tubes. The secondary of the push-pull output transformer in the 245 plate circuit goes directly to the voice coil on the dynamic speaker.

Amrad Model 81 Bel Canto Series

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	180	1.5	....	80	4.	7.5	3.5
224	2 R.F.	2.25	180	1.5	..	80	4.	7.5	3.5
224	3 R.F.	2.25	180	1.5	----	80	4.	7.5	3.5
227	Det.	2.25	30	----	----	----	1.5	1.6	.1
227	1 A. F.	2.25	160	10.5	----	----	4.1	5.2	1.1
227	1 A.F.	2.25	160	10.5	----	----	4.1	5.2	1.1
245	2 A.F.	2.25	250	50	----	----	28	32	4.0
245	2 A.F.	2.25	250	50	----	----	28	32	4.0
280	Rect.	4.65	----	-- -	- --	----	110	—	----

Line voltage, 120. Set on 120-volt tap. Volume control maximum.

***Fig. 2.** Taken with a Jewell analyzer the typical tube voltages would be approximately as shown in the above table*

Kolster Receiver Nos. K21, 23, 24, 28

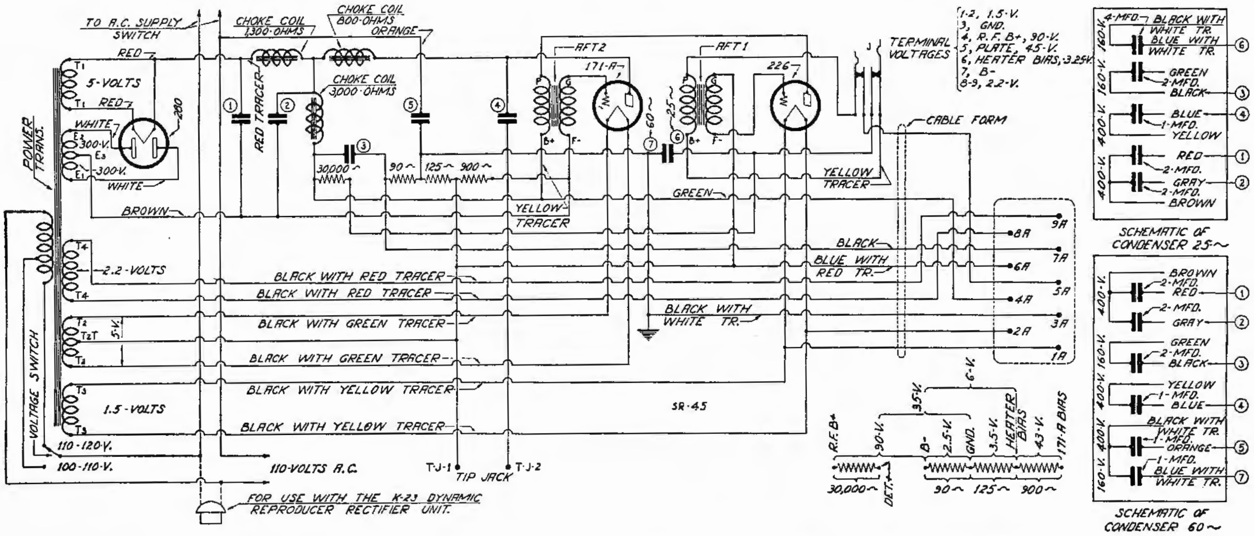


Fig. 1. The power supply used with the Kolster models is shown in this schematic illustration

IN general appearance the Kolster five tube chassis differs very little from the four tube chassis, illustrated schematically on page 81 of the September, 1929, issue of this magazine. With the exception of the longer tube panel, extra tube socket, extra twin .6 mfd bypass condenser and the lack of an antenna switch, the outward appearance is exactly the same.

Volume Control Method

Volume control is by a variable resistance shunted across the antenna inductance directly in the first r. f. grid circuit. (However the schematic shown in the Kolster manual in our laboratory shows the volume control across the primary of the last 226 r. f. stage, and it is thus shown in the diagram Fig. 3 on this page. It is quite likely that changes have been made in later production so that the volume control now appears across the first r. f. grid circuit.)

Alternating current is properly filtered, but to be sure of a minimum of a. c. ripple in the circuits, two hum adjusters are incorporated. One is in the radio frequency filament circuit and bypassed with two .6 mfd condensers from the ground and plate circuits. The other is in the 227 detector heater circuit and in this position when the tube is properly biased, reduces the possibility of a. c. ripple in this stage.

The audio frequency transformers used in the supply for the K21-23 models are the same as those in the supply for the 4 tube chassis described in our September issue, except for the method of connecting the transformer terminal leads.

Kolster Models K 21, 23, 24

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
226	1 R.F.	1.4	84	2.5	....	....	5.8	9.8	4.0
226	2 R.F.	1.4	84	2.5	....	....	5.8	9.8	4.0
226	3 R.F.	1.4	84	2.5	....	....	5.8	9.8	4.0
226	4 R.F.	1.4	84	2.5	....	....	5.8	9.8	4.0
227	Det.	2.0	36	3.5	....	....	1.6	1.6	0.
226	1 A.F.	1.4	72	2.0	....	....	4.8	7.8	3.
210	2 A.F.	7.4	430	32.5	....	....	24	28	4.
281	Rect.	7.0	....	....	....	....	28	....	....
281	Rect.	7.0	....	....	....	....	28	....	....

Line voltage 116.

Fig. 2. An idea of the typical tube voltages may be gained from examining this tube chart based on Jewell measurements

The K 21 power pack cannot be incorporated in the K23 receiver combination because of a slight difference in the wiring of the a. c. supply lines in the power pack assembly. The K23 power pack has a female receptacle which the K21 lacks. The a. c. supply cable male connector of the rectifier plugs into this receptacle.

The condenser bank and chokes of the filtering system are mounted in a housing and by simply removing this shield, individual inspection or removal can easily be performed.

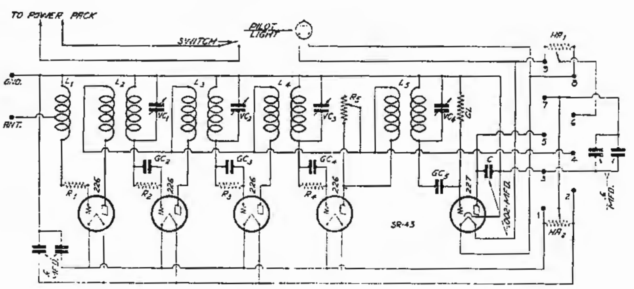


Fig. 3. This illustration at the left is the schematic diagram of the receiver portion of the Kolster models K21, 23, 24 and 28

Continental Star-Raider Model R20

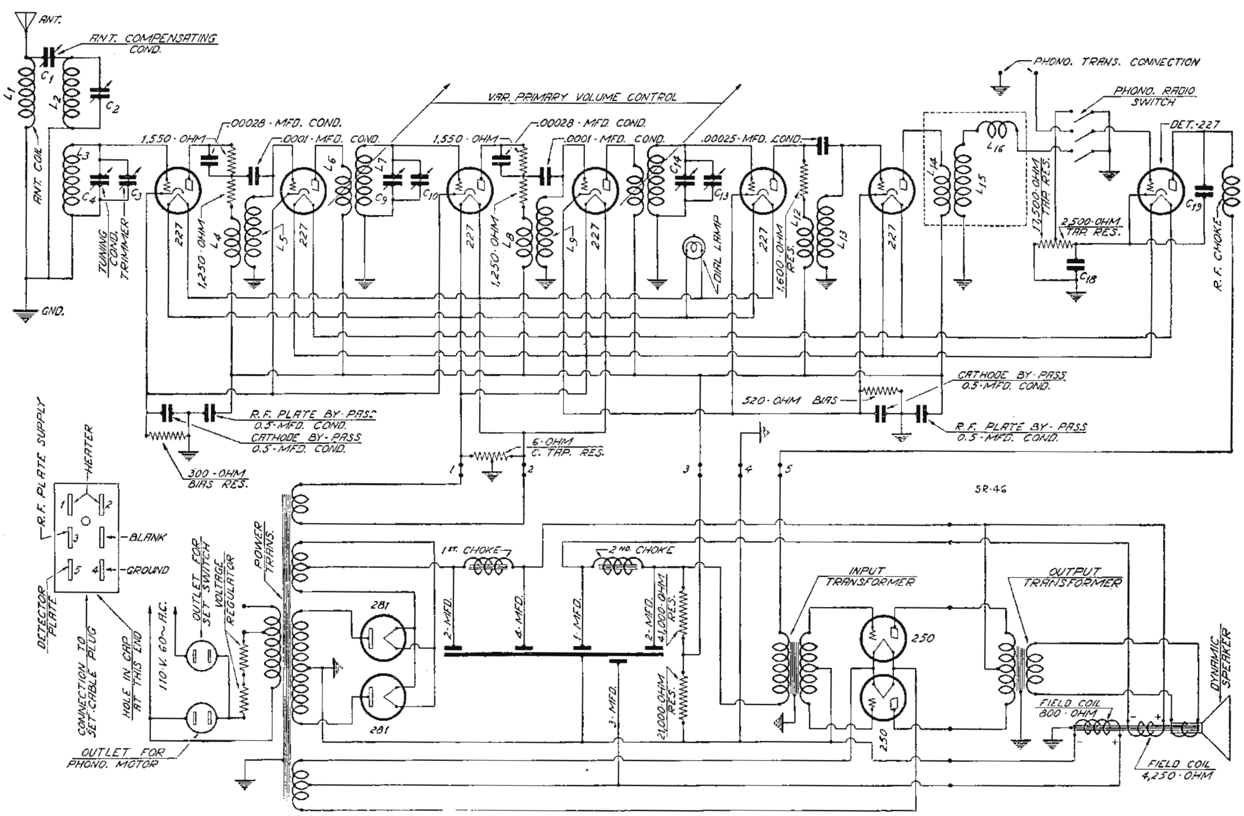


Fig. 1. The complete schematic diagram of the radio frequency end and the power supply of the Continental Star-Raider model R20 is shown above

IT will be observed the same circuit is used throughout the Continental line of receivers as is found in the schematic of the Star-Raider R 20 shown in Figure 1 on this page. This circuit is known as the Technidyne amplifier with which our readers are already familiar. The circuit uses six stages of r. f. arranged alternately in tuned and untuned stages. The r. f. amplifying system is preceded by and coupled to a tuned unit without tube, shown as L2 and C2, and is connected to the antenna system through C1, an adjustment of which is dependent largely upon the capacity of the antenna being used.

Following the r. f. amplifier is the detector stage operating on the so-called plate detection method. The detector grid bias which is about 18 volts at no signal, is obtained in such a manner that as the detector plate current rises with an increase of signal input voltage to the grid of the detector tube, the bias voltage increases in proportion to the rise in plate current.

The detector bias resistor is connected in the circuit in such a way that when the radio-phono switch is thrown to the phono side a section of the bias resistor is shorted out, leaving in the circuit the second portion of the bias resistor which furnishes the proper bias voltage to the detector tube to permit it to operate as an audio amplifier. Also with the radio-phono switch in position for phono reproduction the secondary of the r. f. transformer in the detector stage is disconnected from the grid of the detector tube and grounded, preventing the incoming signal from being transferred to the detector stage through capacity. The grid of the detector tube is connected then to the impedance matching transformer in place of the r. f. transformer.

Continental Model R20, R30, RP40

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
484	1 R.F.	2.85	110	5	5	----	5	9.4	4.4
484	2 R.F.	2.85	126	5	5	----	5.4	10.3	4.9
484	3 R.F.	2.85	112	5	5	----	5	9.6	4.6
484	4 R.F.	2.85	126	5.5	5.5	----	4.9	8.8	3.9
484	5 R.F.	2.85	117	5.5	5.5	----	4.0	8.4	4.4
484	6 R.F.	2.85	120	5.5	5.5	----	4.1	6.0	1.9
484	Det.	2.85	250	20	20	----	1.5	1.7	.2
250	Pwr.	7.2	360	66	----	----	38	45	7.
250	Pwr.	7.2	360	66	----	----	38	45	7.
281	Rect.	7.2	----	----	----	----	55	----	----
281	Rect.	7.2	----	----	----	----	57	----	----

Line voltage 115. Volume control maximum.

Fig. 2. A typical tube voltage analysis as taken with a Weston set tester is shown in this table

Majestic Model 90-B Response Curves

SENSITIVITY measurements on the Majestic 90-B are shown in Fig. 1. Greatest sensitivity at 1400 kc, least at 600, being most sensitive in the area from 1400 to 850 kc, ranging from about 3 uv/m to 5 uv/m over the best part of the broadcast band and rising to about 11 uv/m at 600 kc.

As could be expected from the sensitivity measurement the selectivity curves in Fig. 2 show the 1400 kc curve the broadest, 1000 kc next and the 600 kc the sharpest. The shape of both the 600 and 1000 kc curves is quite symmetrical, but the 1400 kc curve departs from symmetry on the plus 10, 20 and 30 kc off resonance. This departure might be caused by too great a minimum in the antenna compensator.

The fidelity measurements are shown in Fig. 3. From about 90 to 1000 cycles the three curves are in complete agreement. The greatest DB loss is on the 1000 kc curve showing a drop of about 17 DB; the 600 and 1400 kc curves dropping only about 16 DB. Of the three the 1400 kc covers the widest audio range, next the 1000 kc and then the 600 kc. The loss would hardly be appreciable to the ear.

Dummy antenna used was the standard 4 meter one having an inductance of 20 uh, capacity of 200 mmf and resistance of 25 ohms. GR 403-C standard signal generator and type 486 output meter employed in measurements.

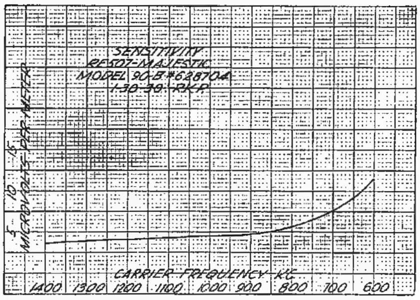


Fig. 1. Measured sensitivity of the Majestic 90-B is indicated in the graph shown above

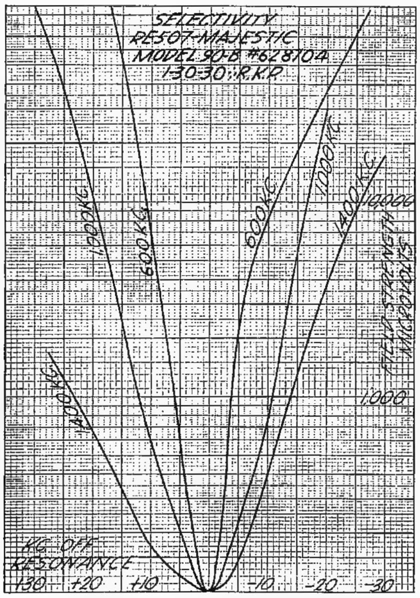


Fig. 2. Selectivity curves taken at three frequencies are shown in this illustration

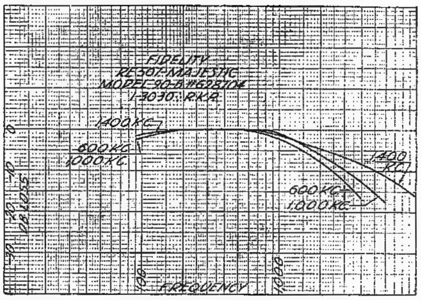


Fig. 3. Fidelity of the Majestic model 90-B recently measured in our laboratory is depicted above

Trio of Curves Taken on Radiola 44

A RATHER unusual sensitivity curve is that shown for the Radiola 44 illustrated in Fig. 1. Most sensitive at 600 kc, least sensitive at 1100 kc, then next most sensitive at 1400 kc. Measurements were made with the local switch and the distance switch on. On the distance switch side the greatest sensitivity was about 7 uv/m, at 600 kc, next most sensitive was 22 uv/m at 1400, and about 60 uv/m at 1100 kc. On the local side the greatest sensitivity was at 600 kc with about 950 uv/m; then 1400 kc with about 3700 uv m, then 1200 kc with 7000 uv m.

In the selectivity curves shown in Fig. 2 the broadest is the 1400 kc, next the 1000 kc curve and the 600 is the sharpest. Considering their width the curves are symmetrical. The 600 kc curves give somewhat satisfactory selectivity, while the 1000 and 1400 kc curves would not give satisfactory selectivity in an area of strong locals.

Fidelity curves on these receivers, especially the 1000 and 1400 kc curves are exceptionally good. They are shown in Fig. 3. The 600 kc curve falls off rather rapidly which is due to the increased selectivity at 600 kc.

Dummy antenna was the standard 4 meter one with 20 uh, 200 mmf and 25 ohms. GR 403-C standard signal generator and 486 output meter.

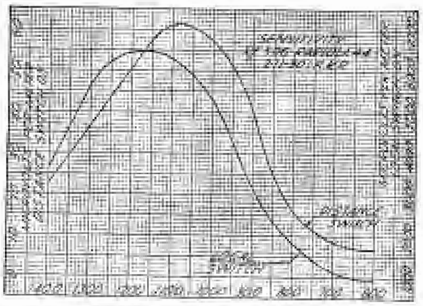


Fig. 1. In this curve may be seen the sensitivity of the Radiola 44 recently measured in our laboratory

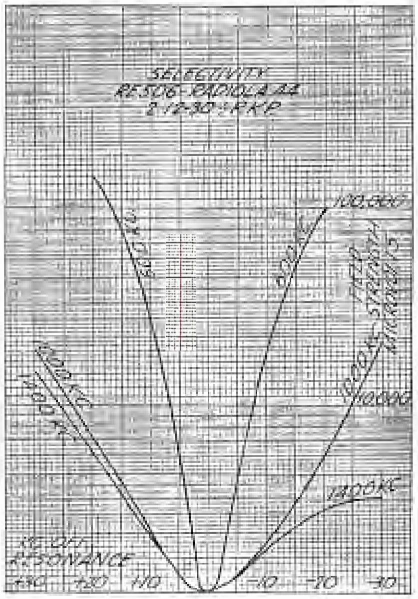


Fig. 2. From this set of curves may be obtained an idea as to the selectivity of the Radiola 44

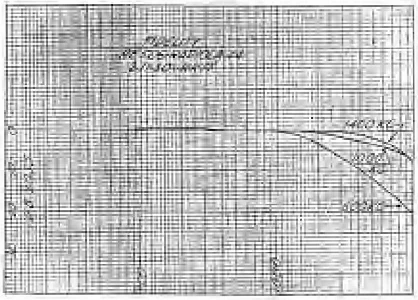


Fig. 3. Tone quality of the receiver is indicated in the above curves taken when the fidelity was measured

Three Atwater Kent 55-C Curves

THREE curves on the Atwater-Kent model 55 C are shown in Figures 1, 2 and 3.

Sensitivity in Fig. 1 has a rather sharp rise above 900 kc but even at its worst the sensitivity is good. At 1400 kc it is less than 1 microvolt per meter which is extremely sensitive. On the local switch at 1400 kc the sensitivity is 20 uv/m with a gradual rise to 160 uv/m at 600 kc. This is good average sensitivity.

The selectivity curves in Fig. 2 show a little better selectivity than is averaged for this type of receiver. It will be noted that the minus side is not symmetrical with the plus side, probably being due to small discrepancies in tuning capacities which with the extreme sensitivity would show a deviation from uniformity.

The fidelity curves in Fig. 3 are in accordance with the selectivity having cutoffs a little too sharp for high quality reproduction. The 600 kc curve for instance is down 28 DB at 5000 cycles. However it is probable that the speaker characteristics compensate for this loss at the high frequency.

Dummy antenna 4 meter having 20 uh, 200 mmf and 25 ohms. GR 403-C signal generator and 486 output meter.

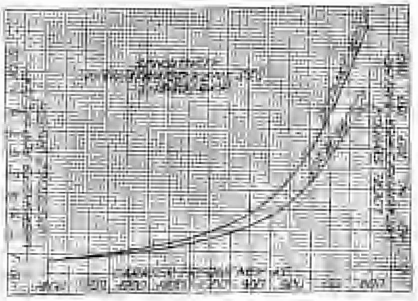


Fig. 1. Sensitivity of the A-K 55-C as measured in our laboratory shows the characteristics illustrated above

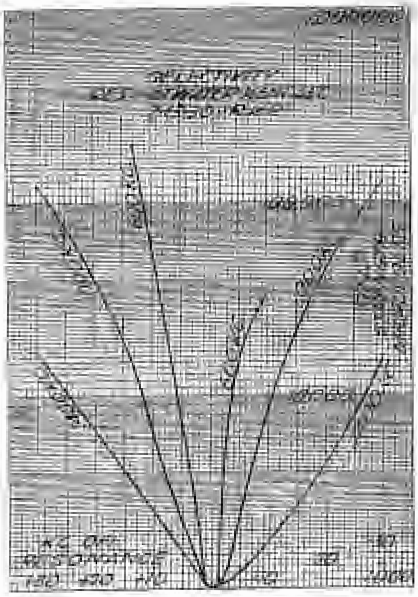


Fig. 2. The selectivity of the receiver under measurement is shown by the three curves in this drawing

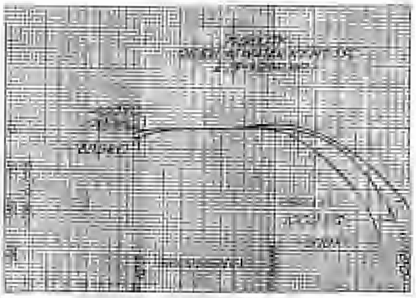


Fig. 3. Fidelity measurements made on the receiver are shown in the graph above

Crosley Model 40-S Has These Curves

THE Crosley model 40-S was recently measured in our laboratory with the following results as indicated in Figures 1, 2 and 3.

Three curves were made on the sensitivity of this model as shown in Fig. 1. Curve A was made with the antenna compensator switch on local, showing a sensitivity at 1400 kc of about 5 uv/m and at 600 kc about 260 uv/m. Curve B was made with the switch on distance showing a sensitivity at 600 kc of 80 uv/m and at 1400 kc of 5 uv/m. Curve C is a combination of both, from 600 to 1050 on distance switch and from 1050 to 1400 made on the local switch, showing an increase in sensitivity at 1400 kc of about 4 uv/m. The average sensitivity is good.

The selectivity curve of this receiver has a rather peculiar shape. At all frequencies the selectivity is rather broad and not satisfactory for congested broadcast areas where distant stations are desired. The lack of uniformity is quite likely due to discrepancies in tuning capacities over the wave band, as it was not possible to trim the tuning condensers. The receiver is a good local receiver as far as sensitivity and selectivity is concerned.

The fidelity of this model is not bad, having only 5 DB loss at 5000 cycles, and a maximum loss of 15 DB at 10,000 cycles. This is very probably due to its lack of selectivity.

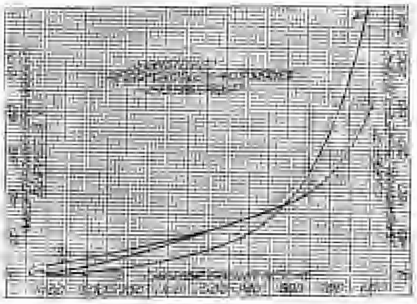


Fig. 1. This curve may be taken as an indication of the sensitivity to be expected from a Crosley model 40-S

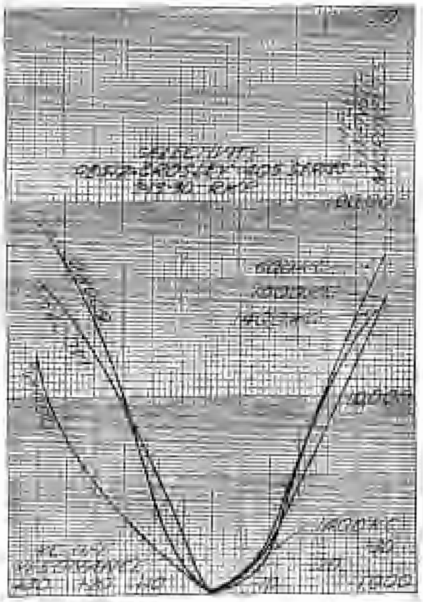


Fig. 2. The selectivity of the 40-S as recently measured in our laboratory is shown in this graph

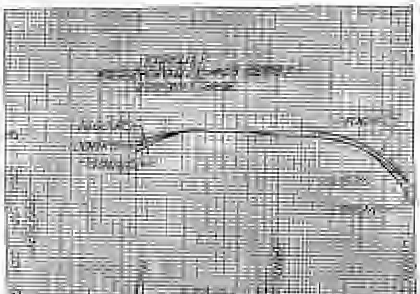


Fig. 3. The tone quality of the set under measurement can be figured out from the fidelity curves given above

Airline Receiver Model 8 as Measured

TWO receivers marketed under the Montgomery Ward name of "Airline" are shown on this page.

The sensitivity curve of the Airline 8 in Fig. 1 shows a maximum sensitivity at 1150 and 600 kc of approximately 22 uv/m, the 1400 kc setting having the minimum sensitivity of 43 uv/m, while from 900 to 700 kc the sensitivity will average 27 uv/m. This is a rather peculiar sensitivity curve and it is probably due to a changing antenna load for which there is no compensation, and a slight deviation in tuning capacities.

The selectivity curves in Fig. 2 show fairly good selectivity at 600 kc. At 1000 kc it is fairly broad and at 1400 kc it is very broad. Both of these curves could probably be bettered with antenna compensation.

The fidelity curve in Fig. 3 has a fairly rapid cutoff beginning at about 800 cycles. The various frequency curves vary with the selectivity of the receiver. However it is not likely all of the variation in fidelity is due to selectivity, but that some is due to normal audio response.

Measurements made with GR 403-C signal generator, 486 output meter and standard dummy antenna of 20 uh, 200 mmf and 25 ohms.

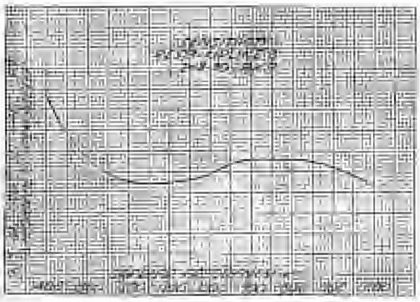


Fig. 1. The sensitivity of the Airline 8 receiver as recently measured in our laboratory is shown above

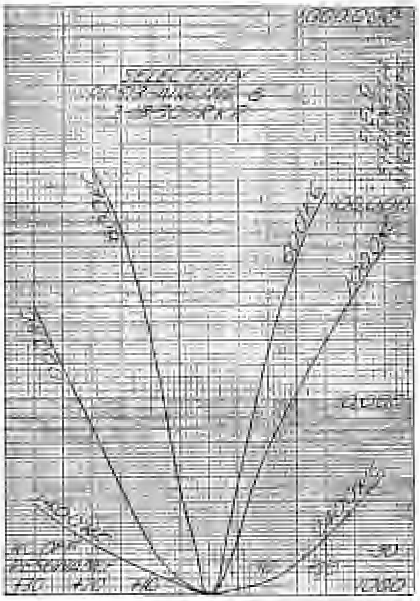


Fig. 2. Based on recent measurements the selectivity of the receiver is depicted in this graph

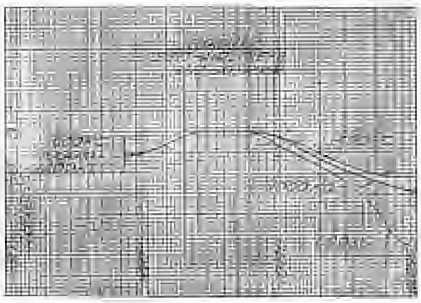


Fig. 3. Tone quality of the receiver is shown in the fidelity curves illustrated here

Curves Taken on Airline Model Nine

IN these graphs are shown the sensitivity, selectivity and fidelity of the Airline 9 model.

The point of maximum sensitivity in Fig. 1 on distance switch is at 600 kc with a gradual decrease of sensitivity up to 1300 kc, and then a sudden increase to 1400 kc. The average sensitivity over the broadcast band may be said to be about 20 uv/m which is slightly below a good average. The sensitivity with the local switch has a variation from 350 uv/m to 510 uv/m which will give ample volume control on strong local signals.

The selectivity curve of this receiver somewhat resembles the fabled band pass curves (the ones that generally appear in advertisements) with a flat top and a narrow skirt. The 600 and 1000 kc curves show a parallel rise for about three times resonance field strength. This condition is quite unusual in a tuned r. f. system. The flares at the top of these two curves are more or less symmetrical in regard to each other. The 1400 kc curve has a tendency toward band pass effect, but flares out more rapidly than the other curves at the same field strength. It might be said on a low percentage modulation, a distant station might be too sharp for good tone quality. The average selectivity of this receiver is slightly better than most sets in its class.

The fidelity in this receiver has all the bad features that the selectivity has good features, but the speaker used compensates for this loss.

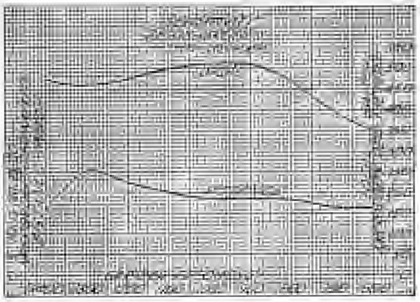


Fig. 1. Two measurements of sensitivity are shown here, one on local and the other on distance settings

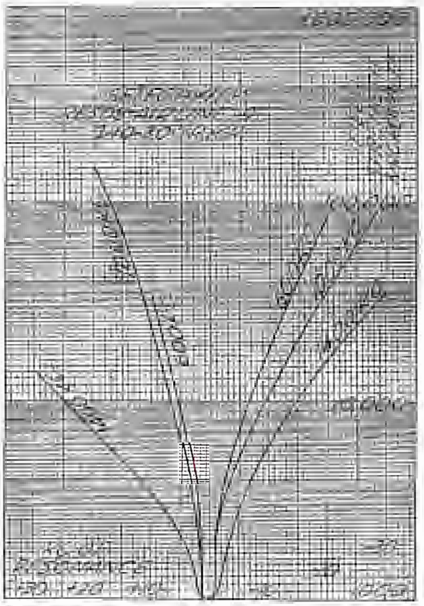


Fig. 2. The selectivity of the receiver under measurement is set forth in the three curves plotted above

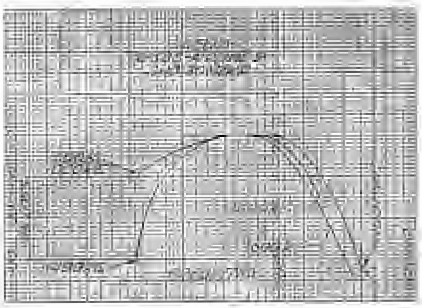
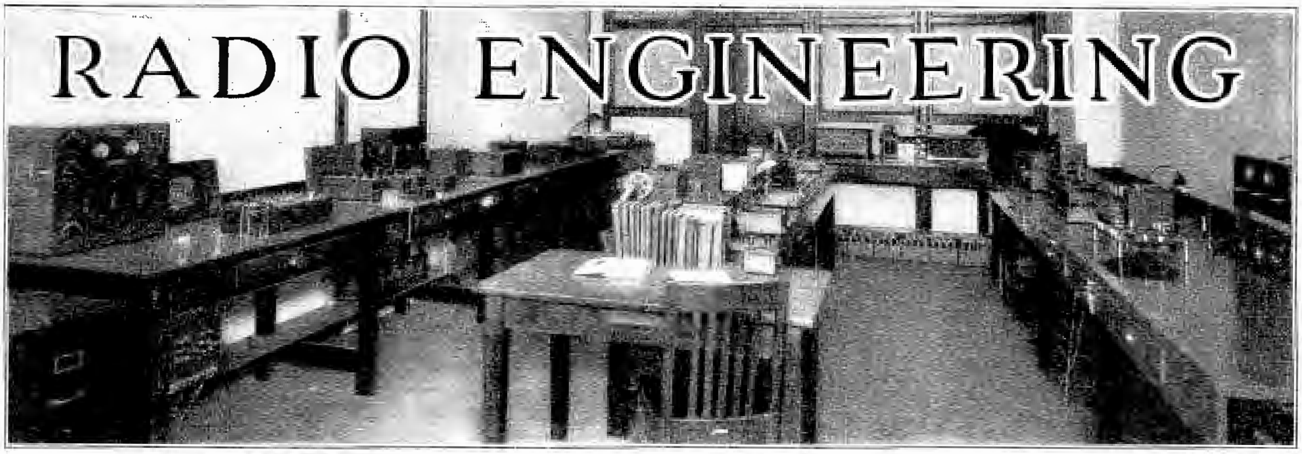


Fig. 3. This graph illustrates tone quality of the receiver as reflected by the fidelity curves above



Further Loftin-White Measurements

FURTHER study and measurement on the preliminary work done in our laboratory by R. K. Pew and related in the January issue of this magazine, page 84 covering the Loftin-White circuit, brings to light some very interesting features of the 2-tube circuit not disclosed in the Pew report or in the original Loftin-White paper which appeared on page 86 of the January issue.

Two Tube Job

Some of the measurement work on the 2 tube L-W layout is shown in the form of a fidelity curve, Figure 3. The schematic of the circuit measured is indicated in Figure 2 and requires no particular comment other than to state that the position of the hum bucking resistance shown at the center of the resistance network in the diagram will depend somewhat on the B supply filter and the input circuit characteristics.

The circuit was changed slightly and the 100,000 and 300,000 ohm resistors were added between the center tap of the filament of the 250 output tube and the positive B source. It was, of course, necessary to change several of the other circuit constants at the same time. It was then possible to use 650 volts on the entire system. Referring to Figure 2. The 25,000 ohm K-G resistor will develop about 21.25 volts negative bias, which, of course, is too much for the grid of the 224. The input of the system is then brought to a point on the voltage divider which is positive, reducing the effective bias on the 224. This point has been set at 350 ohms, which with the .055 amperes flowing through the resistance network will have a voltage drop of 19.25 volts, which opposes the 21.25 volts developed in the K-G resistor, leaving an effective bias in the grid of two volts negative. There is then another 350 ohm resistance which goes to the screen of the 224 delivering a voltage at this point of 38.5 volts. The resistances from B negative to the center tap of the 250 filament equal 4,000 ohms and when the current of the 250 plus the current of the 224 are passed through it the voltage drop across it will be 250 volts, leaving 400 volts across the 250 and the 300.000 and 100.000 ohms resistors. From these values we see that there will be a 110-volt drop across the 100,000 ohm resistor and 290-volt drop across the 300.000 ohm resistor. The bottom of the 250,000 ohm resistor which is in the plate circuit of the 224 is brought to the junction between these two resistors which gives an applied voltage to the plate resistor of 360 volts. The current in the plate of the 224 causes a voltage drop across the plate resistor of 180 volts, which leaves 180 volts effective voltage on the plate of the 224. 180 volts is, of course, to much bias for the 250, so the center tap is brought to the junction between the 100,000 ohm and the 3,300 ohm resistors. The 110-volt drop across the former of course will buck the voltage developed by the plate resistor which will bring the effective bias of the 250 down to 70 volts, which is the normal operating voltage for this tube. All voltage adjustments should be made with the system at rest, as when there is a signal on the 224 the plate current will increase, which increases the voltage drop across the plate resistor increasing the bias on the 250, which decreases the plate current decreasing the current through the resistance network decreasing the voltage drop across the first 350 ohm resistance, which permits a higher effective bias on the 224 which decreases the plate current, decreasing the bias on the 250, etc., until the system is back to the normal operating condition. From this it will be seen that the system is self-adjusting to the field strength of the incoming signal. In fact, the grid may be made very weak, so that it will be free to swing on a very weak signal and yet when a very strong signal is applied the bias automatically goes up to a point where the system is operating at normal conditions. From this it will be seen that it is nearly impossible to overload the system. It will also been seen that this type of detector has all the advantages of the grid leak-condenser and power detectors which is a most desirable condition to have. However, it is possible to overload the system when a signal is applied that is greater than the increase in bias will take care of. In addition to this self-regulating signal feature the B voltage may be varied within wide limits, say 300 to 700 volts, without materially affecting the stability of the system, the only change that is noticeable is a change in amplification. When this amplifier was operated in conjunction with a phonograph pick-up and a Wright-DeCoster theater dynamic the volume was great enough to fill a good-sized theater, and from the response curve, as shown in Figure 3, it will be seen that the fidelity is exceptionally good. As far as the ear is concerned, the curve might be drawn perfectly straight. The loss at the high frequency end is due partially to the large plate resistor and feed-back in the 250 output tube. As an amplifier for phonograph work, this amplifier is exceptionally satisfactory. Operating as a radio receiver, except on high powered locals, not so much can be said for it. The overall amplification of this amplifier was about 425.

From the two tube to the three tube combination was not a very great step. On page 120 circuit in Figure 1 was selected and measured. The GR microvolter and allied equipment illustrated in the photograph Figure 4 was employed for the measurements, from

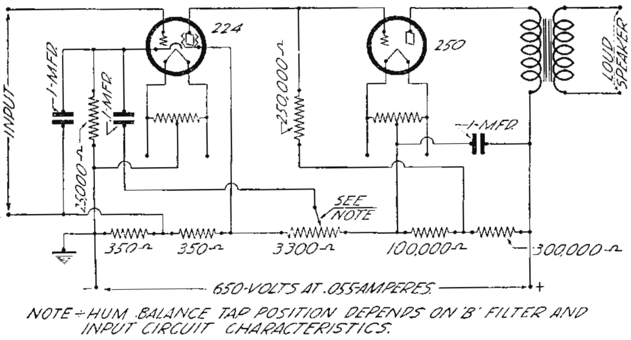


Fig. 2. In this circuit is the 2 tube L-W model on which fidelity has been measured as shown in Figure 3

which the sensitivity, selectivity and fidelity curves, Figures 5, 6 and 7 were plotted. The tuning circuit on input end was merely an inductance in a can tuned with a .00035 mfd condenser. The first 224 was spaced about 10 inches away from the second one. No shielding seemed to improve matters so it was forgotten.

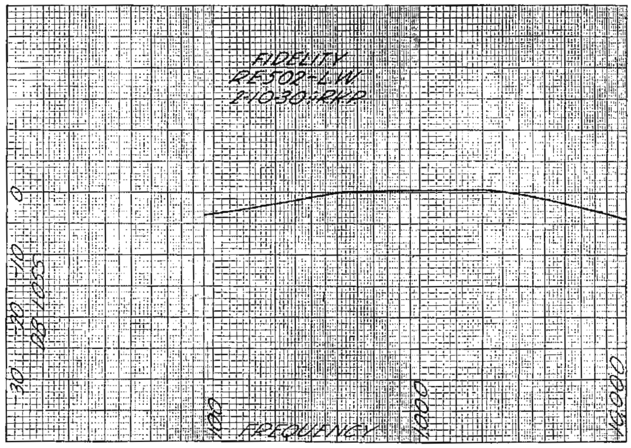
Standard Curves

The three curves were taken in the standard way, the volume on the 3 tube combination being all the way on since there is no volume control in the circuit. The automatic bias was presumed to be operating satisfactorily and the hum bucking slider adjusted for no deflection on the output meter.

Sensitivity in Figure 5 shows greatest at 1400 and least at 600 kc. The microvolts per meter values on the face of the thing would appear quite excessive unless one remembers that this measures the equivalent of a simple detector and a power output tube. The ratio of sensitivity is about 3 to 1. Whether this same ratio would be carried out if sufficient r. f. were fed to the circuit so that the measurements could be started at a sensitivity of a half microvolt per meter is difficult to determine from the appearance of things at this writing. If the ratio of three to one were to obtain when the sensitivity is started at a half microvolt per meter and the top range were to be 1.5 uv/m it is quite likely that the sensitivity of the outfit would be very gratifying. Before our next issue considerably more work will have been done on this one phase of the matter and we should have interesting developments to relate at that time.

On the selectivity curve in Figure 6 the teacup-without-a-handle effect seems to be due entirely to the inductance and capacity characteristics of the tuning system as indicated on the 600 kc curve.

Fig. 3. The tone quality measured on the two tube version of the Loftin-White is shown in this graph of fidelity. In a subsequent measurement the low end was brought up considerably, as may be seen in Figure 7



With the sensitivity being poorest at 600 kc its quite likely that the selectivity at 600 kc would be as pictured in this curve. It is also quite likely that the 1000 and 1400 kc curves are also natural considering the sensitivity curves. From this curve we also might see that any statement as to the excellence of the three tube arrangement as a good broadcast receiver is entirely unwarranted by the measurements indicated, unless one might consider that such a set would be acceptable to one living in a congested metropolitan area where 50 kilocycles separation between locals is considered the criterion of set performance. Essentially such a receiver made as in Figure 1 would be merely a local set.

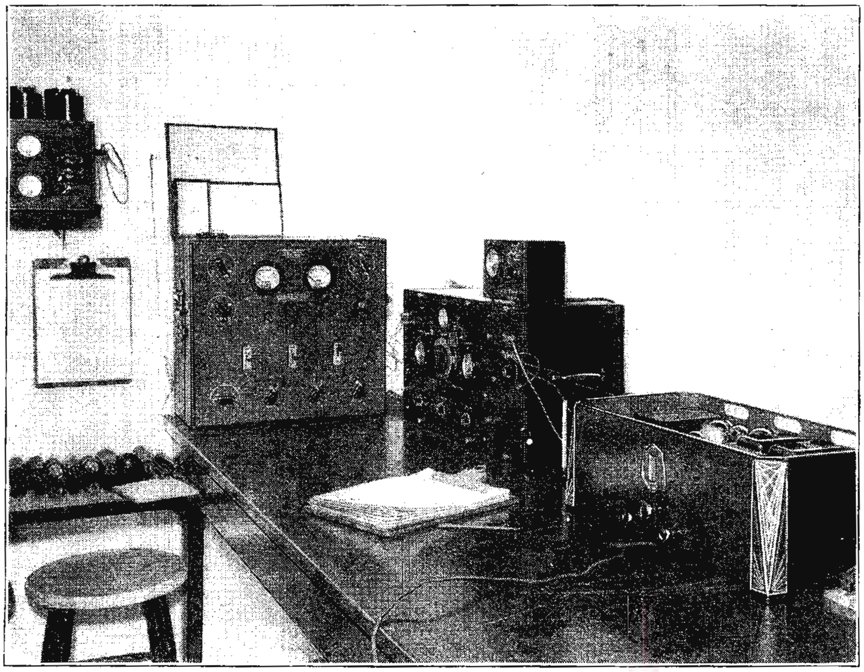


Fig. 4. The tin room, or "King Tut's Tomb" as it is called by the laboratory, is illustrated in this photograph. At the extreme left on a shelf in an r. f. oscillator, next the audio oscillator, then the standard signal generator type 403-C, above it the output meter, and at the right one of the receivers on which sensitivity, selectivity and fidelity curves have been prepared. All apparatus is made by General Radio. Measurement conditions as laid down by the I.R.E.-R.M.A. committees are described elsewhere in this magazine

Good Quality

The quality indicated in the fidelity graph, Figure 7, is quite interesting. This is not a sales curve even if the frequency response from 90 to 1000 cycles would seem to so indicate. A glance at the selectivity curves will immediately show the reason for the good response. The cut off is greatest at 13 DB. A portion of this cut-off, at the high frequencies, is due to the selectivity of the system, but the greatest amount of cut-off is due to capacity feed-back in the 250 output tube.

Most of what has appeared before this part of the study has been related

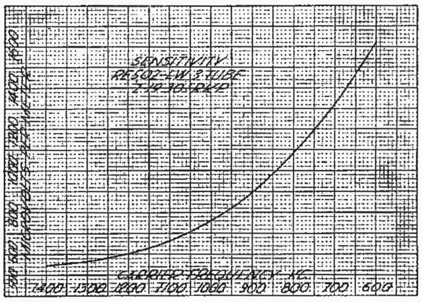


Fig. 5. Sensitivity of the 3 tube L-W using the LC combination indicated is shown in this graph

to the circuit in Figure 1 thrown together to get an approximate idea of what might be expected from the amplifier using a r. f. signal modulated 30 per cent. Taking the amplifier without change and hitching it onto the rear of a four stage tuned system the audio gain in the L-W job was entirely too much to use, the r. f. signal through the tuned system with the volume control (in the screen) backed way down, delivered about 5.6 watts to the output meter when the attenuator on the 403-C was set at zero and the microvolt meter control was turned to minimum. This indicated, apparently, that the r. f. end could stand several additional tuned stages (without tubes) and the audio gain would more than permit excellent standard output with the volume control not entirely on.

See Page 117

Additional information appears on page 117.

CeCo Pentode Circuits

By F. S. Huddy

(Assist. to Chief Engineer, Ceco Mfg. Co.)

CHANGES necessary to make possible the use of the CeCo A. C. Pentode in sets designed to operate with type 224 tubes are neither difficult nor expensive. (Figure 8 illustrates the circuit.)

Tests have shown that although the optimum plate voltage for the Pentode is 250 and the optimum screen voltage is 135, it will work satisfactorily with 180 volts on the plate and 75 on the screen. The last named voltages are those most commonly found in present day sets, and, in general, it is not advisable to atttempt to change them. Where 245's are used in the last audio stage it is a simple matter to connect the plate returns from the Pentodes to the 250 volt tap on the voltage divider. All the Pentodes in a set will operate at the same plate and screen voltages.

The outstanding difference in construction between the Pentode and the 224 is the presence of a space charge grid in the former. Hence the first consideration in changing a set is the provision of a potential of 13.5 volts positive for application to the space charge grid. This may be done in two ways. The simpler is to provide a battery of nine small dry cells connected from the space charge grid terminal on the side of the base to the cathode terminal on the socket. The other way is to connect the space charge terminal through a resistance of 8200 ohms to the 75 volt screen grid tap on the voltage divider or 16,500 ohms to the 135 volt tap. Where it is possible to secure an extra tap on the voltage divider the space charge terminal may be connected to a tap giving a voltage equal to 13.5 plus the grid bias which is usually one and one-half volts. In any one of these connections, the space charge grid should be held at ground potential with respect to any radio frequency voltages by the connection of a one-half microfarad condenser from its terminal on

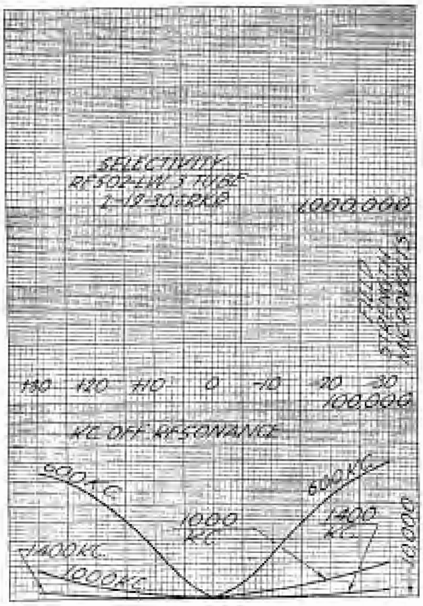


Fig. 6. The selectivity of the simple receiver, indicating a tea cup without a handle, the saucer on which it sets and the table on which it rests may be seen in the 600, 1000 and 1400 kilocycle curves

the base to the ground. When these connections have been properly made, a high resistance d. c. volt-meter will read 13.5 volts between the space charge connection and the cathode terminal. Voltages in excess of 13.5 will give somewhat improved results and very greatly fore-shortened life, while voltages less than 13.5 will cause somewhat inferior reception.

The correct voltage to be applied to the control grid is one and one-half volts negative with respect to the cathode. This is most commonly done by inserting a resistor in series with the negative B return to the cathode. The plate current of the tube causes a voltage drop in the resistor and makes the grid which is connected to the terminal of the resistor nearest to the B supply negative with respect to the cathode.

The plate current of the Pentode is somewhat higher than that of the 224, and for that reason the grid will be made too much negative because of a greater drop in the bias resistor. The current will be different if a separate battery is used to furnish space charge grid potential, and a different value of bias resistor is needed as shown below.

With Separate Battery

Ip 3.5
Is .5

4.0 milliamperes

$$R = \frac{1.5 \text{ volts}}{.004 \text{ amps.}} = 375 \text{ ohms}$$

When Taken from Power Pack

Ip 3.5
Is .5
Is.c. 7.5

11.5 milliamperes

$$R = \frac{1.5 \text{ volts}}{.0115 \text{ amps.}} = 130 \text{ ohms}$$

Aside from the changes outlined above, none others are required to make possible the use of the Pentode.

Owing to the fact that the interelectrode capacities of the Pentode are slightly higher than those of the 224, some small difference in tuning may be noticed, but if Pentodes are used throughout the alignment of the set will not be disturbed.

In some sets using the 224 tubes, some means of neutralizing are employed. When the Pentodes are substituted, it may be necessary to re-adjust the neutralizing condensers in order to prevent oscillation.

It may be found that when Pentodes are used in a set previously adapted to 224's some oscillation will occur at advanced settings of the volume control. This is entirely natural since the tremendous amplification obtainable from the Pentode requires that the set shielding be very complete, more so than that usually found in sets using 224's. It will be found, however, that it will be

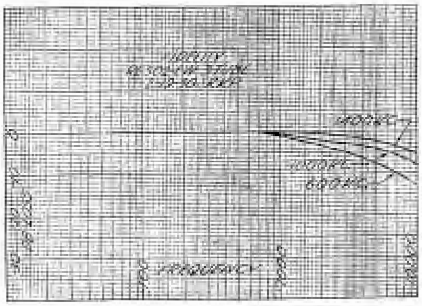


Fig. 7. The fidelity as measured on the three tube combination is set forth in this curve

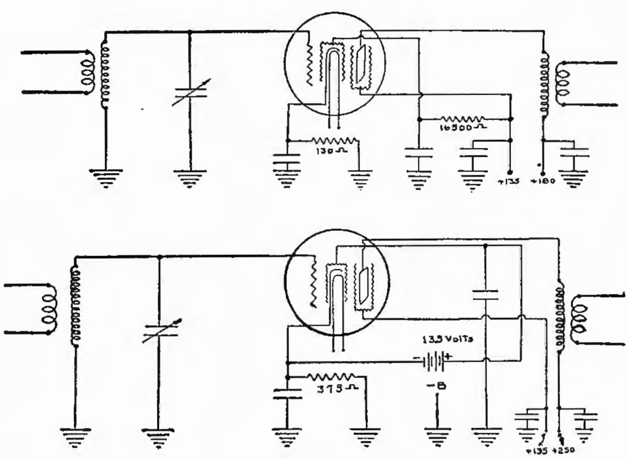


Fig. 8. The diagram supplied by the CeCo engineering department covering the r. f. pentode is illustrated here and forms a part of the statement by Mr. Huddy regarding Ceco's latest tube addition

unnecessary to advance the volume control to the point of oscillation since the greater sensitivity of the Pentode will permit excellent reception at lower settings.

Problems of Television

By R. T. Brackett

University of Nebraska, Lincoln, Neb.

(Presented before Mid-West Section, The Institute of Radio Engineers, Des Moines, Iowa, December 28, 1929.)

ALTHOUGH several organizations are devoting much time and effort to television, it does not at present seem to offer much commercial promise. Through certain limitations now inherent in all systems, we usually are forced to consider not what the eye can appreciate, but rather what the eye can tolerate. The title of this paper has been chosen to permit us to discuss what the eye can appreciate, without seeming to imply a criticism of present workers in the field.

In halftones or in the commercial facsimile transmissions we find an image which is a sort of geometrical approximation, composed of tiny elementary areas. We may define an index of details as the ratio of the smallest perceptible area in the original to the elementary area of transmission. Obviously unity is the desired value for this co-efficient. A greater value means that we are transmitting detail too fine to be appreciated by the eye, while a value less than one means that we are not transmitting fine detail.

If we have determined this index of detail and the area of the picture to be transmitted we know the number of elements required for the approximation.

Scanning

In transmission the elements are con-

(*Continued on page* 117)

Automatic Volume Control Is Explained by Engineers

General Engineering Opinion Favors Circuit If Consistent with Economy and Efficiency

NOW that most of the idiosyncracies of the alternating current set have been ironed out by the radio engineers in the industry, many minds are being directed toward the problem of securing a sure-fire, simple and economical automatic volume control for use on radio receivers.

Already the engineering committee of the R. M. A. has defined an automatic volume control in these words: "Means whereby a receiver accommodates itself to the strength of the received signals within limits, depending upon the characteristics of the signal, but without affecting the quality, so that the sound volume may be manually pre-adjusted."

In order to get an opinion from engineers representing a number of receiver manufacturers the editorial department sent a letter to several manufacturing companies asking their chief engineers for a statement concerning the question of "Manual versus Automatic Volume Control." At the time of going to press with this particular section we have received replies from enough engineers to give a fair idea as to general engineering opinion on the subject. The statements of those engineers responding to our request for data are shown in these columns.

It is observed that the Stromberg-Carlson model 846 uses an automatic volume control circuit in connection with a visual tuning meter for indicating resonance. A silent key is provided for quietness during tuning. A photograph of that particular model is shown on page 92 of this issue.

The statements, in the order of their receipt are shown below:

Dr. Alfred N. Goldsmith

(*Vice President and General Engineer, Radio Corporation of America*)

TO clarify this matter, it is desirable to define in general terms "manual volume control" and "automatic volume control." "Manual volume control" is the knob or dial method of adjusting the loudness of the station by hand to any desired volume within limits imposed in part by the receiver and loudspeaker design." "Automatic volume control" is an electrical method of controlling the loudness of station signals in such fashion that approximately the same volume is obtained from all stations which give signals that are not extremely weak or excessively powerful. Automatic volume control therefore functions through a certain range of signal strengths which, however, are those most usually received.

The outstanding uses of automatic volume control are the following:

In changing from one local station to another, it avoids a terrific crash of sound in passing from a weaker station to a stronger station. It also avoids undue strain on loudspeakers or the ears of the listeners. In passing to more distant stations, it considerably reduces the effects of fading and enables the listener to enjoy programs which otherwise would "swing" too much in volume.

Automatic volume controls can be arranged so that there is little or no noise in tuning between stations and thus avoid a difficulty which might otherwise be experienced in "electrically noisy" locations.

In general, it may be said that unless local electrical noises are excessive, and unless the listener prefers only a few local stations of about equal strength, automatic volume control presents a considerable number of practical operating advantages.

W. E. Holland

(*Chief Engineer, Philadelphia Storage Battery Co.*)

IT is my opinion that automatic volume control has a definite place in the modern radio receiver for the home. This valuable improvement until recently has been available only in high price receivers, and the popularity of it, therefore, cannot be judged by the volume of sales. Furthermore, it was thought that a tuning meter was required and a complicated double manual volume control for adjusting the sensitivity of the receiver as well as the volume level.

In September Philco placed on the market an improved screen grid receiver with simplified automatic volume control at a popular price.

No tuning meter is used. A single manual control is provided to adjust the volume to the desired level, and the automatic volume control system adjusts the sensitivity of the receiver in inverse proportion to the strength of the incoming signal. The receiver is tuned and operated just like any other true single dial receiver, and is even simpler to operate because most local and distance stations can be tuned in with one hand without adjusting the manual volume control. The stations are tuned by ear to the point of greatest clarity or, in the case of distance stations, to the point of minimum static noise. The automatic volume control reduces fading, so that many distance stations can be enjoyed which with the ordinary receiver would periodically fade out completely. The blasting or blaring out of strong local stations during tuning is also prevented, and the volume of strong and weak stations is to a large extent equalized.

One difficulty with automatic volume control, that must be overcome by education, arises from the fact that many people are extremely careless about tuning stations. In other words, they will tune until the station commences to be heard, and then instead of tuning further to increase the volume or clarity of the station they will turn up the manual volume control. Careless tuning, of course, spoils the quality with any highly selective receiver, and with automatic volume control it will also bring in more static and back ground noise for the reason that the receiver is working at high sensitivity when tuned to a weak signal, such as in the edge of the carrier.

Judging by the large and increasing demand for this new receiver, I should say that automatic volume control is on the way to becoming very popular.

K. R. Smith

(Technical Division, Brunswick-Balke-Collender Co.)

I BEVIEVE that the automatic volume control will be very much in demand where its design insures a more constant level output for use in remote control radio sets. Of course, this type of automatic volume control is a very nice refinement, especially where one is tuning for distance in the home and does not care to accidentally tune in on a local station, which would cause a tremendous noise.

Paul G. Andres

(Chief Engineer, Temple Corporation)

THE question of "Automatic versus Manually Operated Volume Control" offers an extremely interesting problem because of the advantages and disadvantages which are associated with this feature. A decision on whether or not automatic volume control is feasible and can be extensively applied is determined by the proper evaluation of its merits against its disadvantages. Briefly stated, the advantages as we see automatic volume control operation are as follows:

First, prevention of sudden bursts of volume on tuning through a loud local station. This not only prevents a jar to the nervous system of the listener but to the mechanism of the loudspeaker as well.

Second, the questionable elimination of fading with a sufficient degree of satisfaction to be commercial. This latter point has always been a hypothetical advantage but the absolute control of the automatic circuits is not sufficient to eliminate anything except very nominal fading.

The disadvantages of an automatic volume control system can be briefly summarized as follows:

First, Additional cost and complexity of circuits.

Second, If the volume control is made sufficiently quick acting to eliminate the highly objectionable rapid fading, then there is a certain tendency to suppress low frequencies or bass tones.

Third, Difficulty of tuning to exact resonance and corresponding distortion on stronger stations might become a serious commercial problem unless suitable additional equipment is installed to insure tuning on resonance.

Radio receiving sets are being designed more and more along the line of simplification and decreased service. Consequently, the addition of any auxiliary equipment must have a definite and tangible advantage before it should be considered as a necessary part of every receiver. It is our opinion that the addition of automatic volume control systems may find application in expensive and extremely high grade receivers where the matter of cost and service are of secondary importance, while for ordinary receivers in the medium and low price class range this feature is indeed of questionable value.

Pentode Not So Hot

TO advise the radio public and industry correctly and authoritatively regarding the "new" pentode radio tube, the Radio Manufacturers Association, comprising all important manufacturers, has issued a statement regarding the pentode. It was declared neither new nor revolutionary. No improvement in performance can be obtained with pentodes that cannot be had with present tubes, the official statement declared, and it is unlikely that pentodes will replace present tubes this year.

The statement was prepared by Walter E. Holland, a prominent radio engineer of Philadelphia, and Director of the Engineering Division of the Radio Manufacturers Association, after consultation with other leading radio engineers.

Neither New Nor Novel

"There is nothing new or revolutionary about pentodes," said Director Holland. "No improvement in performance can now be obtained with pentodes that cannot be had with present tubes. A given result is possible with less tubes, using pentodes, but it is unlikely that the cost of a complete radio receiver would be any less.

"The pentode is used more widely in England because of the greater popularity of battery operated portable sets, and because patent licenses are based on the number of tubes in the receiver. Reduction of number of tubes has, therefore, been more important in England, just as low-powered automobiles are more popular there on account of the license taxes being based upon horsepower of the motor. These factors are not important in this country, so that there is no advantage here at present in either low-powered automobiles or pentodes "

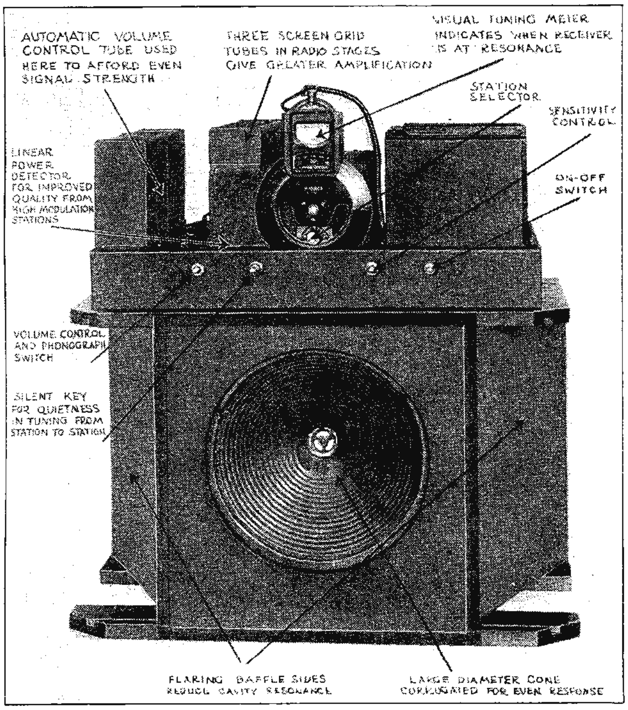
Summarizing the development in Europe of the pentode tube and experimental work in this country, Director Holland added:

"The pentode tube has long been known abroad and has found limited commercial use there, especially in England. Many radio receiver and vacuum tube engineers in this country have experimented with this type of vacuum tube, and are thoroughly familiar with its characteristics and possible applications.

"The pentode, as the name implies, has five electrodes or electrical elements. It has the usual cathode and plate, but between these elements there are three grids or screens as compared with two in the tetrode, commonly known as the screen grid tube.

"The pentodes developed abroad are designed for use in the last audio stage, where we use triode power tubes, such as the 245 and 250 tubes.

"There is a possible application of the pentode to radio frequency circuits, but it is unlikely that this type of tube will prove of much practical importance as a radio frequency amplifier. All it could do would be to reduce the number of stages of amplification re-



An interesting photograph of the Stromberg-Carlson model 846 receiver chassis is shown at the left. Some of the features of the receiver are shown at the arrows. A visual tuning meter and a silent key for tuning are two ideas not found in the usual receivers

quired for a given sensitivity. The elimination of a stage of radio frequency amplification ordinarily means a reduction in the number of tuned circuits, and such a reduction is impracticable for the reason that a given number of tuned circuits are essential to give the high degree of selectivity needed under the broadcasting conditions existing in this country.

Useful on D.C. Jobs

"The pentode power tubes used abroad have greater sensitivity, and, therefore, provide higher amplification per stage than our triode power tubes. This makes it possible to eliminate a state of audio amplification and work from the detector directly into a single power stage without overloading the detector or the radio frequency amplifier tubes. Another advantage is that it is possible with pentodes to obtain greater undistorted output where the plate voltage is limited, as in battery receivers and receivers for operation of the 110 volt direct current supply used in certain sections of a few cities.

"Against the above advantages the pentode has a number of disadvantages. It is a most difficult tube to manufacture with uniformity owing to its complexity, and to the fact that it must be exhausted to an extremely high degree of vacuum. Non-uniformity of pentodes will make greater differences in the operation of a radio receiver than with tubes of the present type. It is inherently a high-cost tube.

Questionable Advantage

"In radio receivers for use on the common alternating current supply used for house lighting, the pentode presents a more difficult problem from the standpoint of manufacturing cost, than the standard type of power tube. With present power tubes of the 245 type it is almost universal practice to use two tubes connected in push-pull circuit to reduce hum and improve the quality of reproduction. Owing to the high cost of pentodes and the greater complexity of the circuits, it is a question whether it is practical to use pentodes in push-pull. On the other hand, if a single pentode is used to give the same result as two triode power tubes in push-pull, the cost of the filter, required to smooth out the ripple in the rectified alternating current, will come up probably enough to more than offset any possible saving in eliminating the power tube and the usual first stage of audio amplification. In addition a larger and more expensive output transformer would have to be used on account of the high direct current flowing in one direction in the primary winding of the transformer.

Warns Against Blasting

To insure perfect tonal volume in broadcasting, KMOX has installed in its studios, instruments known as galvanometers, electrical sound indicators to warn artists against "blasting" into the microphone.

The sound volume galvanometer has always been a part of standard equipment of a speech input panel, to guide the operator in regulating sound volume; so George Junkin, Director-Announcer of KMOX, decided to place these indicators close to all microphones in the studio so that the artist, broadcasting, could co-operate with the control operator in sending out the proper sound level.

"Blasting" usually is caused by an artist standing too close to a microphone and, with a galvanometer next to each "mike," the artist is enabled to take the proper placement by watching the dial movements of the instrument.

Synchronization System

TWO methods for improving radio broadcasting were presented during the Federal Radio Commission's symposium held recently in Washington, D. C., by representatives of the Westinghouse Electric and Manufacturing Company.

The methods were: (1) Synchronization of two or more stations upon a single wave length. (2) A radio transmitting antenna system for increasing the strength of the local signal and at the same time minimizing the amount of signal sent to a distance, or for just the opposite purpose, to decrease the local signal and increase the distant signal.

According to Walter C. Evans, superintendent of the Westinghouse radio operations department, the new antenna system will make it possible for a cleared channel station to broadcast with higher power without blanketing the surrounding area. The system can also be used so that a local station can send out a strong signal in its own territory without interferring with distant stations

Advantages

Synchronization has the advantage of making it possible to increase the service area of a program furnished identically to two or more stations without increasing the number of channels used. It also reduces fading. A third advantage claimed is that a small booster station can be erected to give service in a "dead spot" area where the parent station is not received.

Westinghouse was represented before the Commission by Mr. Evans, Frank Conrad, assistant chief engineer, and S. M. Kintner, research department manager. Dr. Conrad invented and superintended the development of the synchronization and antenna methods, according to Mr. Evans.

It was said that Westinghouse has operated synchronized stations since 1925 when WBZ in Springfield, Mass., and WBZA in Boston first successfully broadcast on the same wave length. Late in 1929 KYW in Chicago was synchronized with KYWA in order to eliminate a "dead spot" on the north side of the city.

The new system will first be applied in the new KDKA which is being built near Saxonburg, Pa. Experiments with the antenna have been carried on for several months with a short wave station on the Saxonburg site.

When it is desired to have a station send out a strong local signal without distance transmission the antenna is built so that it radiates a powerful wave along the ground but does not send one into the air where it would be deflected to distant areas by the Heaviside layer. If the station is on a cleared channel it can be made to send out a strong sky wave with a small amount of ground wave. This will allow the powerful stations of the country to cover wide areas without interfering with receivers in their immediate vicinity.

How It's Done

At KDKA this effect will be achieved with eight individual antennae set on 110-foot poles ranged in a circle 800 feet in diameter. In order to send out a strong sky wave the antennae are so arranged that the horizontal radiations of each one will be "blocked off" by the signals of the other antennae. Thus the only way in which the major part of the signal strength can escape is upward whence it will be deflected back to earth at a distance by the Heaviside layer

This upward movement of the signals is compared to the action of a lawn sprinkler which sends its spray upward and outward so that it is distributed at a distance, but not immediately around the source.

The method of synchronization advocated by the Westinghouse group is that of generating a frequency and supplying it to one or more radio stations over either wire or radio facilities to be multiplied at the several stations sufficiently to be put out on the air as a carrier wave. Methods which do not depend upon a wire or radio connection between the stations have not proved satisfactory, it was said.

Wire Connections

Both the New England and Chicago synchronization projects utilize wire connections. At one time the Westinghouse organization effected synchronization between KDKA and KYW by sending the carrier frequency from Pittsburgh to Chicago by short waves. In this experiment the trouble caused by fading was avoided by the insertion of a mechanical link in the circuit at each station the inertia of which carried it over the period of fading. However the short wave means of synchronizing was carried on only as an experiment while the connection of the stations by wire is a thoroughly tested method.

New Insulator

A DESCRIPTION of Victron, a new insulator, is contained in a recent letter to the Editor from G. P. F. Smith of the Naugatuck Chemical Corporation, 1790 Broadway, N. Y. The data is so interesting we are passing the information along to engineers.

Victron is a synthetic resin which may be obtained commercially either in the form of a molding powder or in various shapes. The powder can be readily molded by heating to 120-140 deg. C. and applying moderate pressure. It is a true thermo plastic and can be remolded indefinitely. Objejcts molded from it under proper conditions are colorless and perfectly transparent.

It may be mixed with coloring ingredients and fillers to provide any properties or colors desired. The finished articles have a high gloss and require no polishing subsequent to molding.

Victron is an excellent dielectric and is one of the few known insulating materials which will withstand high frequency voltage. It has been subjected to frequencies up to 75,000 k. c. without being noticeably affected. At 100 k. c. it has a power factor of less than .03 per cent, a dielectric constant of 2.96 and a dielectric strength of 520 volts per mil. It is not affected by moderately strong acids, by inorganic bases, is not readily oxidized and does not absorb water.

It has a density of 1.60, a tensile strength of 3300 to 4000 pounds, a transverse strength of 6800 to 8000 pounds and a softening point of approximately 90 deg. C. It is readily machined and all the properties of the pure material may be readily changed over a rather wide range by the use of proper compounding materials.

Victron is soluble in such solvents as benzol, toluol, ethyl benzol, xylol, ethyl acetate, carbon disulphide, chloroform, carbon tetra chloride, aniline and pyridine. It swells in gasoline and turpentine. It is not affected by acetone, methyl, alcohol, ethyl alcohol, amyl alcohol, glycerine or mineral oils.

This material has been handled purely as a laboratory development but plans are underway which contemplate its commercial production and exploitation.

Des Moines I. R. E. Meeting

AN interesting sectional meeting of the Institute of Radio Engineers was held at Des Moines, Iowa, on December 28th in connection with the annual meeting of the American Association for the advancement of science.

At noon on December 28th the luncheon was held at the Chamberlain Hotel with Professor J. C. Jensen acting as toastmaster. Toasts were responded to by Professor B. B. Brackett, Vermilion, South Dakota; Paul C. Rawls, Des Moines, Iowa; H. D. Hayes, Chicago, Illinois; and Dr. E. A. Kennelly, Harvard University.

After the luncheon the technical session was held and covered approximately four hours time. The program as regards the delivery of papers was as follows:

"Problems of Television" by Professor R. T. Brackett, College of Engineering, University of Nebraska, Lincoln, Nebraska.

"Locating Radio Interference with the Oscillograph" by J. P. McNeely, Electrical Engineer, Iowa Engineering Experiment Station. The paper read by P. J. Konkle, Radio Engineer, Iowa State College, Ames, Iowa.

"Building Radio Transmitters for the Chinese Government" by Paul C. Rawls, Des Moines, Iowa.

"Variation of the Resistance of a Radio Condenser with Capacity and Frequency" by Professor R. R. Ramsey, Department of Physics, University of Indiana, Bloomington, Indiana.

"Should the Load Resistance of the Tube be *Rp* or 2 *Rp* for no Distortion?" by Professor R. R. Ramsey.

"The Measurements of the Magnetic Field Intensity inside of a Coil Carrying Radio Frequency Current" by Roy H. Mortimore, Graceland, Lamoni, Iowa.

"The activities of the Radio Inspection Service in the Middle West" by H. D. Hayes, U. S. Supervisor of Radio, Chicago, Illinois.

Then followed a symposium on educational broadcasting with the following talks: "The Public Demand, Courses Needed and Audiences Available" W. I. Griffith, Director Station WOI, Iowa State College, Ames, Iowa.

"Engineering Problems Involved" by Professor B. B. Brackett, Director Station KUFD, University of South Dakota, Vermilion, South Dakota.

"Organization and Finance" by Dean H. M. Crothers, Director Station KFDY, South Dakota State College, Brookings, South Dakota.

A great deal of credit for the success of the meeting was voted to Professor J. C. Jensen, Chairman of the Committee, from Lincoln, Nebraska, and the secretary S. T. Hutchison, of Des Moines, Iowa, both of whom labored arduously to make a record sectional meeting. Others on the committee were Charles A. Culver, Northfield, Minnesota, H. M. Crothers, Brookings, South Dakota and John H. Miller, Chicago, Illinois.

Removing Wire Enamel

A method used to remove enamel from copper wire, in the Valley Appliances, Inc., plant at Rochester, N. Y., has recently been disclosed.

The enamel on all sizes of copper wire is removed by shorting the wire between electrodes connected to a 75 K. V. A. transformer, the secondary having 2 volts and 375 amperes. This is used with variable resistance in the primary which controls the current, depending upon the size of the wire to be stripped.

The electrodes are placed the distance apart that the enamel is to be removed. The wire is heated to a cherry red and immediately dipped in alcohol until the wire is cold and then a clean bright copper surface is exposed which makes it very easy to tin. During the operation, the wire is annealed slightly, which helps in assembling the leads to solder lugs.

Production varies according to sizes of wire and the number of leads on the coil with the average is about 300 leads of No. 15 wire cleaned for a distance of 2 inches.

Does Away with Getter

ALTHOUGH it has been generally held by radio engineers and technicians that a getter or chemical clean-up must be employed in conjunction with a thoriated tungsten filament, the DeForest engineering staff has evolved a process which does away with the getter. This process, which is now employed in producing DeForest transmitting audions, avoids the Langmuir patent covering the employment of a vaporizable getter in conjunction with a thoriated tungsten filament, according to Allen B. DuMont, Chief Engineer of the DeForest Radio Company.

"We are producing three popular types of transmitting tubes employing thoriated tungsten filaments but without the usual vaporizable getter," states Mr. DuMont. "These audions are the 545 type, which is a 50-watt audio amplifier; the 511 type, or 50-watt oscillator; and the 503-A, or 50-watt R. F. amplifier. These audions clearly refute the claim made in the Langmuir patents, namely, that a successful thoriated tungsten filament tube requires a vaporizable getter, and establish a new principle in the radio tube art."

Haugh Joins Valley

Arthur T. Haugh, former president of the Radio Manufacturers Association and well known in the radio and automotive industries, has been elected vice-president in charge of merchandising of Valley Appliances, Inc., manufacturers of the Symington reproducer, at Rochester, New York.

Dunn with Sprague

According to recent advices W. L. Dunn, former chief engineer of the Colonial Radio Corporation, has joined Sprague Specialties at Quincy, Massachusetts, as head of their engineering department.

Mr. Dunn will be in charge of research work and it is felt that his experience in the designing radio receivers will be of great assistance in helping Sprague interests determine how they can further improve and adapt their products for use in radio circuits.

Radio Developments During 1929

By JOHN LISTON
(General Electric Co.)

THE recently developed line of hot-cathode mercury-vapor rectifying tubes has been applied generally to radio transmitters. The line includes tubes of various ratings from 0.6 to 20-amp. peak values of rectified current. The largest rectifier set so far constructed is designed to deliver 50 amp. at 15,000 volts, and the equipment is probably the largest high-voltage rectifier which has been produced commercially.

New Rectifiers

The hot-cathode mercury-vapor rectifier tubes used have remarkable efficiency. The particular type employed in this rectifier is capable of passing 20 amp. with a potential drop of only 18 volts. The potential drop in the tube is practically independent of the current, and for this reason care must be exercised when operating such tubes in parallel to make certain that each tube carries its share of the load.

A total of 18 of these tubes is used in the rectifier, arranged in three independent channels of six tubes each. Each channel is provided with a separate surge reactor which serves the double purpose of keeping the load equalized among the three channels and of assisting in the reduction of the 300-cycle ripple inherent in this type of circuit. (The line frequently is 50 cycles.) A common high-voltage condenser bank completes the smoothing network and results in a direct-current output having a ripple component of the order of 0.05 per cent.

Number of Advantages

The circuit used for each of the three channels is known as the "three-phase full wave connection" and has a number of advantages over the well-known "double Y" and "triple T" circuits, commonly associated with high-voltage rectifier practice. Chief among these is the fact that no special design is necessary for the plate transformers. Rectification occurs during each half cycle of each phase and consequently there is not direct-current component in the windings. Since rectification takes place over both halves of the cycle, the transformer windings are utilized to practically the same extent as they would be under alternating-current load conditions.

This circuit has long been known to the art but was not used extensively until the advent of the mercury-vapor tube because of the regulation which would result if the conventionel high-vacuum rectifier tube were used.

Any single channel can be used alone, or any two channels or all three may be used at once. The operating characteristics may be summarized as follows:

Input power: 2300 volts, 50 cycles, 3-phase delta.

Output power: 4000-15,000 volts d. c.; 0-50 amp. d. c.

Output ripple: Approximately 0.05 per cent.

Conversion efficiency at full load: 96 per cent.

Input power-factor: 92 per cent lagging.

Overall regulating from no load to full load: approximately 8.6 per cent.

Broadcasting

A new 50-kw. broadcasting transmitter incorporating modern features was constructed and placed in operation. By the system of linear amplification used, 100 per cent modulation is obtained; the output varying between 200 kw. and zero. Two tubes in the output circuit, are operated on the push-pull principle and the high-voltage d. c. power supply normally operated at 18,000 volts, is obtained by mercury-vapor rectifier tubes. Improved frequency stability is obtained by modern methods in the utilization of quartz crystals, which determine the frequency of the emitted wave.

Communication

To fill the need for high-power short-wave transmitters for communication purposes, improved designs having an output of 20 kw. at 14 meters, increasing to 40 kw. at 42 meters, were constructed; provision being made to shift rapidly between any two wavelengths in the band. Each equipment consists of a crystal-controlled exciter, a power amplifier and a rectifier. The methods adopted for mounting and operating the crystal result in considerably higher frequency precision and stability than were previously obtainable. Four water-cooled tubes are used in the power amplifier. Mercury-vapor rectifying tubes are used throughout the set; entirely excluding rotating machines.

Development of facsimile telegraphy for communication service, on the principles of picture transmission rather than Morse code, resulted in improved terminal apparatus; more extensive transmitting and receiving facilities at

Fig. 1. In this photograph is shown a power amplifier for 20 and 40 kw short wave transmitters, this being an improved design made by General Electric Co. having an output of 20 kw at 14 meters and increase up to 40 kw at 42 meters. Each equipment consists of a crystal control exciter, power amplifier and a rectifier

the Schenectady and California terminals of the developmental channel, and comprehensive data on propagation phenomena. Radio transmitters, receivers, and facsimile terminal equipment are now available for commercial use.

Airport Communication

Commercial aviation now receives weather reports and other data essential for safe navigation through the installation of a number of 2-kw. radio-telephone transmitters at many leading airports. A total of 47 of these transmitters will soon be in active service under the jurisdiction of the Department of Commerce, Airway Division, and

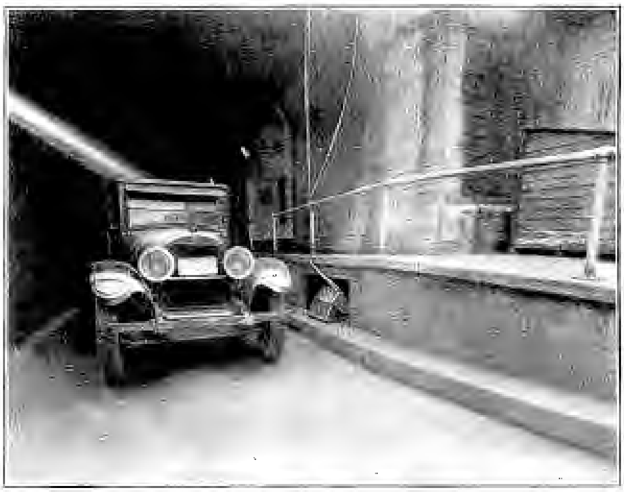


Fig. 2. Automobiles passing the exit end of one of the two-mile tubes of the Holland tunnel under the Hudson river are counted by means of a photo-electric tube and the count is registered on a dial located in the administration building. The apparatus consists of a small flood light mounted in an inclined position and projecting a slight beam of light upon a circular window in a box placed beneath the sidewalk at the opposite side of the roadway. The box contains a photo-electric tube, an amplifying tube and an electrical relay

seven were installed by the Transcontinental Air Transport Company. The equipment covers a frequency range of 100 kc. (3000 m.) to 550 kc. (545 m.). Continuous-wave and tone telegraphy are provided as well as telephony. The frequency band used for telephony is 300 kc. (1000 m.) to 350 kc. (850 m.). Provision is made for both local and remote control so that the operator need not be located near the transmitter.

A short-wave receiver was produced for the reception of communication and broadcast signals covering a frequency range of 1200 kc. (250 m.) to 25,000 kc. (12 m.).

Developmental Station

The short-wave transmitter at this station have continued to render reliable service in transmitting direct accounts of important events in world history to foreign countries. Events in connection with the Round the World flight of the Graf Zeppelin on three occasions were successfully broadcast through station W2XK, 17,300 kc. (17.3 m.) to European stations, where the programs were broadcast. Stations W2XAF 9,530 kc. (31.48 m.) and W2XAC 8,650 kc. (34.7 m.) were used regularly for transmitting to Commander Byrd and his party at Little America. A special directive antenna is used in conjunction with this service to insure reception in this far-off region. The regular evening programs of WGY are also broadcast through stations W2XAF and W2XAD. Station W2XCW, 2,150 kc. (140 m.) was utilized in connection with the development of television.

Carrier-Current Communication

Terminal equipment rated at 50 watts output incorporates a number of important improvements which mainly provide for increased flexibility in the transmission and reception of calls. By the use of a variable-band pass filter, a larger number of carrier channels on the same system of adjacent systems are

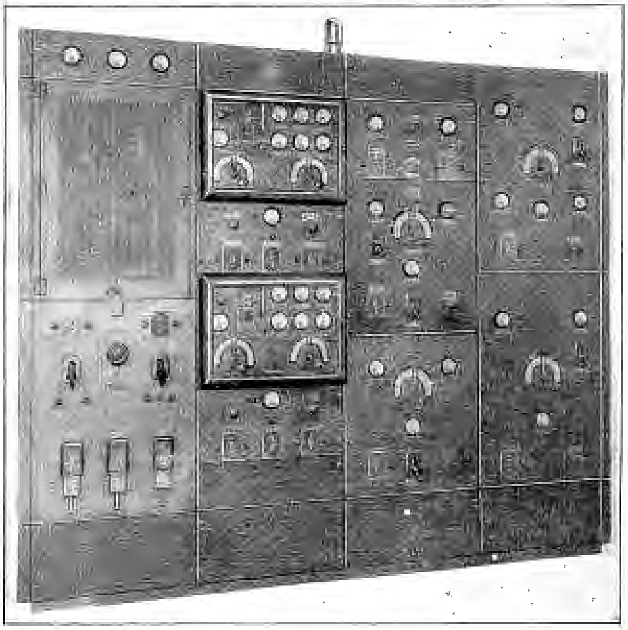


Fig. 3. This panel is one kw exciter unit, crystal controlled, for short wave transmitters and is the first unit of the short wave installation, the power amplifier unit having been illustrated in the photograph in Fig. 1

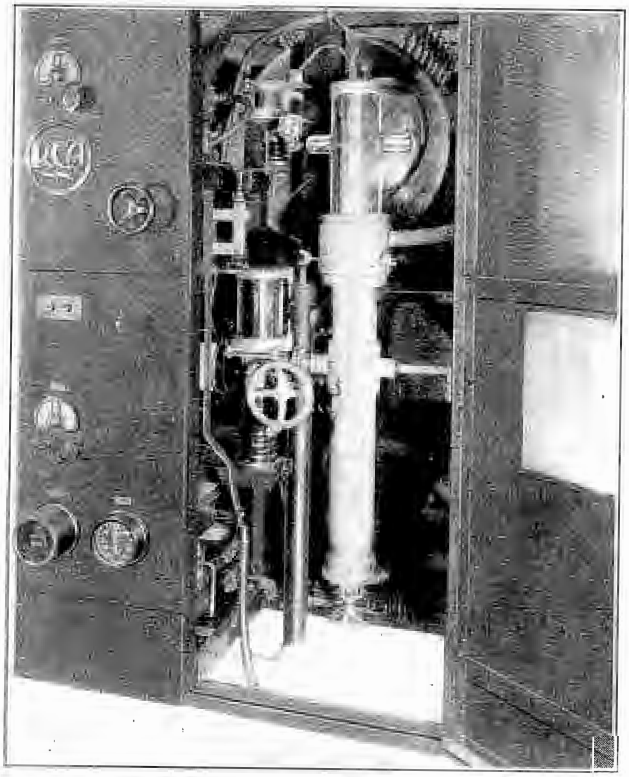


Fig. 4. This photograph represents a typical 50 kw broadcasting power amplifier. By the system of linear amplification used, 100 per cent modulation is obtained, the output varying between 200 kw and zero. Two tubes in the output circuit are operated in push-pull and the high voltage d. c. power supply normally operated at 18,000 volts is obtained by a mercury vapor rectifier tube. Improved frequency stability is secured by modern methods and utilization of quartz crystals which determine the frequency of the emitted wave

possible without interference between channels.

A new low-power equipment, known as the booth type, has already found wide application. The operation is simplex, the send-receive control being located on the combination telephone hand set in the form of a push-button switch. Provision is made for a selective transmission and reception of calls for inter-communication with all other types of G-E carrier-communication equipment. The power supply is normally from storage batteries but the set may be operated from dry cells, for intermittent service.

Vacuum Tube Applications

Thyratrons, the hot-cathode mercury-vapor tubes having a control element, are finding application to power circuit. By varying the phase of the voltage applied to the control element of these tubes in a rectifier circuit, the rectifier output may be controlled in a very efficient manner. Control equipment of this type was utilized for operating the lighting for the Chicago Civic Opera. The controlled output of the rectifier varies the saturation in an iron-core reactance, a secondary winding on this reactance being in series with the lights to be controlled. Absence of the inherent losses of resistance dimmer rheostats which in the case of the Chicago Civic Opera installation would be large since the total controlled lamp loa damounts to 1250 kw., and the provision for a flexible remote control are two outstanding advantages of this system.

Photo-electric control units were designed to operate relays by changes in the intensity of light and may be applied to the control of street lights, airport beacons, sign lighting, and similar uses.

One application of this type consists of a box, about the size of an ordinary radio-receiving set. On one end is a lens which allows light from the outside of a building to fall upon a photo-electric tube which is adjusted for a certain degree of daylight intensity. Whenever the light from outside falls below this point, it causes a relay to switch on the electric lights in the building. The operation is reversed and the lights switched off when the natural illumination is sufficient to meet the requirements.

Automobile Counter

At the exit end of one of the two-mile tubes of the Holland tunnel under the Hudson River, a photo-electric tube is utilized to count the number of vehicles that pass, and the count is registered on a dial located in the administration building.

The apparatus used consists of a small floodlight mounted in an inclined position and projecting a slender beam of light upon a circular window in a box placed beneath the sidewalk at the opposite side of the roadway. The box contains a photo-electric tube, an amplifying tube, and an electrical relay.

Every time a vehicle passes the spot, the beam of light falling upon the photo-electric tube through the window is interrupted, affecting the photo-electric tube so that a slight electrical impulse is created. This is amplified by the vacuum tube and fed to the relay. The latter energizes a transmission circuit, the other end of which is in the administration building where a registering dial is actuated by the electric current so that it turns, in response to each impulse from the relay.

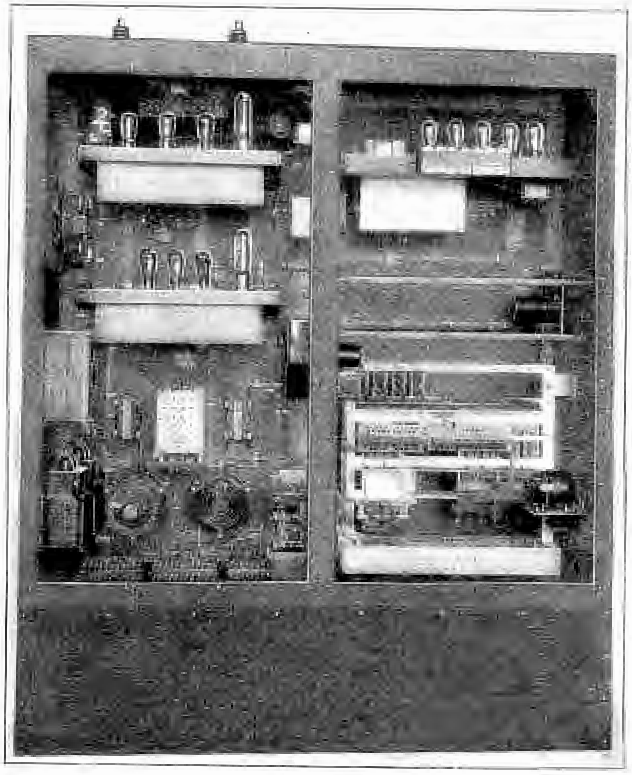


Fig. 5. In carrier current communication the terminal's equipment illustrated in this photograph is rated at 50 watts output and incorporates a number of important improvements which mainly provide for increased stability in the transmission and reception of calls. By the use of a variable band pass filter, a larger number of carrier channels on the same system or adjacent systems are possible without interference between channels

Vacuum Tube Becomes Heart of New Elevator Control System

(*Continued from page* 60)

the direction of which a passenger desires to travel. A corridor lantern also lights to show the passenger which car will be the first to reach his floor traveling in the desired direction. An operator receiving a signal from a floor push-button throws

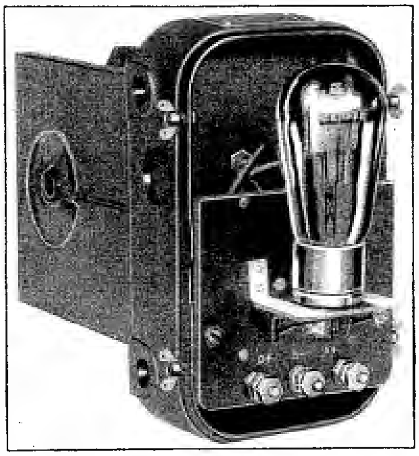


Fig. 2. In this photograph may be seen a typical car levelling unit, front view, with cover removed

his car switch to the off position and the car is stopped in the same manner as described.

With this system the operator does not need to know where he is in the hatchway and as long as he pushes the button for each floor called and shuts off his power switch each time the light flashes or the bell rings he knows that he will make every stop required.

Oscillation Fundamental

The fundamental frequency of these oscillators is set at a pre-determined point at the factory usually at 100 or 200 kc. On account of the partial shielding involved and the fact that they are operated in a building that is usually well shielded anyway, the possibility of interference to radio reception is extremely slight particularly in view of the fact that few receivers are operated in buildings of the type where these modern elevators are in use.

Amplification of Heat Voltages Is Used for Diagnostic Work

(*Continued from page* 59)

ignored when using the string instrument, but since the reverse prevails, the heart voltage cannot be detected through the string unless the skin voltage is first neutralized. This neutralization or compensation requires time and patience and must precede the taking of the record on each of the three leads. In some patients the skin voltage is variable to so great an extent that standardization becomes difficult and sometimes impossible. With the electrocardiograph as now designed the factor of skin voltage may be dismissed entirely. Also body resistance regardless of how high or how low does not change the sensitivity nor the deflection time of the galvanometer used in this modern apparatus.

Portability

Several of the features of such a unit used for diagnostic purposes are the fact that no over-shooting is possible on account of the galvanometer being immersed in oil, the apparatus also operates in daylight and therefore no darkened room is necessary. The special motor insures constant film speed and the elimination of a timing device means a greater accuracy in interpretation with no confusing lines on the film. With the portable outfit illustrated in this article it therefore may be seen that the machine may be carried to the patient in the hospitals instead of the reverse being done.

Radio Has Contributed Many Aids for Safety in Air Navigation

(*Continued from page* 51)

suggestion to the operator of the plane that he is to steer so that his two reeds shown as two color bands of white will be vibrating equally. This means, too, that when the color bands of white are uneven the pilot should steer towards the shorter reed. One advantage of this reed indicator claimed by the manufacturers is that with regard to direction through the air it gives information that the compass does not and cannot give. A compass of any type can at best only show the pilot either direction at the north or south or east or west in which he is flying. But the compass cannot tell him his position. On account of drift due to wing movement, a plane may while keeping its compass direction drift miles from its proper course. The drift hazard does not exist for the pilot who is using a reed indicator to follow a radio boulevard of the air.

The radio beacon likewise decreases the hazard from fog or rain or darkness. It is well accepted that the radio beam is the only one that will pierce a fog. Granting that the pilot is certain that his altitude is correct the radio beacon seen on his visual reed indicator enables him to fly securely through fog, snow, rain or darkness without the hazards due to loss of direction.

Radio Altimeter

From the foregoing paragraphs it has been seen that the pilot of a ship may know his directions and know whether he is on his course or not, but he is still in the dark, so to speak, as to his altitude. In the case of determining the altitude of a plane when flying blind, it appears that the recent altimeter developed by Dr. E. F. W. Alexanderson, consulting engineer of the General Electric Company at Schenectady, will fill a long felt need. This device is illustrated photographically in Figure 6 and Figure 8. Essentially it consists of a miniature transmitter and receiver, the transmitter projecting a radio wave downward and upon the echo of this wave being received the machine interprets the delayed echo in terms of altitude. Green, yellow and red lights give warnings corresponding to altitudes of 250, 100 and 50 feet. In the photograph shown in Figure 8 may be seen the radio set which transmits the radio wave and preserves the echo.

According to a recent release from the General Electric Company red, green and yellow lights familiar in railroad signals and in more recent years in highway traffic signals, have now been adapted to aviation in a new radio echo altimeter developed by Dr. Alexanderson. This new device is demonstrated for the first time at the All American Air Exposition held some time ago in Detroit.

Lights Show Height

However, the lights in the altimeter do not indicate stop, go and caution. In the Alexanderson altimeter which is illustrated in this article and been successfully employed in actual flight, the lights give a visual warning of depth to the flyer. When the green light flashes on the cockpit panel the pilot knows that he is 250 feet above ground; when the yellow light flashes he knows he is 100 feet above ground, and the red light gives a positive warning that the ground is only 50 feet below.

Nearly two years ago army flyers from Wright field consulted with engineers and scientists at the General Electric Company outlining to them some of the most serious problems of aviation. Among these problems they mentioned the importance of a method of measuring the absolute height above ground. In rain and in fog as well as in night flying the pilot has no means of knowing infallibly the distance above the ground and consequently the perils of operation under these conditions have been very great.

Dr. Alexanderson set to work on the theory that the time interval required for a radio impulse to travel from a plane to the ground and back again to its recieving set on the plane might be practically adopted as a reliable altitude indicator.

Visual Recording

The visual recording instrument is small and may be mounted on a cockpit panel in full view of the pilot. It consists of a meter on which ground distances up to 3,000 feet may be recorded, but it is in the lower regions that danger lies and it is to the recordings down to 50 feet that he has been most interested.

Because the time interval between the outgoing and the reflected radio impulse is so short, radio waves traveling with a speed of light, an indirect method of making such measurements was adopted by Dr. Alexanderson. In his experiments he used an oscillating receiver, one of the type which sends out a wave which may be picked up on other receivers as a squealing beat or note. The echo or reflected signal was picked up on the same receiver which sent out the wave. Dr. Alexanderson discovered that every time the airplanes changed altitude by half a wavelength a whistling note went through a complete tone cycle from low pitch to a high pitch and back again to a low pitch. By counting the cycles of the tone it was possible to measure the altitude, the measuring stick being one-half the wavelength of the antenna oscillator.

By means of the meter graduated from 3,000 to 200 feet the pilot may read his altitude within these limits at any time. The echos indicating height are periodic, becoming stronger as the plane approaches ground. The periodic character of the echo and the chance that the pilot would not see the instrument at the instant an echo was recorded presented a problem which Dr. Alexanderson has met by developing a memory meter. In this instrument the echo is recorded as altitude when it occurs and the meter continues to hold that reading until the stronger echo, indicating a lower altitude occurs. In approaching the earth the memory meter gives a continuous indication of altitude. If depth sounding be desired when climbing, in which process the echo is becoming weaker, a pushbutton may be used to eliminate the memory features of the meter and each succeeding reading is taken as an indication of the next echo. Thus a depth sounding may be taken at any time during the cruise whether the plane is ascending or descending.

An idea of the work being done in accommodating radio to the air transport industry may be secured from the recent statement made by Thorp Hiscock, chairman of the Aeronautical Chamber of Commerce, technical radio sub-committee, and chief of communication of the Boeing system, operators of the San Francisco, Chicago, Los Angeles, Seattle airmail express and passenger route.

Mr. Hiscock said that perhaps the greatest immediate progress in the development for aeronautical purposes has been shown by the Department of Commerce Airways Division under the leadership of Captain F. C. Hingsburg. During the last year the Department of Commerce weather broadcast stations have been established on the transcontinental airways from Boston to San Francisco, and the circuit from Los Angeles to Seattle is almost completed. These stations work in the thousand meter band and broadcast weather forecasts and local weather conditions to flyers as often as at thirty-minute intervals.

Beacon Network

In addition the Department of Commerce has installed radio range or beacon stations at approximately 200-mile intervals to assure flyers the ability of staying on the airway. Stations in operation at the present time extend from Boston to Omaha and the experience over this section has been most gratifying. The network is being extended to the coast and later will extend from Los Angles to Seattle in the west and into the south from Chicago. These weather broadcasts and beacon services are extended by the Department of Commerce as an aid to navigation and protection in the interests of safety and will lead rapidly to the decreasing hazards of flight.

It is recognized that in aeronautical communication and other radio facilities that the ground network must lead in installation. Thus it has been found that complete ground network must be installed and in operation before aircraft flying over these networks will be provided with the necessary equipment to take full advantage of the service offered.

Equipment Developed

According to Mr. Hiscock commercial development of particular equipment somewhat lags behind the desires and needs of the industry, but equipment manufacturers are fast taking up the slack and deliveries are now being made of aircraft units long desired by the operators. Receiving units prepared for installation and aircraft where everything must be by remote control are now developed. Light aircraft transmitters are available so that complete two-way communications may be had, which will function in mail planes having but a single pilot where both room and weight are controlling factors. Much development work has been done by these manufacturers in conjunction with air transport operators in the producing of this equipment.

As a result of work during the past year airport transmitters of low power capable of transmitting of a distance from ten to fifteen miles are available and will undoubtedly eventually be a requirement for those airports dseiring Department of Commerce rating. The installation of such transmitters will create a ground network making available to flyers carrying long wave beacon receivers local weather and landing information throughout the entire breadth of the country. These airport transmitters following regulations of the Federal Radio Commission of September 9th will function on a frequency of 278 k. c. Restricted range of these transmitters will permit practically all airports to function without congestion or interference on adjacent bands. The Department of Commerce will have its weather broadcasting and radio arranged so that by the installation in an airplane of a single receiver the pilot will have available weather reports, radio beacons and local weather and landing information.

An interesting example of the progress in this field is shown in the radiophone service which is practically completed on the San Francisco-Chicago division and begun on the Seattle-Los Angeles division of the Boeing system, air mail express and passenger operators of these routes. Twenty-two ground stations in nine states are being completed and 50 airplanes have been bonded, shielded and wired and the B. A. T. pilots are talking from altitudes as great as 12,000 feet to ground with stations 200 miles distant. In addition the pilot can receive with the same headset used for voice communication, direct from radio beacon service, an aural system of communication broadcast by the government. Thus the Boeing pilots have continuous communication, both voice and radio, with ground stations before and back of them. Operators regard radiophone as one of the greatest advances made in the history of commercial flying and radio within the next year will manifest itself in increased safety and higher performance records which the air transport companies will obtain.

Study Flying Conditions

In a recent booklet on "Aviation Communication," issued by the Western Electric Company, D. K. Martin, of the apparatus development department, says the first step in the Western Electric development program as represented by activities of the Bell Telephone laboratories was undertaken two or more years ago when a thorough survey was made of the communication requirements of the air transport. This was followed by the purchase of a Fairchild cabin monoplane with which intensive studies have been made under actual flying conditions. By the use of this plane a better understanding has been obtained of the requirements of such a communication system and a quantitative study has been made of transmitting conditions encountered in airplane operation.

Certain transmission studies, including radio field strength measurements have been made for many years in connection with the engineering of broadcast stations of the trans-Atlantic radio circuit. In this work, however, data was required only of the transmission efficiency between two points on the earth surface. For this new undertaking a third dimension, altitude, was involved and an additional difficulty was brought in due to the rapid change in position of the plane.

The first transmission measurements were made employing the laboratories plane flying from Hadley airport to New Jersey as a base. These tests were made in the frequency bands of from 285 to 315 and from 315 to 350 kilocycles which had been set aside for radio beacons and weather transmission service respectively. For measuring the signal received in the airplane the Western Electric field string measuring set, 44A test set of the type developed for use by the Department of Commerce was employed. This instrument was adapted for use in the airplane by substituting a short vertical rod antenna for the loop usually employed. Similar tests were made on the Pacific Coast by a field party in charge of R. F. Bair. From data secured a determination has been made of the sensitivity necessary for an airplane radio receiver to make it possible to receive dependably beacon signals and weather broadcasts transmitted by radiotelephone. In general it was found that at these frequencies transmission conditions between ground and an airplane was not greatly different from those existing between two points on the ground.

As a result of the investigations carried on a new and compact radio receiving set known as the Model 6008A is being manufactured by the Western Electric Co.

Radio Enthusiast May Put a Screen Grid Receiver in His Car

(*Continued from page* 56)

other from the untuned stage of r. f. to the two tuned stages, then the power detector and finally into the two stages of resistance coupling. It can be seen that each coil is completely shielded by means of neat, small metal cans. The straight line frequency condensers are of a fine, sturdy type to withstand the shocks due to the jolting of the car. The sockets are of the manufacturer's type and are marked for their respective tubes.

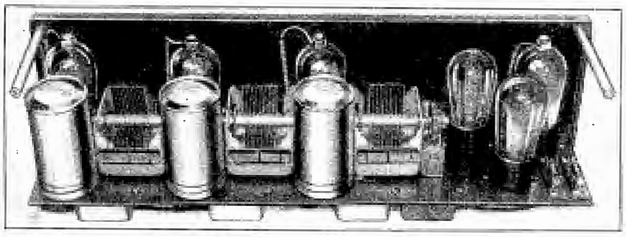


Fig. 3. The rear of the receiver is shown here after the cover has been removed

Examining the photograph in Fig. 3 at the extreme right will be seen the two small fuses, these being placed in the circuit so that if any difficulties arise the fuse will be blown and the receiver will not be damaged. By the same token if any trouble arises in the receiver itself it will not place a short on the lighting or ignition lines on the car itself.

According to the designer, the mounting and wiring of the receiver can be completed in about two or three hours. Each part has been selected for its quality as well as its usefulness in the direct application to this particular receiver. The steel chassis furnishes a set which is strong mechanically and attests its durability. The complete outside part of the chassis and shield cover is crystallized, which gives the receiver a finished and pleasing appearance.

The length of the "Voice of the Road" receiver is 18 inches, the height 6 inches and the depth 4 inches. These dimensions are the smallest possible that could be used without hampering the electrical design of the receiver.

Electrical Design

According to the designer, the electrical design of the "Voice of the Road" presented a problem of no small dimensions. The first thing to think of was the fact that a receiver of extreme sensitivity was needed. This of course is necessary due to the fact that most cars are completely shielded because they are constructed of metal. This prevents the impressed signal voltage from getting to the aerial, which is usually placed on the inside of the car. Three stages of screen grid of radio frequency amplification were chosen to obtain this desired sensitivity. These three stages were designed so as to give the greatest possible gain that could be obtained. This method of design completely swept aside any possibility of the use of suppressor resistors in the grid circuits. It therefore became necessary to choke and by-pass every possible place in order to prevent stray radio frequency currents from going where they should not. As the set is designed at present it is completely devoid of all oscillation if it is constructed exactly as shown in the various diagrams.

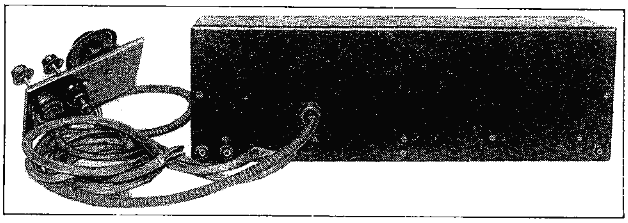


Fig. 4. The completed receiver is housed in a metal container, the flexible control shafting being shown at the left

Since it is necessary there be only one tuning control for simplicity in tuning, it becomes necessary to obtain some method of coupling the antenna circuit, so that a change in various lengths or types of antenna will have no effect on the tuning. There are two methods in which to obtain this effect. One is using a resistance in an untuned stage of radio frequency, and another is using a choke that would replace the resistor. There is no particular advantage of one over the other. The resistance was chosen because it is easier to connect in the circuit and also takes up less space, which is a prime factor of importance.

Coupling Method

In choosing the method of coupling between the stages of radio frequency the designer first thought of the impedance method. The impedance method necessitated the use of condensers. These condensers prevent the plate current from entering into the tuning circuit of the radio frequency stage, but if by chance the condenser were to short circuit, the "B" batteries might easily be ruined. In order to obtain a grid bias on the grid of the radio frequency stage a resistance must be placed in the circuit. The choke coil is inserted in the circuit in order to keep the high frequency signal out of the "B" batteries where it probably would feed into a preceding stage, causing the circuit to oscillate.

It can easily be seen that this means a plurality of by-passes and resistances, aside from adding to the weight and difficulty of wiring. The condensers and resistances always had high frequency fields around them, making it almost impossible to shield the circuits. All this results in a highly critical set, unsuited for anything but a laboratory. It was for this reason that the designer chose the r. f. transformer method, as being the most sensitive, dependable and efficient.

It was not found necessary to place choke coils in the screen grid leads to prevent oscillation, because the set is perfectly

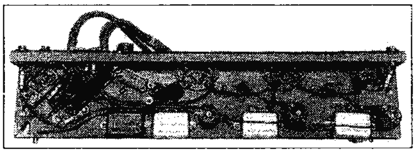


Fig. 5. This is a bottom view of the auto radio receiver

stable without anything more than a ½ microfarad across screen grid supply line.

The radio frequency plate leads must be choked in order to prevent oscillation. This is done with a 140 millihenry choke coil in each battery lead to the radio frequency coil.

Type of Detection

The next problem which confronted the designer was the type of detector that should be employed. The question here lies between the power detector and grid-leak condenser arrangement. The power detector is by far more suitable than the grid-leak type. This is because it becomes necessary for the detector to handle the great gain which is built up in the three stages of screen grid radio frequency amplification. The condenser and leak arrangement would overload if it was called upon to handle this gain. This in turn would cause the set to distort, giving a poor quality of reproduction in the speaker. The power detector in turn will handle this great gain without distortion and therefore becomes fixed in place. The A-27 is chosen and it fits admirably in its place.

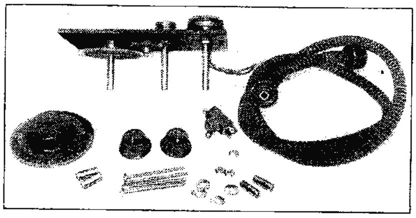


Fig. 6. This illustration shows the flexible shafting for control and the gearing arrangement for tuning the set

The next problem which needed attention was the type of audio system to use. Resistance coupled amplification was chosen in this case. Resistance coupled audio amplification will give as faithful reproduction as the best designed audio frequency transformer. From a point of view of weight it is apparent that the resistances are enormously lighter than the transformers. This fact alone is enough for one to appreciate the advantage of a resistance coupled amplifier in the set. The resistances are tucked in nicely underneath the panel, shortening the leads considerably and facilitating the wiring to a great degree. A 24 screen-grid tube is employed in the first audio frequency signal. A 12 is employed in the last stage.

Finishing the electrical discussion, one finally arrives at the following conclusion for the set:

The antenna feeds into a 24 tube through a 500,000 ohm resistance. The 24 tube feeds into a tuned transformer stage which supplies a second tuned transformer 24 stage, which in turn feeds the power detector 27 stage. The detector tube works into a 24 as a first audio, thence into a 12 as a power amplifier. The three radio frequency tubes are connected in series across the 6 volts "A" supply. While this means that the tubes have only 2 volts each, the reader may satisfy himself that 2 volts is all that is necessary to make these tubes work with full efficiency. The detector is in series with the first audio tube and also with a $\frac{1}{4}$-ohm resistance. This will allow $2\frac{1}{2}$ volts on both the detector and first audio. The output tube is connected across the low side of the $\frac{1}{4}$-ohm filament resistor and therefore has 5 volts impressed on its filament.

Remote Control

A remote control has been designed for the constructor which is very easy to put together. The method of remote control employs the use of a flexible shafting extending from the receiver to the control, which is on the dashboard. At the receiver end, a worm gear meshes with a flat gear, giving a gear ratio of 30 to 1. On the control panel at the dashboard a compound system of gears, of a 30 to 1 ratio reverses the vernier motion on the condensers. This method gives a direct reading dial on the dashboard and enables the operator to log his stations as he does on his set at home. The compound system of gearing, shown in the photograph at the dashboard comes completely mounted on a metal base plate. It is comprised of four gears which mesh 1 to 5 and then 1 to 6, giving a resultant motion of 30 to 1. These four gears are mounted on three studs, which are in turn mounted on the metal base plate mentioned above. Four long bushings are also mounted on the base plate for the dashboard mounting. At the receiver end the worm gear is coupled to the flexible shafting by means of a threaded collar and square key (which incidentally is the same at the control side). The threaded collar is part of bearing block for the worm gear. This bearing block gives the worm gear a positive motion. It prevents the slightest deviation from the proper movement of the worm. This last precaution is an absolute necessity because of the accurate motion which a worm must actuate in order that it operate correctly. The worm gear in turn meshes with a flat ground gear which is mounted on the shaft which in turn couples all the condensers. From the shaft on the condensers to the tuning knob the operator can be absolutely assured of a positive motion for every possible precaution has been taken into account.

The volume control and filament switch are arranged on a single knob. A five wire shielded cable supplied in order that the two leads necessary for the switch and the two leads necessary for the volume control be connected in their respective positions in the circuit. There are therefore only two controls on the dashboard. The main tuning knob and the volume and switch combined. Here we have as simple a tuning device as has ever been designed.

The "B" battery voltages are not very critical. It may surprise some to notice the designer is placing 135 to 180 volts on the plate of the detector tube. This high voltage is needed because he is employing a power detector which works at the top of the plate characteristic curve.

One will notice the chassis is so constructed the parts will fit in the proper places as specified in the construction directions. To insure absolute perfection in the operation of the "Voice of the Road" it is necessary to have every wire in its proper place in reference to the parts about it. This method of wiring is described in the diagrams which come with the parts. In order to do away with excessive shielding it was found necessary to make the resistors and condensers as small as possible.

Hi-Q 30 D. C. Designed by Hammarlund for Operation on Batteries

(*Continued from page* 53)

Curve D was made with all condensers phased at 1400 kc.

From these three curves it is shown that the condensers do not track over the entire wave band. Accordingly curve A was made with all but the antenna band pass condenser phased at 1000 kc. The antenna condenser was retuned every 100 kilocycles. From this curve it is seen that the majority of deviations in sensitivity is due to the variation of antenna load with a change of frequency which causes a change in effective inductance of the first tuning circuit, which throws this circuit out of resonance with the balance of the unit. It is probable that the curve would come down considerably on the low frequency end if the remaining tuning circuits were rebalanced at each test frequency. Curve A is by far the best as it shows a more uniform sensitivity over the band. The maximum sensitivity on all of the curves except B will average about 6 microvolts per meter which can be considered as very good sensitivity for this type of receiver. While for the most satisfactory operation of the receiver curve B may be considered as probably the one best suited for average use, inasmuch as the maximum sensitivity average is between 600 kc. and 1125 kc. which frequencies include the majority of high class stations. This condition will cause the high frequency end to be less sensitive and therefore the apparent selectivity on the high frequency stations will be greater.

On the selectivity curve shown in Fig. 5 are indicated selectivity as measured at 600, 1000 and 1400 kc. On the 600 kc. curve on the minus side it will be noticed that the rise is very sharp and has a slight flare at the top. It will be seen that a local station would have to have a field strength 100 times greater than that of the station on an adjacent channel before it would interfere, while on the plus side the rise is not as rapid as on the minus side. A local station on this side would only need to have 80 times the field strength of an adjacent channel station before it would interfere. The 1000 kc. curve flares more widely than at 600 kc. and would require only about a quarter of the field strength to give interference as on the 600 kc. curve. The two sides of this curve are almost equal. The 1400 kc. curve is rather an odd looking one. The plus side is quite average but the minus side falls off exceedingly rapidly and very likely it is due to the action of the tuning condensers changing in relation to each other. These curves were made with the receiver balanced at 1000 kc. and very probably the 1400 curve would change materially had it been balanced at that point.

Fidelity of the receiver is represented by the three curves shown in the fidelity graph, Fig. 6. The fidelity of this receiver is very uniform. The 1400 kc. curve is about as good as could be asked, having a very defined and rapid cutoff at 6000 cycles, falling off 30 db between 6000 and 10,000 cycles. The flat portion from 90 cycles to 6000 cycles is the natural characteristic of the amplifier where the cutoff is predetermined in the construction of the transformers. The 600 kc. curve has the cutoff beginning at 1000 cycles. While the amplifier has the power to amplify on high frequencies the extreme sharpness at 600 kc. cuts off the high frequencies and the curve is the result of selectivity. The 1000 kc. curve is between the 600 and 1400 kc. curve and follows in accordance with the selectivity curves in Fig. 5. However a 15 db loss is quite permissible in most amplifiers and it will be seen that the 1000 kc. and the 1400 kc. curves have this amount of loss at the very high frequencies, while the 600 kc. has this loss at about 4500 cycles. In general the fidelity of this receiver may be compared to that of the best. In general the receiver as a whole should be very satisfactory if and when it is properly adjusted to the given conditions of the locality in which it is being used.

Scott Designs Remote Control for His Screen Grid Super

(*Continued from page* 57)

buttons and a volume control knob, the latter shown in the right in the photograph. Eight of these buttons represent distinct station settings and the call letters of these stations may be placed in the little name plate alongside of each of the

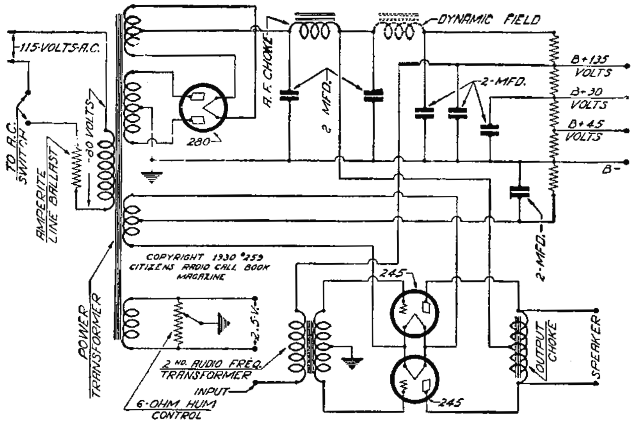


Fig. 3. The above drawing represents the schematic details of the power supply used in connection with the Scott a. c. shield grid 10 receiver

eight buttons. The cable used with the remote control is a very small one and its length may be varied in accordance with the distance required for the installation.

In the schematic illustration, Figure 2, custom builders will recognize the diagram of the Scott receiver, but with several changes made in order to use a 224 as the first detector and a 227 as the second detector. Another change may be seen in the use of a resistive-capacity coupling between the 227 and the first audio, as against a transformer coupling in the earlier models. The power supply used with the receiver is illustrated in Figure 3.

Curves Taken on H. F. L. Mastertone

(*Continued from page* 61)

probable that the audio frequency system alone would show a fairly flat response over the audible range, the cutoff being attributable to the selectivity of the r. f. and i. f. end of the receiver.

Measurement

It might be said that this receiver was measured with a dummy antenna having 200 mmf, 25 ohms resistance and no inductance, inasmuch as these receivers are operated on practically no antenna. Also these measurements were made with the standardized 30 per cent modulated carrier and that these curves would appear somewhat different under a condition of 100 per cent modulation, as occurs on the high powered, heavily modulated stations. For instance, the sensitivity would be greater, and the fidelity would be better.

Energy Collector Size

Referring to the irregularity of the sensitivity curve in Fig. 1 around 800 kc, it is found this is caused by using an antenna capacity for measurement that is in excess of the value for which the receiver was designed. Using 200 mmf. capacity in the dummy the 800 kc hump appears, whereas when measured with an antenna of 100 mmf (more nearly the value required for the operation of the set) the hump flattens out.

With respect to the off-shoot on the minus side of the 1400 kc curve in Fig. 2, selectivity, it may be stated that this action is linked up with the capacity of the antenna used in measuring, and bears considerably on the setting of the rocker arm on the trimmer condenser. With an antenna having 200 mmf as used in the measurement the rocker arm does not have quite sufficient thrust of capacity trimming to permit exact resonance. However, when a 100 mmf capacity is used in the dummy the rocker action can permit exact resonance. All of which points to the fact too large an energy collector should not be used on the receiver, unless the long antenna coil supplied especially by the manufacturer, is used.

Response Curves on Hi-Q 30 A. C. Set

(*Continued from page* 64)

as that of the d. c., probably due to the greater sensitivity of the a. c. over the d. c. receiver. The 600 and 1000 kilocycle curves are almost linear. The 1400 kilocycle curve is a little better than average on the plus side and quite broad on the minus side. This is due to the gang condenser being out of phase. By phasing the condenser at 1400 kc. the minus side would probably follow the pattern of the plus side.

Fidelity

Fidelity may be seen in Fig. 3. The 1400 and 1000 kilocycle curves are about average and the loss is not appreciable, but the 600 kilocycle curve is a little too rapid a loss for good quality on the high frequencies.

The measurements made on the receiver were in accordance with standard, the G. R. 403-C standard signal generator being used, with a 486 output meter of the same make, and a 377 G. R. audio frequency oscillator. The dummy antenna used was one having an L of 20 microhenries, C of 200 mmf and R of 25 ohms.

Lincoln DeLuxe 10 Response Curves

(*Continued from page* 65)

is rather low the selectivity curve at 1400 kc. would be more pronounced, and by the same process of reasoning if the 600 to 900 kc. region of the sensitivity curve is excellent then of necessity the same frequency region in the selectivity curve would be broader. Taken as a whole the selectivity curve is excellent.

An examination of the fidelity curve will disclose the fact that the flat portion of the curve is from 200 to 500 cycles, which generally takes in most of the speaking voice frequencies. The loss above 3000 cycles on the 600 and 1400 kc. bands will be noticeable to the ear while the loss on the 1000 kc. curve will not be noticed until 5000 cycles has been reached. The cutoff is very rapid on all curves above 5000 cycles. The loss on the low frequency end of the curves will not be noticed.

Very probably the sensitivity when measured at 400 kc is low because the antenna trimmer capacity was at minimum capacity and needed less capacity for resonance. When operated on the antenna recommended by the designer this receiver would therefore perform satisfactorily.

Amplifier With Universal Input and Output For Experimenters

(*Continued from page* 55)

combination of this safety factor with the fused transformer make it almost impossible to burn out the amplifier.

High Safety Factor

Small connector plugs make it possible to quickly change the set-up in which the amplifier is used since plugs may be permanently attached to any input and output circuits that are normally used. Although the input condenser to the filter has a very high safety factor, it is made in a separate unit so that it can be replaced in the rare instances in which this may be necessary without replacing the complete condenser block. This and many other precautions have been exercised in addition to the abnormally high safety factors have been used throughout.

In testing the amplifier, it is important to remember that its full capabilities can only be determined by having an input source and an output device which will supply both the very low and the very high frequencies. Where a pickup is used, for example, which is "down" on the bass and which cuts off at about 4,000 cycles, the difference is not evident on a casual test. With the increasing use of pickups having a better high frequency response, radio receivers with band selector circuits and other inputs with better high frequencies, superior performance will be increasingly appreciated.

Details Now Available for Practical Radiovision Reception

(Continued from page 62)

vision programs regularly, for the benefit of "lookers-in." These are the Jenkins radiovision stations broadcasting on weekdays as follows:

Station W2XCR, Jersey City, N. J., 139 meters, 3 to 5 P. M. and 8 to 10 P. M.

Station W3XK, Washington, D. C., 103-147 meters, 7 to 9 P. M.

(The hours are given in Eastern Standard Time.)

It is interesting to note Station W2XCR at Jersey City, N. J., frequently operates in combination with the DeForest experimental radio telephone transmitter, W2XCD, at Passaic, N. J., for the simultaneous transmission of pictures and sounds, or what are known as radio talkies. The DeForest transmitter operates on 187 meters, and the signals may be tuned in by the usual broadcast receiver, at the lower end of the dial. In the case of the Jenkins radio talkies, recently demonstrated to the public at local radio expositions, the programs, in the form of synchronized films and disk records, originate at the Jenkins studio. The picture signals are sent to the transmitter on the roof of the plant. The sound signals picked up from the disk record, are amplified and sent by direct telephone line to the DeForest radio telephone transmitter at Passaic. To receive the Jenkins radio talkies, a standard broadcast receiver is tuned to the sound component, while a radiovision receiver picks up the corresponding pictures. Synchronism is automatic and perfect.

For the present, the Jenkins programs comprise half-tone subjects, picked up from special films, with or without sound accompaniment, as well as silhouette or black-and-white subjects, also from films. There are test pictures which are transmitted for the purpose of checking up the efficiency of radiovision receivers by the lookers-in. Voice announcements are made between pictures, as well as at the beginning and end of each program, as contrasted with the code signals formerly employed.

Although the two Jenkins transmitters are licensed for 5-kilowatt rating, the usual service range of these stations is conservatively estimated at one hundred miles. Nevertheless, under satisfactory conditions the signals from both are being received successfully in many parts of the country, such as throughout the Middle West, South, and in New England. Therefore, most experimenters in the eastern half of our country are probably within reach of these two regular program stations.

Receiver, Amplifier, Radiovisor

Three elements enter into the reception of radiovision programs: (1) a suitable short-wave receiver, covering the 100-150 meter band in which radiovision signals are now transmitted; (b) a suitable power amplifier, designed for the critical requirements of television; and (c) a suitable radiovisor, or "unscrambler" to convert the audio signals into corresponding pictorial detail. It is well to include a loud-speaker, so that radiovision signals, with their characteristic buzz-saw note, may be tuned in readily, after which the amplifier output is thrown over to the radiovisor for visual reproduction.

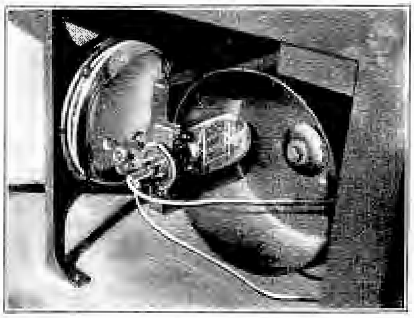
Aside from the foregoing equipment, the very first consideration is a good signal, with ample strength and properly modulated. Many television failures may be traced to insufficient signal strength. Whereas a "sound" radio signal may be considered quite powerful, since it operates the loud-speaker with ample volume, a radiovision signal must be at least that strong to modulate the television lamp, while a powerful sig-

Photo I shows a front view of the large Jenkins radiovisor showing the shadowbox and the control panel. This type of radiovisor has been seen by fans at the radio shows during the latter part of 1929. It is intended more for home entertainment than for experimental purposes

nal may be one which would be super-powerful with loud-speaker rendition. One reason for the powerful radiovision signal as a prerequisite, is that inductive interference, or so-called man-made static, is more troublesome in visual than in aural rendition. Hence the receiver should be relatively insensitive, depending on a powerful signal for maximum signal to background ratio. In this manner the pictures can be kept clean and free from streaks, blurs and troublesome patterns arising from "background noises." Fortunately, intermittent inductive interference, such as that from an oil burner or electric sign flasher, is not as annoying as in sound broadcasting, and may be hardly noticed. It is steady interference, such as that from a sparking motor, that causes the appearance of a steady and prominent blemish in the pictures.

The Radiovision Receiver

While the usual short-wave receiver may be employed for tuning in radiovision signals, it is usually impossible to obtain satisfactory half-tone pictures. The use of a regenerative detector may result in excessive selectivity, which shaves off the wide side bands of the radiovision signal, thereby taking away from the latent pictorial values. Also, the short-wave receiver, usually intended primarily for radio telegraph and possibly radio telephone signals, is incapable of amplifying



In Photo J may be seen the mechanism of the radiovisor, showing the scanning drum, television lamp and magnifying lens. The synchronous motor and the selector disc do not appear in this picture

Photograph K illustrates the latest Jenkins experimental console containing a model 200 radiovisor mechanism with the special Jenkins television receiver and loud speaker

the necessary wide range of frequencies called for with pictorial signals. With these drawbacks in mind, the Jenkins engineering staff has developed a suitable short-wave receiver especially designed for the peculiar and rigid requirements of radiovision. This receiver is non-regenerative. It permits of tuning in the entire signal width. It incorporates a power amplifier capable of handling all frequencies from 15 to 30,000 cycles. It contains a power pack for operation on 110-volt alternating current supply. Lastly, it has a single tuning control, with volume control and coupling control.

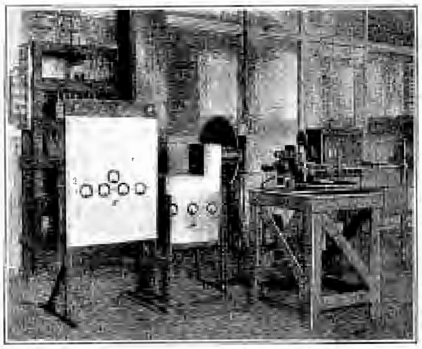
With the usual short-wave receiver, usually comprising a regenerative detector with one stage of radio-frequency amplification, perhaps with a screen-grid tube, fair silhouette or black-and-white pictures can be obtained. At least the beginner can start with a standard short-wave receiver, if same is available. However, the lack of detail in the half-tone pictures tuned in, must not be blamed on the transmitter but rather on the short-wave tuner which probably shears off the side bands by excessive selectivity, particularly when the regeneration is pushed to the utmost so as to strengthen the intercepted signal.

In Fig. 1 is presented the general scheme of a satisfactory short-wave tuner for radiovision reception. Inasmuch as the various constants are given with the diagram, it is unnecessary to go into such details here. Suffice it to state that only the best parts should be employed, for such a receiver is far more critical than the usual broadcast receiver.

Fig. 2 indicates the suggested layout for the components, but is offered here more to indicate how the parts are mounted in the case of the commercial job. For the home-made receiver, the components may be mounted on the usual breadboard, without regard for compactness.

The design of the radio-frequency end of the radiovision receiver involves the features of high amplification, band-pass

Photograph L shows the latest improved Jenkins transmitting scanning system with specially shielded amplifiers and a synchronously driven pickup for transmitting radio-talkies



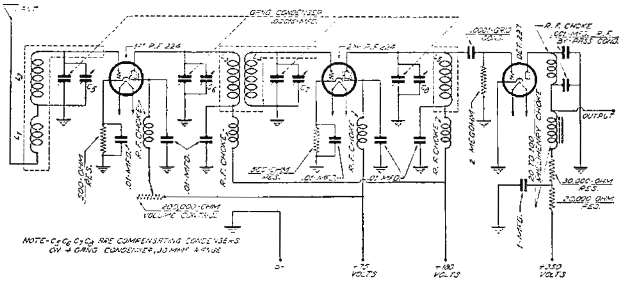


Fig. 1 shows the circuit of the r. f. end of the receiver, the constants and values being shown in the table below the illustration

Receiver Constants

L_1 = 24 turns No. 32 d. c. c. on 1" diam.
L_2 = 48 turns No. 32 d. c. c. on 1" diam.
Ends together
L_3 = 48 turns No. 32 d. c. c. on 1" diam.
L_4 = 48 turns No. 32 d. c. c. on 1" diam.
ends ½" apart
L_5 = 48 turns No. 32 d. c. c. on 1" diameter.
L_6 = R. F. choke.
L_7 = R. F. choke.
L_8 = R. F. choke.
L_9 = R. F. choke.
L_{10} = R. F. choke.
L_{11} = 20 to 100 millihenry choke.
C_1, C_2, C_3, C_4 = 4 gang .00015 condenser gang, shielded.
C_5, C_6, C_7, C_8 = compensators on 4 gang condensers, 30 mmf range.
C_9 = .0001 grid condenser.
C_{10}, C_{11} = .001 r. f. bypass condensers, detector plate.
C_{12}, C_{13} = .01 r. f. bypass condensers, r. f. cathodes.
C_{14}, C_{15} = 0.1 r. f. bypass condensres, r. f. screen grids.
C_{16}, C_{17} = .01 r. f. bypass condensers, r. f. plates.
C_{18} = 1 mf audio bypass condenser, detector plate.
R_1, R_2 = 500 ohm resistors, r. f. cathodes.
R_3 = 2 megohm grid leak, detector.
R_4 = 30,000 ohm resistor, detector plate.
R_5 = 20,000 ohm resistor, detector plate.
R_6 = 0-200,000 ohm variable resistor, volume control.

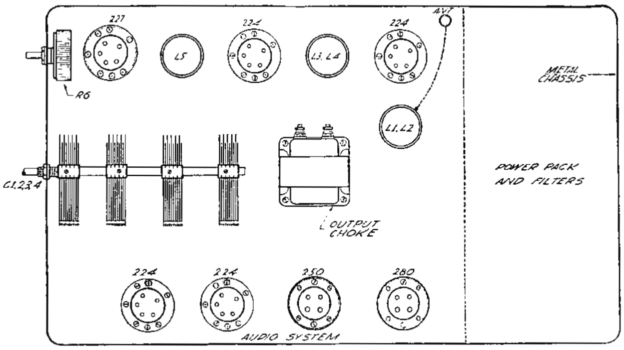


Fig. 2. This is a graphic layout of the parts for the r. f. receiver and its power supply

tuning, volume control, and stabilization. In Fig. 1 it will be noted that these features are provided for in the simplest possible manner, such as:

1. *Band Pass Tuning.*—The equivalent of a two-stage band pass filter is obtained, together with a tuned antenna, by using a four-gang condenser and slightly "staggering" the antenna and detector tuned circuits. The width of the band pass should be approximately 60,000 cycles.

2. *Volume Control.*—The use of a 0-200,000 variable resistor in the screen-grid of the first r. f. tube allows a volume

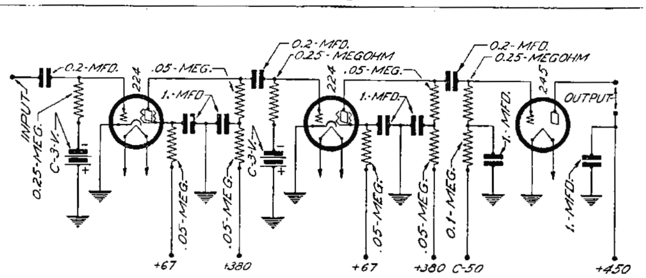


Fig. 3 is a switching arrangement for throwing the output of the radio set either onto the radiovisor or onto the speaker so the operator may hear the voice announcements which precede the transmission of pictures

Amplifier Constants

$C_1, C_2, C_3 = 0.2$ mf.
$C_4, C_5, C_6, C_7, C_8, C_9 = 1.$ mf.
$R_1, R_2, R_3 = 0.25$ meg.
$R_4, R_5, R_6, R_7, R_8, R_9 = .05$ meg.
$R_{10} = 0.1$ meg.

control range of about twenty to one, and does not disturb the selectivity characteristic.

3. *Stability.*—Stability must be secured by complete shielding of the r. f. coils, condensers, and tubes, as in the suggested arrangement shown in Fig. 2. If oscillation persists, it may be eliminated by lowering the d. c. voltages applied to the r. f. tubes.

4. *Sensitivity.*—A sensitivity of ten microvolts per meter is desirable for reception up to 500 miles from the transmitter. Assuming a gain of twenty in each r. f. stage, and a gain of six thousand from detector to television tube or neon tube (three-stage audio system), with 90 volts across the neon tube, the sensitivity is close to ten microvolts per meter. This gain is only realized by careful shielding and correct operation.

As for construction notes, the following points must be em-

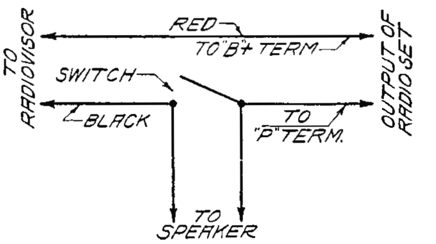


Fig. 4. This illustration is that of the audio amplifier whose constants are shown below the drawing

phasized in building the radiovision receiver:

1. *Shielding.*—(a) Tuning coils should be shielded with copper cans. (b) Gang condensers should be completely shielded. (c) Control grid leads should be shielded. (d) All d. c. supply leads must have filter choke and condensers on *each* r. f. stage individually.

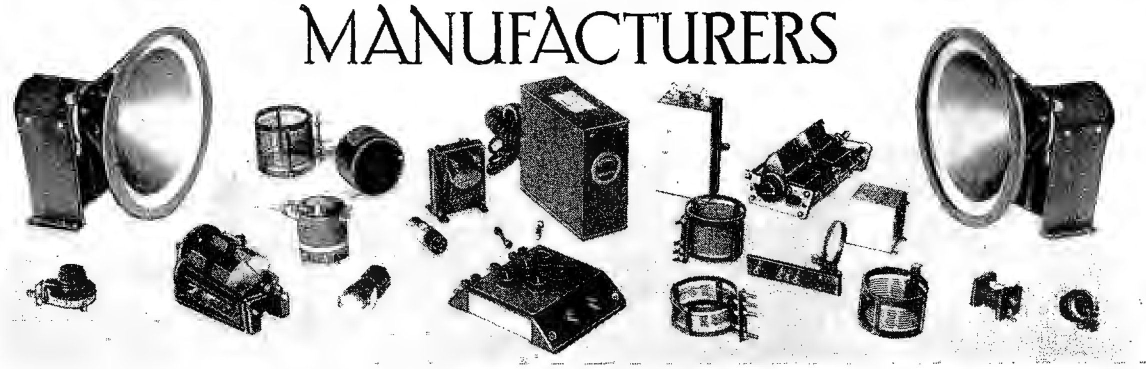
2. *Coupling of Tuning Coils.*—(a) The antenna should be closely coupled to the first tuned circuit. (b) The band-pass filter coils *L*-3 and *L*-4 should be fairly loosely coupled, spaced with one-half inch between their nearest ends, on a 1-inch diameter tube.

3. *Placement of Parts.*—The coil, tube and gang condenser of each stage should be as close to each other as possible, and the units of each stage arranged in successive order to prevent feed-back coupling from the detector to the antenna.

4. *Choice of Tubes.*—The use of -24 type tubes is recommended because this type offers high amplification, small A-C hum, and is non-microphonic. However, a -27 type tube has been found more successful as a detector because of its stability. Either a grid-leak-condenser or bias detector can be used, depending on the number of audio stages following and the type of output circuit, to give a "positive" picture.

(*Continued on page* 114)

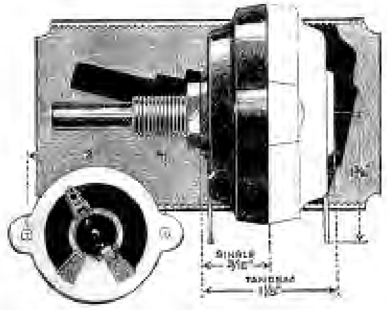
WITH THE ACCESSORY & PARTS MANUFACTURERS



Electrad Super-Tonatrol

TWO variable resistances are combined into a single unit in the Model B super-Tonatrol marketed by Electrad, Inc., an illustration of which is shown in this column.

A tapered resistor can be used in the antenna circuit while a uniform resistance operated by the same shaft can be used to control the screen voltage. The resistance variation in the antenna section is small during the first half of rotation of the shaft. The model B is available in usual sizes of resistances with practically any desired taper. The model B will dissipate three watts and is bakelite covered.



Ferranti Rectifier Meters

A NEW line of meters for radio use has been announced by Ferranti, Inc. Two types have recently been seen, one being a projecting pattern and the other the flush pattern.

Of especial interest are the Ferranti rectifier instruments for use on alternating current. The standard Ferranti 2½ in. radio instrument movements are combined with copper-oxide rectifiers to produce self-contained a. c. instruments having the following features: (1) High torque, equal to that of moving coil instruments; (2) efficient damping, again equal to that of ordinary moving coil instruments; (3) very small current consumption, which is constant for all ranges, unlike the majority of a. c. instruments; and (4) improved scale shape. Consumption is either 7.5 MA or 1.5 MA, and these figures apply to the 1 volt range equally. In the single range pattern these instruments are available in ranges from 0-1.5 MA to 0.50 MA, and from 0-1V to 0-250V. These instruments are supplied in the projecting, flush and portable patterns. They are correct on all power supply frequencies and wave-forms; peaked or other distorted wave-forms are not read correctly, as the calibration is r. m. s. volts. The instruments are corrected for temperature, the error being very small. Ferranti has tested these for frequency ranges of 20 to 6000 cycles per second and the errors are not greater than 1 per cent. This class of instrument is particularly suitable for low voltage and current ranges, and for cases where a very low volt-ampere consumption is essential. For general laboratory work the milliammeters and low range voltmeters are unequalled, combining low consumption with the robustness of switchboard instruments.

The rectifier instruments described above have been extended in range to include a micro-ammeter, the only one of its type available. The full scale deflection is obtained with 750 micro-amperes, and thus is of the utmost use for laboratory work both at power and at audio frequencies.

The volt-drop at full scale is only about 0.25 volt, so that its empedance is not prohibitively high as one of the moving iron or dynamometer types would be.

The instrument is corrected for temperature error, and its scale is nearly evenly divided from microamperes.

The impedance is not constant for different frequencies, increasing slightly with frequency and also varies with the current. This is only of consequence for bridge measurements, however, and can be allowed for.

Applications, beyond the obvious uses in a laboratory or test room, include telephone current measurements and as an indicator in electrolytic work.

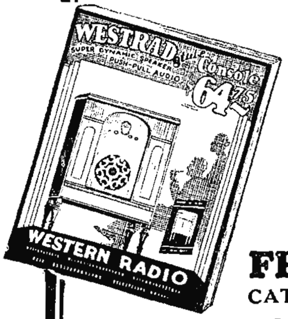
Supreme Tube Tester Model 50

THE Supreme Instruments Corporation of Greenwood, Mississippi, announces the Supreme Tube Tester Model 50.

The unit is self-contained and requires no batteries, drawing its supply from any cycle, 110 volt a. c. line.

A unique feature that is of great value, is the constant

(Continued on page 125)



(*Continued from page* 112)

5. *Power Supply.*—An A-C power pack is recommended because of the use of A-C heater tubes, and also to handle the heavy current drain of the output tube. In this case a bleeder resistor or voltage divider is necessary to provide the various operating voltages. but if a B-battery plate supply is employed, the voltages are taken off battery taps.

6. *Hum Control.*—The heaters should be in parallel and biased to plus 10 volts.

So much for the r. f. end of the receiver. The audio end should be of the resistance-coupled type, preferably employing the -24 or A-C screen-grid tubes for the highest voltage gain possible. Inasmuch as resistance-coupled amplifying circuits are common knowledge to readers of these columns, only one diagram is presented at this time. The simplest form of amplifier for the beginner in radiovision is a four-stage resistance-coupled unit, such as are available on the open market. Although the resistance values and voltages may not be absolutely correct, fair enough results may be obtained, and the experimenter may work out better values by actual experimentation. The point to bear in mind is ample output for the proper operation of the television or neon lamp. In the past, the experimenters have employed the -71 type power tube with 180 volts or less on the plate. The output from such a power tube is insufficient. The -45 type power tube is essential for satisfactory radiovision pictures. The usual television lamp requires 1.5 watts of undistorted input for good response. The voltage of the output circuit should be around 200 volts d. c., and the a. c. signal about 50 volts R. M. S. on the neon lamp proper.

In radio broadcasting, the modulated voltages are composites of frequencies ranging from about 50 to 5,000 cycles. Consequently, the transformer-coupled audio amplifier is capable of fairly satisfactory reproduction. In radiovision, however, the signal components cover a band of frequencies ranging from as low as 15 cycles, up to as high as 30,000 cycles. Obviously, the audio frequency amplifier of standard design is quite incapable of passing this entire band satisfactorily.

The high-frequency response of any amplifier is dependent upon the admittances due to shunt or stray capacities remaining negligibly low in comparison with those of the other circuit elements. Since the inherent stray capacities of transformer and impedance windings make it impossible to design a device that will cover the entire range, the television worker is limited to some form of resistance coupling.

In Fig. 4 we have the resistance-coupled amplifier developed by the Jenkins engineering staff for use with the Jenkins Radiovisor. This amplifier has a straight line of uniform reproduction from 100 to 10,000 cycles. While it decreases from 15,000 to 30,000 cycles, the decrease is not sufficient to impair the quality of the television image. The values in this circuit remain constant to the maximum practical degree. Filtering by means of resistances and condensers does much towards keeping the elements at their assigned values, by terminating each resistance effectively at ground and keeping the signal voltages out of the battery circuits.

In the Jenkins short-wave receiver now available, the r. f. tuner, power amplifier and power pack are included in the common chassis, with the correct values for maximum detail in the pictures.

Scanning Problems

Having tuned in and amplified the radiovision signals, the next and final step is to "unscramble" them. The scanning mechanism which is to the radiovision receiver what the loudspeaker is to the sound broadcast receiver, is generally a prolific source of trouble. Aside from the r. f. and audio ends of the receiver proper, the scanning disk is a contributing factor to poor results. Many scanning disks on the mar-

(*Continued on page* 116)

(Continued from page 114)
ket are inaccurately made, with improperly positioned holes that cannot weave a uniform pattern of lights and shadows. Many of the disks are not mechanically true, and therefore wobble to cause further distortion. The accuracy of any scanning disk may be readily tested by feeding the television lamp unmodulated or pure d. c. such as that from batteries or a good B-eliminator. When the disk is rotated at proper speed, there should appear a more or less solid and glowing pattern. If black streaks are noticeable, it is an indication of inaccurately spaced holes.

Another problem is that of synchronism, or maintaining the receiving disk at the same speed and in proper step with the transmitting scanner. In the earlier radiovision receivers, a variable speed motor was employed, with the variable speed control serving to bring the scanning disk into step and to maintain step with the transmitted signals. A push-button, shorting the series resistor in the motor circuit, served as an accelerator to get the pictures into step. More recently, however, the synchronous motor, operating preferably on the same 110-volt alternating current supply as the transmitter, has become the accepted synchronizing means. When operating on a common alternating current power system, it is possible to obtain virtually automatic synchronism. In the case of Station W2XCR, operating on the Public Service power system, there is an interconnection of power system extending throughout New Jersey, into part of New York State, and into Pennsylvania. The receiving scanner, in this instance, need only be brought into proper step with the signal, whereupon it maintains automatic synchronism. When operating on a different power system, the scanning disk can be readily kept in step by manual control, with little difficulty.

Still another problem is that of framing the picture in the vertical and horizontal planes. The vertical or up-and-down framing, necessary when portions of two pictures appear one above the other, is accomplished either by snapping the motor switch one or more times, or by shifting the aperture of the light source, as covered later on. The horizontal or left-to-right framing is achieved by shifting the motor frame or the aperture of the light source.

Fool-Proof Radiovisors

The various problems of scanning and synchronizing have had to be solved for the layman. To this end the Jenkins engineering staff has developed two simple, fool-proof yet positive forms of scanning mechanisms. First, there is the large model, intended for use in the average home living room, which comprises a large synchronous motor with control panel, a scanning drum and selector shutter, and a magnifying lens, contained in a neat cabinet with recessed opening or shadow-box through which the pictures are viewed by as many as six persons at a time. The control panel contains two switches, one to switch on and off the motor, and to be rapidly snapped for vertical framing, and the other to switch from loud-speaker to television lamp, to simplify tuning in the signals. In combination with the Jenkins short-wave radiovision receiver, this radiovisor comprises the simplest possible form of equipment for lay use.

Of far greater interest to the readers of these columns, however, is the small Jenkins radiovisor especially intended for experimental use. It represents the most compact arrangement of scanning and synchronizing means, and lends itself not only to immediate results under regular conditions, but also to changes and modifications in step with future progress of the art.

The small Jenkins radiovisor, shown in the accompanying illustrations, makes use of a novel form of motor. Two distinct motor elements are employed, namely, an eddy current motor, similar to the familiar watt-hour meter, which brings the disk up to speed, and a miniature synchronous motor which maintains the required speed of 900 R. P. M. Once the speed is attained, the eddy current motor merely serves to make up for losses due to friction and windage, so that the current through its windings may consequently be reduced to a minimum. The shaft that carries the scanning disk and the eddy current disk and rotor, is mounted on ball bearings so as to reduce friction to an absolute minimum. A speed control knob serves to bring the motor up to speed and to make slight adjustments in its speed. The operation is absolutely silent.

The pictures, although small, are exceedingly sharp and rich in detail, as viewed through the magnifying lens. The television lamp is contained in a lamp housing in the form of an adjustable elongated cover, with an oblong aperture at the side of the necessary dimensions for a complete picture frame. For framing, therefore, the lamp housing is raised or lowered, or turned from side to side.

Receiving the Radiovision Programs

The method of obtaining radiovision programs varies with the equipment available. However, supposing the reader has a short-wave receiver, power amplifier, and suitable scanner, the process is as follows:

First of all, the arrangement shown in Fig. 3 should be installed, for the purpose of switching from loud-speaker to television lamp, to facilitate tuning in signals. A similar arrangement is built into the large Jenkins radiovisor. With this arrangement, the switch is thrown to the loud-speaker position, or open, and the short-wave signals tuned in. These signals sound not unlike a buzz saw, with a rising and falling pitch. With the signals tuned in as loudly as possible, the switch is thrown to the radiovisor or closed position, and the radiovisor motor started. The single dot of light first seen with the scanning disk at rest, becomes a line, then several lines, and finally a glowing screen. With the disk out of synchronism, the signal will be evidenced by an irregular pattern in the field of vision. It becomes necessary to adjust the scanning disk speed and step until satisfactory pictures appear on the glowing screen. If a variable speed is employed, this may require considerable manipulation.

In the case of the small Jenkins radiovisor, especially when operating on the same power system as the transmitter, the process is relatively simple. After some practice the disk may be synchronized with small effort within a period of a few seconds, by following these directions:

1. Turn on motor by means of toggle switch.
2. Turn rheostat hard to the right so as to pass through and beyond synchronous speed.
3. Retard speed slightly by means of rheostat.
4. Reduce speed still further by braking with thumb and index finger on the end of shaft, until picture appears.
5. If the picture travels to the right, the power due to the eddy current motor is too great and the rheostat should be turned to the left. If it travels to the left, the power should be increased as the frictional load is too great for the synchronous motor to handle.
6. When synchronism has been attained, the motor will "hunt" slightly. If left alone, this will correct itself by gradual decay of the oscillating motion. However, it may be rapidly corrected by tapping lightly on the shaft as the picture swings toward the right.

Once synchronism is reached, the picture may appear out of frame either horizontally or vertically. The lamp shell or housing is movable, and should be shifted to the correct position so as to center the image properly. If operating on a power system different from that of the transmitter, the speed may be regulated with the rheostat and with the braking of the fingers on the shaft, with little difficulty.

Television standards assume a picture of 48 lines transmitted 15 times per second. There are experimental off-standard stations utilizing off-standard scanning mechanisms. The Jenkins radiovisor is provided with a disk having 48 apertures per spiral, but 24 and 60 hole disks are avilable to experimenters, together with rotor elements to give a speed of 1200 R. P. M. for 20 pictures-per-second signals. The rotating elements are readily interchangeable by removing the rear pedestal carrying the synchronous motor coils and the lamp housing. Also, when operating on different power system than that of the transmitter, there is being made available a synchronizing attachment which operates from the radiovision signal itself. This attachment will soon make possible automatic synchronization without regard to a common a. c. power system.

A Field for the Experimenter

By means of the radiovisors recently developed, the experimenter can engage in successful radiovision reception from the start, without having to pass through the slow, tedious and often discouraging steps encountered in home-made equipment and the home variety of engineering. However, the small Jenkins radiovisor, which represents no greater investment than the usual driving motor, speed control and scanning mechanism, permits of immediate results yet at the same time admits of alterations and changes in keeping with experimental progress. With interchangeable scanning disks and rotors, the experimenter may tune in different signals.

Television is certainly here—today—especially for the experimenters. In fact, it is on the experimenters that this art must rise or fall. Just as experimenters developed sound broadcasting in the early days, so that it might become a commplace institution and a vast industry, so radiovision now beckons to the experimenters of the world for a similar interest and ardent support.

Radio Engineering

(*Continued from page* 90)

sidered successively in a sequence and the geometric order in the sequence is represented as a time order in a signal train. The transfer from one order to the other is called scanning.

From halftones it is found that to approximate a good index of detail in a portrait view of one person, about 25,000 elements are required.

At the extreme facsimile speeds now available, such a transmission requires at least two seconds. Since a single television transmission must be completed in about 1/20 second, we are restricted to about 1/40 x 23,000 elements. In fact we do find 576 elements almost standard for present television transmissions. Generally an attempt to exceed this number meets discouraging failure.

Since it is obviously absurd to transmit less than the full portrait view of the subject, our index of detail must be lowered. The result is much as if the subject were photographed through a screen at a distance, with a narrow angle lense.

Mechanical methods of scanning seem to be at the root of much of our trouble. A representative device is the scanning disc first described in 1884. In photography it finds a counterpart in the pinhole camera. At any instant light is admitted to the screen through a pinhole corresponding to one element, which is at that moment illuminated to some normal brillance. Since all elements must be viewed equally in the sequence, the average brilliance equals this normal brilliance divided by the number of elements. For the 25,000 element picture this gives us a factor of 4.23 x 10^5 to obtain our average brillance. Since the optical system must be capable of flooding the whole screen to normal brillance, the total light efficiency is innersely as the square of the number of elements, or, for our 23,000 element picture, 1.9 x 10^7 per cent.

Considerable improvement can be effected through lense and prism discs, mirror wheels, drums, optical levers, and similar devices, but always, it seems, with some added complication which offsets the theoretical gain. Thus in wheel and drum devices the scanning sequence may be made to encircle the drum several times, and the diameter reduced. However, the speed is thereby increased. Other devices increase the light efficiency through reducing the total amount of light developed. Unfortunately light efficiency is not a very significant quantity—increasing this does not necessarily increase picture brilliance.

Illumination Decrease

So far, every scanning system developed imposes a prohibitive decrease in illumination, and in overcoming this we are confronted with a prohibitive increase in size, or speed, or mechanical and optical complexity. Viewing the situation as a whole, it does not seem that mechanical scanning systems offer much promise, though we do not at present know of any other.

One reason for the tolerance of mechanical scanning and its accompanying low average illumination is distrust of extreme brillance in scanning spots.

According to Fechner's law of sensation, eye response is a logarithmic function of brillance. Hence it has been stated that in scanning the eye response should be as the time average of the logarithm of the spot brillance.

Retinal Adaptation

However, Fechner's law describes a retinal adaptation which takes some seconds. It does not apply very well for short pulses of light. For example, who of us has not watched the countryside during a thunderstorm at night? Frequently the illumination reaches a value which applied persistently would dazzle and blind, yet applied in a very short pulse, it brings extraordinary vision.

If in a visual field of low brilliance we introduce a point of high brilliance, only a small area of the retina saturates. Normal vision persists in the rest of the eye, provided the total light entering the eye is not much increased. If now we remove the brilliant point, the saturation persists momentarily as indicated by the insensitivity of this one small region. Hence in studying the nature of eye response, it should make little difference whether we illuminate areas successively or simultaneously.

Acting upon this supposition, we have begun, at Brace Laboratory, an investigation of eye response to intermittent illumination. We have used twenty light pulses per second, each of 500 micro-seconds duration. This gives an average brilliance equal to 1 per cent of the peak brilliance. This is balanced in a Lummer-Brodhum photometer against a persistent illumination.

We seem to be finding eye response to be much greater than the logarithm of average brilliance. This is true even when the peak brilliance runs far up into the region where the eye is supposedly saturated. It looks very much as if we shall be able to use small scanning spots of high brilliance when we can produce them.

Whole fields of problems are involved in television. Probably the afternoon would not be sufficient to review them. However, the present key problems seem to be, first to effect a scanning much more thorough than any now used, second to increase many fold the brilliance of the received image, and third to determine the actual eye response to such a brilliant scanning.

More Loftin-White Data

After pages 87 to 89 of this issue had gone to press one of the staff who was experimentally inclined hooked up the circuit shown in Figure 1 on page 120, which is the three tube Loftin-White and used it as a local receiver on Chicago stations. The quality was excellent, signal strength very good considering it as a detector, non-regenerative, and selectivity (not measured) was good on locals, since every one of the local stations was picked up on good speaker volume. WIBO with the weakest signal strength at the laboratory had sufficient kick to give a reading of .050 watts on his modulated carrier. All other Chicago stations had a stronger field strength than the first station mentioned.

(*Continued on page* 120)

Receiver Response Curves and How They May Be Interpreted

Interesting Account of the Steps and Equipment in the Measurement of a Radio Receiving Set

By R. K. Pew
(Technical Editor)

BEGINNING with this issue we are publishing curves on factory and kit made receivers by which the reader may very readily compare the different receivers. The Standardization Committee of The Institute of Radio Engineers set up a method for the standardized measurement of radio receivers for sensitivity, selectivity and fidelity. The fundamentals of this standardization are as follows:—(1) An audio frequency source being capable of a varying frequency from 30 cycles to 10,000 cycles and sufficient voltage output to modulate a radio frequency oscillator 30 per cent. (2) A radio frequency oscillator having a calibrated frequency range of 550 to 1500 kilocycles. (3) A calibrated output attenuator calibrated in terms of micro-volts R. M. S. (4) A dummy antenna having a self inductance of 20 micro-henries, 200 micro-microfarads and a resistance of 25 ohms. (5) An output meter calibrated at .050 watts (50 milli-watts) with a continuously variable impedance load from 10 to 10,000 ohms.

Set Up Sequence

In Figure 2 is graphically illustrated how these various instruments are connected in respect to each other. All sensitivity and selectivity measurements are made with a modulation frequency of 400 cycles with thirty per cent modulation. The fidelity curves are measured by the standard transmission-unit formula (Voltage ratio log X 20) figured on a basis of 400 cycles as the index line.

Sensitivity

The first measurement is usually for sensitivity and is made as follows: The receiver to be measured is set up turned on and very carefully balanced and phased so that it is operating at the most efficient point. The output meter is connected and the radio frequency oscillator started and tuned to 600 kc. The receiver is then very carefully tuned to this frequency and the input adjusted until the output meter registers .050 watts. The input to the receiver is calibrated in terms of micro-volts R. M. S. and the reading as indicated is the sensitivity in micro-volts (field strength). To obtain the sensitivity in micro-volts per meter it is only necessary to divide the micro-volts by 4 which gives the sensitivity in micro-volts per meter for a four meter antenna, which has been adopted as standard for measurement purposes.

Curve Plotted

These measurements are made at every one hundred kilocycles from 600 to 1400 kc and plotted on cross section paper as illustrated in Figure 3. Of course the less micro-volts per meter the more sensitive the receiver and vice-versa. When comparing two receivers care should be taken that the divisions on the left of the graph are in relation to each other, if not your deductions might be false.

Looking at Figure 3 the sensitivity at 1400 kc is approximately two micro-volts per meter, at 1300 kc 2.75, etc., until at 600 kc the sensitivity is 13 micro-volts per meter. The desirable sensitivity curve would be a straight line from 1400 to 600 kc but this is hardly possible due to the change in L C ratio over the frequency band. The sensitivity as illustrated is very good average sensitivity.

Selectivity

The selectivity measurements are usually taken next. It is necessary to make all selectivity measurements at the receivers most insensitive point in order that all of the curves will start at the same place at resonance. And usually the measurements are made with a base of some number of ten such as 10, 100, 1000, etc.

Some of our first measurements were made with 10 and 100 as a base which later was found to be not entirely satisfactory as it did not lend an entirely satisfactory means of direct comparison. Hereafter all measurements will be based on a field strength of 1000 micro-volts, except in cases where receivers have an automatic volume control which would create the necessity of using 10 or 100 as the base line.

The procedure of measurement in this case is as follows: The oscillator is adjusted to 600 kc and the receiver is tuned very carefully to this frequency. The attenuator is adjusted to 10, 100

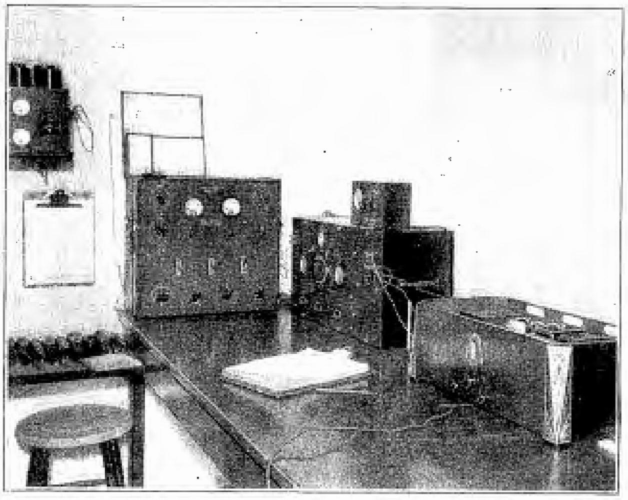


Fig. 1. In this shielded room all measurements on receivers and kits are made as described in the accompanying article by Mr. Pew. The nature and functions of the different units shown in the picture are explained in this article

Fig. 2. This is a graphic idea of the apparatus used and its sequence

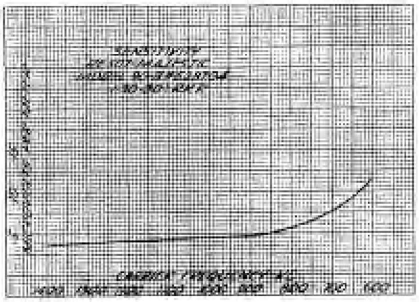


Fig. 3. Sensitivity curve

or 1000 micro-volts, as the case demands, and the volume control adjusted until an output of .050 watts has been attained. The oscillator is then varied a definite number of kilocycles off resonance from the receiver in both directions and in each case the oscillator output is increased until the receiver output has again reached .050 watts. These readings are recorded for all frequencies and a curve is plotted from these figures. The same procedure is repeated at 1000 and 1400 kc. The three curves are plotted on three cycle cross section paper as illustrated in Figure 4.

Looking at Figure 4 it will be noticed that at 600 kc the receiver is more sharp than at 1000 kc and 1000 kc is more sharp than at 1400 kc. This is the usual case with a tuned radio frequency receiver. With the superheterodyne receiver it is some times just the opposite as will be seen in the selectivity curve on the Lincoln Deluxe Ten on page 65 of this issue. The ideal selectivity curve would look like a U with its widest point five kilocycles each side of the resonance point. And the selectivity would be the same at all frequencies, but of course like other ideals this is not obtainable, at least not yet. Referring again to the Lincoln it will be seen that this receiver is exceptionally sharp which causes what is known as sideband cutting which will have a tendency to cut off the overtones making the quality somewhat flat. Referring to the selectivity of the Scott A. C. Ten on page 120 it will be seen that the selectivity, while not as great as the Lincoln is very good and does not suffer from sideband cutting. It will also be noticed that the three selectivity curves are almost parallel which means that the selectivity over the wave band is almost the same. Referring to the Braxton-King selectivity curves on page 121 it will be noticed the selectivity curves are more like each other than in the case of Scott's receiver. However the selectivity is not quite as good as in Scott's. The selectivity on all three of these receivers is exceptionally good and the difference, especially between Scott's and Braxton-King is so slight that it is questionable whether the operation of these two receivers could he determined as to which was the more selective. The selectivity of the Majestic as illustrated in Figure 4 is quite good for a tuned radio frequency type of receiver. The plus side of the 1400 kc curve is somewhat out of shape with the minus side. This is probably caused by the tuning condenser being slightly out of line at these points.

Fidelity

The procedure in measuring fidelity is as follows: The oscillator is adjusted to 600 kc and modulated 30 per cent at 400 cycles and the receiver very carefully tuned to this frequency, the output of the oscillator is then turned to most any place such as 200 microvolts and the volume control of the receiver adjusted so that the ouput meter indicates .050 watts. The frequency of the low frequency oscillator is then varied at the standard measuring frequencies between 30 and 10,000 cycles

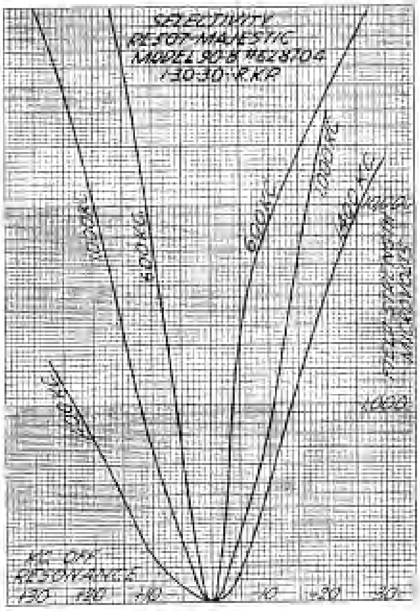


Fig. 4. Selectivity curves

always keeping the radio frequency oscillator modulated 30 per cent, and the radio frequency oscillator output varied up or down, as the situation demands, to maintain .050 watts in the output circuit. The values of increase or decrease in microvolts from the original setting at 400 cycles are noted. The ratio between the setting at 400 cycles and the other frequencies are figured and the logarithm of this number is determined and multiplied by 20 and the result is either loss or gain in DB's.

These figures are then plotted on 3 cycle cross-section paper as illustrated in Figure 5. Looking at Figure 5 it will be noticed that the high frequencies do not fall off evenly. This is due to selectivity. The greater the selectivity the greater the fall off at the high frequencies. It is entirely possible that if

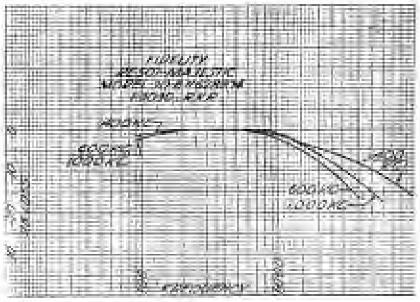


Fig. 5. Fidelity curves

the audio frequency amplifier were measured alone the curve would be nearly flat all the way to ten thousand cycles. Just because the fidelity curve of a receiver may not be so good it does not indicate that the quality of the reproduction will not be good as in most cases the speakers used are so designed that they have a rising characteristic where the receiver has a decrease. In any event the worst possible thing that could happen would be a thinness in the high frequencies and a lack of overtones and harmonics which are required to give the fullness of tone so desired. A poor fidelity curve does not indicate distortion as distortion is caused by too great a harmonic content of the frequency impressed.

The I. R. E. has designated the greatest amount of harmonic content permissible as 5 per cent. We have made no measurements as to distortion yet, but probably will in the forthcoming issues. The amount of DB loss in a receiver that is permissible has not been determined as far as we know and it is difficult to say just how much loss will be determined by the ear as such loss that is appreciable to the ear depends upon the individuals and the type of music that is being played. A little loss on some music will be very noticeable while a great deal of loss on other types of music will not be noticed. Therefore it would not be fair to judge a receiver too harshly if it does not have a fidelity curve which is above average.

The Equipment

Just a few words about the equipment which is being used in our laboratory for making these measurements. Looking at Figure 1:—The large square instrument on the left is a General Radio low frequency oscillator type 377 which has a frequency range from 60 to 90,000 cycles. The instrument to the right of this oscillator is the General Radio standard signal generator type 403-C which has a self contained calibrated attenuator. The small box on top of the standard signal generator is the General Radio type 486 output meter which consists of a copper oxide rectifier and a constant impedance network of 4,000 ohms. When the output impedance of a receiver prohibits the use of this meter a General Radio type 426-A Vacuum Tube Voltmeter with an associated resistance network is used. Optimum output coupling is maintained, as near as possible, on all receivers. The entire outfit is placed in a shielded room made of galvanized iron lapped six inches on either side of the seams and soldered. The shielding is so effective that with the door closed and a very sensitive superheterodyne operating the 5,000 watt station which is located across the street can not be heard. The receiver is absolutely dead. The a. c. lines are brought into "King Tut's Tomb" through individually shielded wires which are bonded every six inches. The a. c. lines are also very carefully filtered to eliminate any trace of line noise that may be occurring.

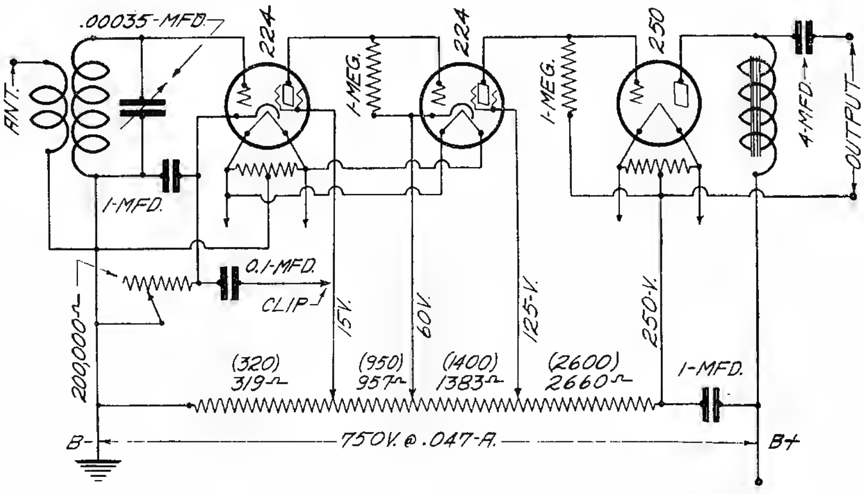


Fig. 1. The circuit of the 3 tube Loftin-White is here illustrated

Loftin-White Data

(*Continued from page* 117)

The values of resistance shown in Figure 1 will be quite satisfactory for average conditions of the 3-tube combination. However, by means of a standard signal generator and an output meter the response of the set may be run up quite a bit, even though the hum level also comes up with the signal level. For example, with the exact value of resistances and voltages shown in Figure 1 the sensitivity of the set at 600 kc would be around 8,000 to 8,500 microvolts. Then when adjusted with the signal generator for maximum output the sensitivity of the 3-tube set would be around 5,000 to 5,500 microvolts. However, in too greatly increasing the sensitivity of the layout the hum level came up too much. This hum level is apparently due to the incomplete filtration and choking in the 281 used as a half-wave rectifier in the power supply.

For Tinkerers

For those who wish to tinker with the circuit several interesting things may be mentioned. The resistor in the cathode-ground lead of the first 224 should be a 200,000 ohm variable. It should be varied until the current in that circuit reads 20 microamperes. At that position this tube operates best as far as detection and amplification is concerned.

Probably this would not be the best operating point if the r. f. signal input was inordinately increased, but for gen-

Family of Curves on Scott A. C. Ten

THREE curves on the Scott A. C. Ten are shown on this page in Figures 1, 2 and 3.

The sensitivity as illustrated in Fig. 1 is merely relative as the actual sensitivity on the receiver was so far below one-half microvolt per meter that it could not be measured. The sensitivity curve shows the general outline as to the amount of relative sensitivity over the wave band, showing greatest sensitivity at 1400 kc and least at 600 kc.

The selectivity curves are illustrated in Fig. 2. It will be noticed that all three curves are nearly alike. For practical purposes they might be drawn as one curve. This feature is a very desirable one inasmuch as it indicates the selectivity is the same at any place in the broadcast band. There is very little tendency at any frequency to have very much flare.

The fidelity curves as shown in Fig. 3 are what may be expected from glancing at the selectivity curve, having a flat characteristic from 200 to 1300 cycles. The high frequency cut off is not as rapid as some receivers which have been measured in our laboratory, but the harmonics and overtones will be cut out to some extent. This type of fidelity curve is characteristic of the selectivity and cannot be bettered without a sacrifice of selectivity. The actual loss of the high frequencies will probably not be noticed by the ear as in the majority of loud speakers there is a rising characteristic at the high frequencies.

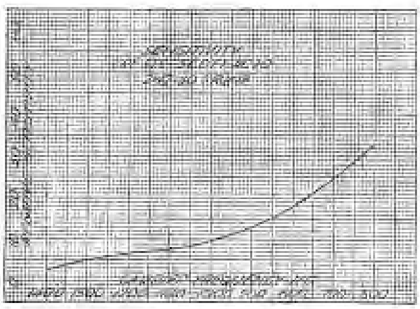


Fig. 1. Sensitivity curve

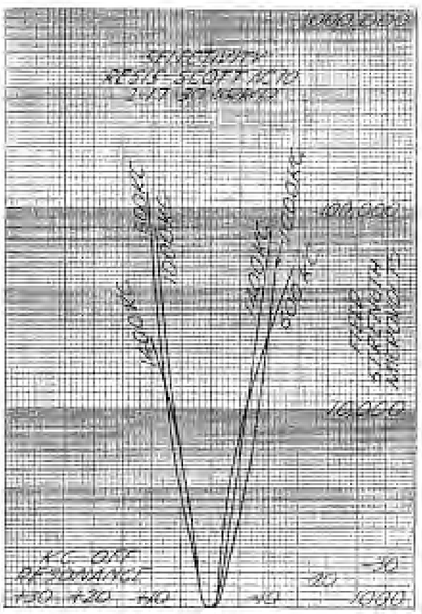


Fig. 2. Selectivity curves

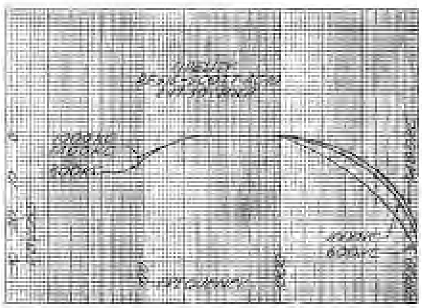


Fig. 3. Fidelity curves

eral use as a 3 tube set this is the best operating value.

Hum Buck

The hum bucking resistance which is shown in the schematic as being on a clip, should be set a few ohms to the right of the position where the first screen is attached. In this particular model the hum-buck clip was always a few ohms to the right of the first screen.

From the standpoint of hum (when measured on an output meter) the position of the tap on the center-tap resistance across the 2.5 volt filament line is quite critical. While the change could not be detected by ear, nevertheless when measuring on an output meter there was quite a decided hum null when the most favorable spot was touched.

Use Output Meter

It is also quite likely that an improvement in hum level can be made by using a potentiometer across the 250 filament, the arm going to the positive 250 volts tap, and then varying this arm until least hum can be detected on the output meter. Of course this difference might not be ascertained by ear, but with a meter probably some benefit would show up.

Other Circuit Work

In forthcoming issues of this magazine it is expected more information will be presented together with measurements, and constructional data, on the use of this combination behind r. f. stages of some type.

We shall be glad to hear from experimenters and engineers who have made any studies bearing on the type of circuit mentioned in the foregoing remarks.

Seamless Tubing

THE National Harris Wire Company of Newark, N. J., has installed additional machinery for the production of seamless nickel tubing for use as cathodes in a. c. heater type radio tubes. This seamless tube is said to offer many advantages and is rapidly replacing the seamed tube used in the past.

Seamless tubing is used in several sizes, the smallest measuring 1/16 of an inch in dia. with a wall .0015 thick, or about the thickness of a sheet of tissue. This very thin wall added many difficulties to the tube drawing technique, and new methods and machinery had to be devised to produce a perfect product.

About the Pentodes

SINCE everyone seems to be talking about the pentode, whether much is being done with it or not, it would seem that engineers will have the summer before them in which they may experiment with the tube. This is, of course, providing the engineers have nothing else to worry about between now and the trade show in June.

A recent telegram from Sylvania Products advises this department that although Sylvania completed developing a pentode tube last August, the company does not intend marketing pentode tubes until after their advantages in experimental receivers are fully demonstrated.

Engineering Roster

Our editorial department maintains a roster of engineers engaged in the radio industry.

Inquiries as to location of engineers are welcomed.

We also solicit advice concerning staff changes so this roster may reflect the greatest accuracy.

Braxton-King Response Curves Made

THREE measurements were made on the Braxton-King super as shown in Figures 1, 2 and 3.

The sensitivity of this receiver as illustrated in Figure 1 is merely relative inasmuch as the actual sensitivity was so much greater than one half microvolt per meter that it could not be measured on our laboratory setup. The relative sensitivity over the wave band is not quite as uniform as it could be. This is probably caused by the great amount of change in the LC ratio of the antenna coupler which is characteristic of this set. However at its most insensitive point the sensitivity is exceedingly good.

The selectivity curves in Figure 2 are probably the best as far as uniformity is concerned which our laboratory has yet measured. There is a slight discrepancy in the 1400 kc curve on the minus side but this will not detract from the overall selectivity of the receiver. The selectivity of this receiver is extremely good. It is quite possible to get good twenty kilocycle separation between a weak distant station and a high powered local station. The average selectivity may be said to be exceedingly good.

In Figure 3 are the fidelity curves which are of course reflected in the selectivity curves. The slight warp in the minus side of the 1400 kc selectivity curve is reflected in the fidelity curve for that frequency by not having as great a loss above 2000 cycles. The 600 and 1000 kc curves are nearly alike, the differences between them being approximately the same as the difference between the two selectivity curves for those frequencies.

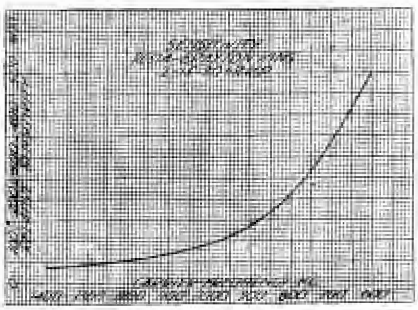


Fig. 1. Sensitivity curve

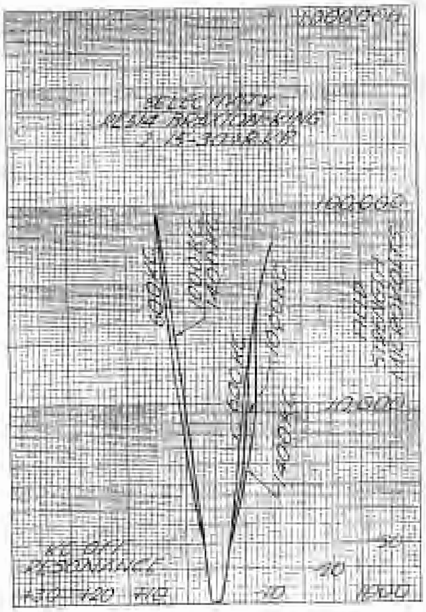


Fig. 2. Selectivity curves

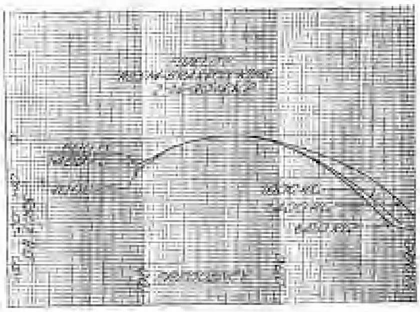


Fig. 3. Fidelity curves

Neco Short Wave A.C.-D.C. Receivers

INSTANT shift from one short wave band to another by the flip of a switch, single control tuning, smooth volume control and self-contained power supply, are some of the outstanding features of the Neco short wave receivers, one for alternating current, and the other for battery operation, described briefly on this page.

The two schematic diagrams, one in Fig. 2 and the other in Fig. 3, give an idea of the circuit arrangement and constants. The photograph in Fig. 1 shows the inside of the cabinet, which is of metal with a crystalline finish.

S. G. Detector

Probably the chief feature of the receiver is the use of a screen grid tube as a detector, which provides extreme sensitivity, stability and volume comparable to that of broadcast receivers. The regeneration control alters the screen voltage of the detector, is extremely smooth and has no effect upon the wavelength of the receiver. Thus the receiver may be once logged and the log will be permanent.

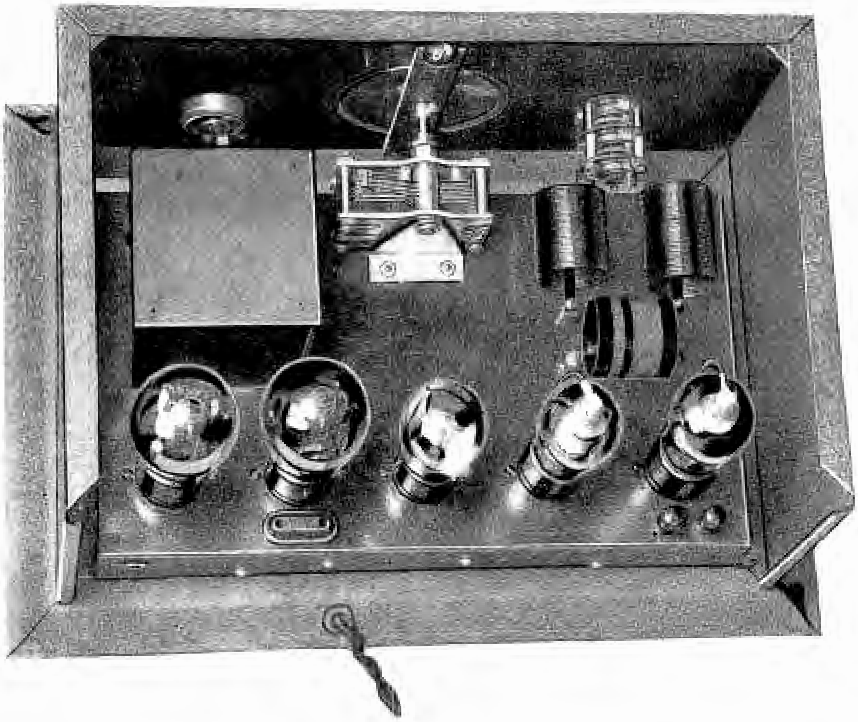


Fig. 1. This photograph shows the inside rear of one of the Neco short wave receivers described briefly on this page

In Metal Cabinets

Both the a. c. and d. c. models are housed in a crystalline finished metal cabinet and chassis. The steel chassis and cabinet provide extreme strength and shielding, preventing interference from outside stations and aiding the sensitivity of the receiver. The coils, however, are kept away from the steel chassis so their r. f. resistance will not be increased due to their proximity to magnetic material The tone quality is good because in the a. c. set resistance coupling is employed between the detector and the first audio stage so that full advantage may be taken of the maximum gain from the 224 detector. Resistance coupling in the first stage is not used in the battery model because of the voltage drop across the plate resistor.

Tuning Chart Helps

Each receiver is supplied with a chart showing stations tuned in on tests and points at which stations may be received, this being a decided help for the novice.

A special receiver of this kind, only for amateur work, is also made in both a. c. and d. c. models. They differ from the other sets in that condensers and coils are designed so as to just cover the amateur band. thus spreading amateur signals over the entire dial.

Extra coils may be obtained to plug into the receiver to cover other wavelengths. Extra coils are made with the following ranges: 13 to 19 meters, 120 to 200 meters, 190 to 360 meters and from 350 to 650 meters.

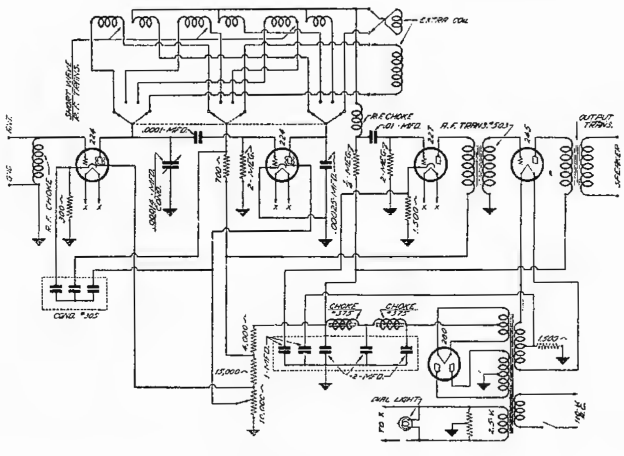


Fig. 2. The schematic circuit of the a c. Neco model is shown here

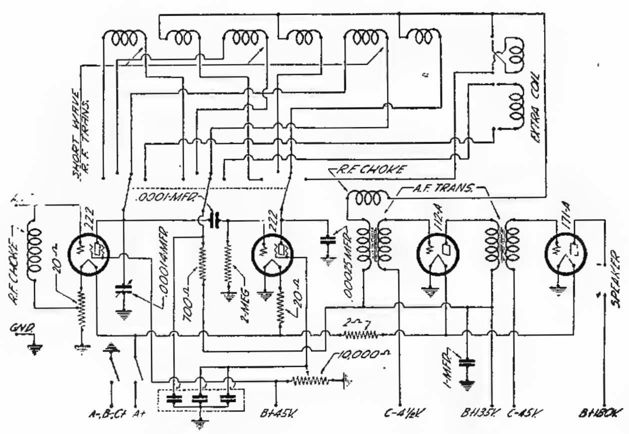


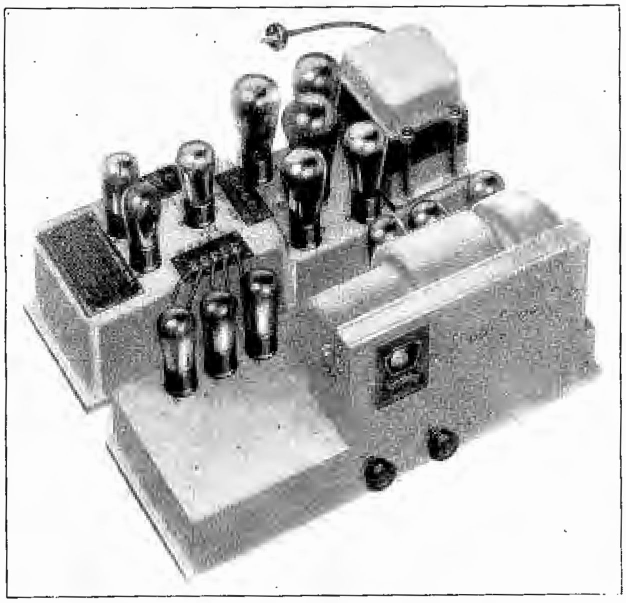
Fig. 3. This drawing is the schematic of the battery operated Neco receiver

Victoreen Circumnavigator Super

THE Victoreen Radio Co. has been associated with the manufacture of radio parts for the past eight years. In 1930, however, they are leaving this field and are now in production with a complete factory built receiver. This receiver naturally employs the superheterodyne circuit with which this organization has been so closely associated for the past six years.

Unique Features

The Victoreen Circumnavigator now in production embodies many new and unique features. The chassis itself (shown here) is a distinct departure from accepted construction prac-



tice, inasmuch as it is designed in two complete units—a tuner and an amplifier—each housed in a cast aluminum case. This makes a chassis extremely rugged in construction and thoroughly shielded. The tuner uses a drum dial graduated in kilocycles and calibrated uniformly over the entire broadcast band. To accomplish this, the Victoreen Radio Co. use straight line frequency condensers built to special specifications. The divisions on the dial provide for one division for each channel on the broadcast band and selectivity is such that these channels are all available.

The circuit arrangement provides for six tubes in the tunner consisting of a stage of r. f., oscillator, first detector, and three stages of intermediate frequency. The amplifier contains the second detector as well as first and second audio stages.

Fourteen tubes in all are used in the entire chassis. However, this carries a 9 to 5 rating in technical radio terms. This means that nine tubes are required for the radio receiver proper and five are used in the amplifier for either rectification or balance. In addition to the tubes mentioned above the amplifier also uses full wave rectification and two voltage regulator tubes. In addition the C bias is rectified by its own tube. This means there are no resistances in the plate circuit of the B supply. A summary of the tubes used consists of: eight 227 tubes; two 281 rectifier tubes; two 874 voltage regulator tubes; one 291-A rectifier for "C"; one 250 in the output.

The two voltage regulator tubes maintain a constant potential on the receiver proper. One tube provides for a potential of 90 volts through the second detector; the other, 180 volts on the first audio. This helps make this receiver smooth and quiet in operation.

The construction and arrangement of parts in the tuner is outstanding. The antenna coupler as well as a stage of tuned radio frequency and the oscillator coil are wound on a threaded lava tube. This provides extreme accuracy in measuring and standardization of both capacity and inductance. Moreover the use of lava prevents shrinkage or any tendency to warp, and provides for long life and service.

Non-Harmonic

The intermediate frequency transformers are contained in shielded copper cases, each individually tuned and matched. The intermediates are peaked at 152½ kilocycles. With proper shielding and the stage of tuned r. f. this receiver has been made non-harmonic and is the only superheterodyne now in the market on a production basis having this qualification.

There are but two panel controls for the operation of this receiver—one control for tuning and one for volume. The variable condensers are all aligned and balanced into the circuit to permit perfect tuning with a single dial.

This receiver is designed to operate with ground and antenna. Under proper local conditions an outside antenna of 75 feet, including lead-in is recommended. However, this receiver has a normal range of several hundred miles with ground only. An antenna, however, is recommended at all times and an inside antenna is acceptable where local conditions demand.

The new Victoreen is offered in three high grade cabinets of period design: A lowboy of true Gothic; a highboy designed in the period of Louis XVI; and a most handsome combination cabinets in Elizabethan period. The latter cabinet is available either in antique oak or walnut finish.

The new Victoreen receiver comes to the public at a very opportune time. Definite value has been built in the chassis proper and enables the Victoreen Radio Co. to offer a six months guarantee against defects in either workmanship or material.

Attaining Uniformity in Tube Manufacture

By EDGAR H. FELIX

THE vacuum tube is produced in larger quantities than any other precision instrument. Not only must its parts be accurately made and correctly assembled, but, unlike other precision devices, the very electrons of which its materials are composed must be adapted to their purpose. The parts of a watch move at velocities which can be perceived by the eye but the electrons in a vacuum tube move at speeds of hundreds of thousands of miles a second. So we are concerned not only with mere mechanical precision. The manufacture of a vacuum tube is a process of physics as well as of mechanics. For this reason, an unusual amount of skillful hand labor

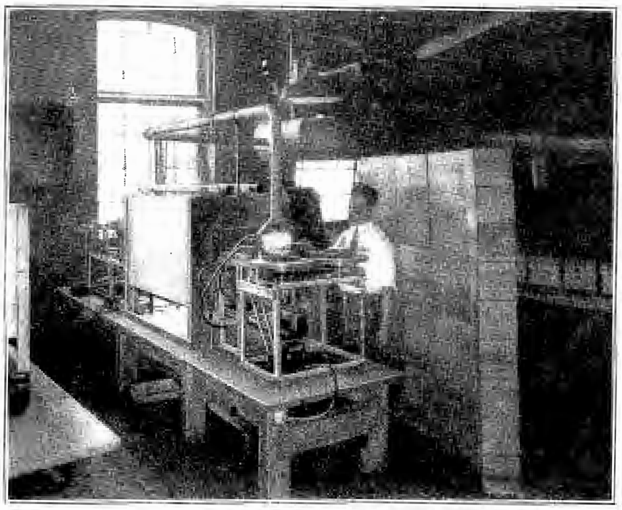


Fig. 1. Photograph shows a carbonizing furnace used for producing a carbonized surface on the material used for making tube plates by a continuous process with temperatures automatically controlled

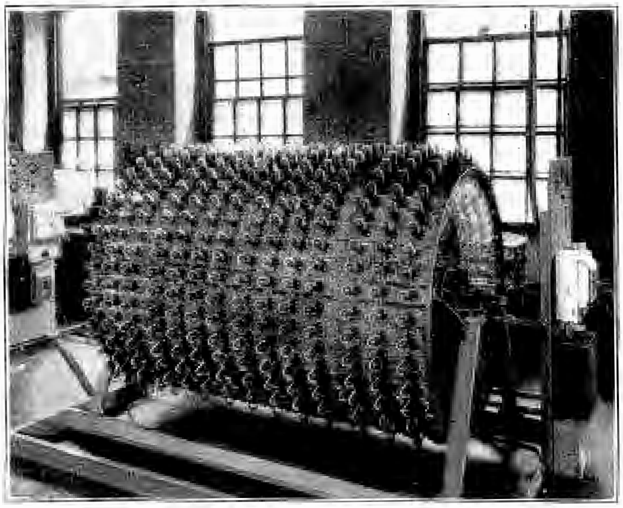


Fig. 2. This rotary aging machine automatically subjects every Eveready Raytheon tube to form nine to fifteen different voltages and conditions. Every tube is tested and any weakness which has developed causes the tube's rejection

enters into vacuum tube production.

One of the leading manufacturers in the field has recognized the importance of conscientious precision so forcibly that he has located his plant in a city where generations of precision-minded watchmakers live. Although no effort has been overlooked to apply automatic machine production methods, the importance attached to the training and supervision of the human element has brought its reward in the remarkable uniformity attained and the small percentage of rejections necessary in this plant.

A brief outline of the manufacturing processes involved in making a vacuum tube is convincing evidence that the conscientiousness and the morale of the manufacturer and every member of his staff are as important a contribution to long life and quality of reproduction as design and material of the vacuum tube itself.

The manufacturing process may be logically divided into nine steps as follows: (1) Preparation of a considerable number of separate parts. (2) Assembly of the stem. (3) Assembly of the control elements. (4) Combination of stem and elements. (5) Mounting and evacuation. (6) Basing. (7) Activation. (8) Testing. (9) Packing and shipping.

Even the preliminary processes of preparing the separate parts before asesmbly begins involve the human element. The average person, looking at a vacuum tube like a four-pillar a. c. screen grid tube, is unlikely to appreciate the fact that there are 72 separate parts in the assembly of that tube. Some of these parts are purchased by the tube maker as raw material and require only such simple processes as general physical examination and cutting to proper length and size but others require a most extensive treatment before they assume their individual identity as parts ready to go into the vacuum tube.

Half a Millionth of a Pound

The spiral grids, for example, used in the screen grid types and some of the others, are delivered to the manufacturer as wire on a spool. An exceedingly accurate operation is involved to assure that the grid wire is of the correct diameter. Although measuring instruments of the caliper type might be used to make the minute measurement necessary to check the diameter of the grid wire, the pressure of such a measuring instrument upon the molybdenum wire employed would permit of too wide a latitude. At the plant where Eveready Raytheon tubes are made, which is the one already referred to, a pair of accurately spaced mechanically operated cutters snip off a 200 millimeter length of grid wire from each spool that is delivered to the plant to be used for this purpose. This length of wire is weighed on a scale calibrated in *thousandths of a gram*. A thousandth of a gram is, roughtly, a *half a millionth of a pound!* The moisture of your breath can change the weight of the standard test length of wire over a wide range of this scale! This accurate method of measuring the diameter of the grid wire within three ten thousandths of an inch.

Before it becomes a grid, the wire on the spool is first spun into spiral form mechanically. Raytheon uses two holybdenum supporting wires instead of the usual one. These supports act as spacers, holding the spiral rigidly and at a uniform pitch. The grid wire, with its supports is then cut into the correct length for the various types of grids used in different tubes. An accurate inspection is then made to assure that precisely the correct number of turns of wire have been cut off to constitute a grid of the type desired. How essential this inspection is indicated by the fact that a change from 34 to 36 turns on the 224 control grid would make a change of 20 per cent in the resulting plate current!

The making of a spiral grid is only a sample of many similar operations required under the first classification, the preparation of the individual parts. Care is required in assembling plates, in preparing filaments, coating them, cutting them to length, cutting up the glass rods which are made into stems and the bulbs which become the envelopes for the whole device. Many of these processes are exceedingly interesting but usually the first inspection of a vacuum tube plant leaves one in a state of confusion. The usual impression is that the whole process of tube manufacture is of such gigantic complexity that no one can understand it all anyway and that the ceaseless eye of the inspector is constantly focused on about everything that goes on. When one realizes, for example, that a difference of a sixteenth of an inch in the length of the coating on the cathode of the heater tube will make a ten to fifteen per cent difference in the tube's characteristics, this amazing conscientiousness, manifested throughout a plant like Raytheon, becomes fully justified.

Assembling the Stem

Having secured a collection of grids, plates, filaments, connecting wires, insulators, supporting pillars and glass parts, we proceed now to the assembly of the stem. The stem is the glass part which you see when looking down into the tube, through which the leads and support wires pass. It is the foundation of the vacuum tube around which the rest of the tube is built. The first process in assembly is to take the various elements, which pass through the stem, including supporting pillars, leads, etc., and to place them in a jig which holds them in their correct relative positions. A piece of glass is placed around them and the first glass blowing process begins. When the operator has assembled the parts in the jig,

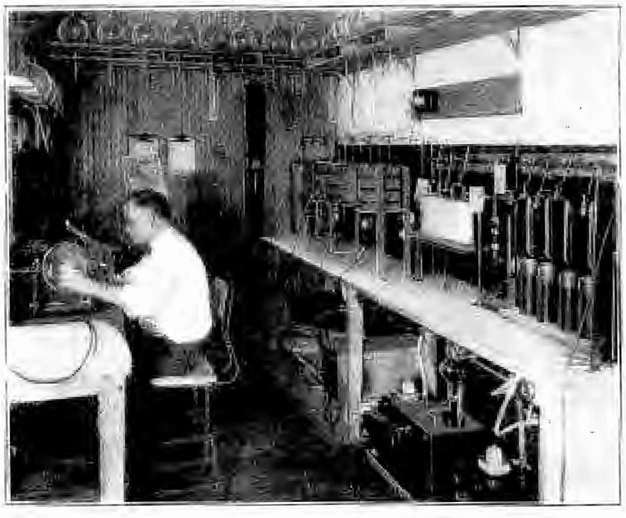


Fig. 3. Separation and purification of rare gases for gas type rectifier tubes

the rest of the work is done automatically. The glass stem is heated in progressive stages until it is ready to mould. Then four dies come up and squeeze the glass around the wires which are held in the jig, after which the tube passes through a series of progressive cooling positions at each end and is ready to advance to further manufacturing processes.

The jig used to hold the parts in most plants consists of a frame with a row of holes in a straight line into which the parts are placed in the correct order just as you see them in the stem in the final assembly. The Raytheon construction is unusual in that the jig is in the form of a cross because the elements of the Eveready Raytheon tube are supported by four pillars in the form of a square in order to secure a more rigid structure. The effect of the four pillars is to protect the elements from weaving and vibration, prolonging the life of the filaments by reducing the strain to which they are subjected and avoiding microphonic difficulties and damage in

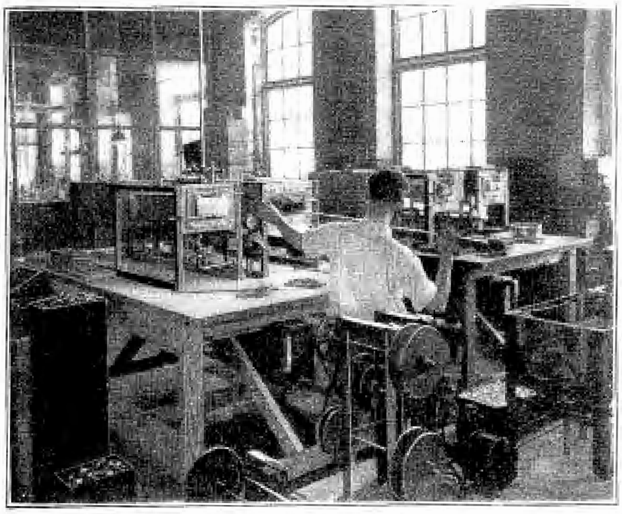


Fig. 4. Hydrogen furnaces for cleaning metal parts. Hydrogen gas at high temperature removes all traces of oxide or dirt left on the parts after preliminary forming operations

shipment by reason of the greater rigidity afforded by this construction.

Various parts which serve no electrical function are also added to the stem. These are required in producing the physical properties necessary to the operation of the tube later in the process of manufacture. A glass tube is inserted into the stem to which the vacuum pumps are later connected. A getter cup is attached to one of the supporting pillars which flashes up at a certain point in the evacuating process to eliminate any final trace of gas.

Concurrent with the assembly of the stem, an assembly of control elements is made, consisting, in the case of most tubes, of one or two grids, a plate, insulating spacers, lead wires and supports for the filament. This assembly forms the mass of elements so conspicuous to the eye at the top of the tube. Most of these assembly operations are concluded with a spot welding process which literally makes two metal parts one. Some of these assembly processes involve exceedingly small parts like tiny lavite insulators through which connecting leads are threaded to reach down toward the stem without electrically touching an element other than that with which it is connected.

Vacuum the Crowning Achievement

The element and the stem assembly are then joined by hooking the filament in place and fastening the elements to the supporting pillars by spot welding. The glass envelope or bulb is then blown into place and the painstaking process of vacuum making begins. A series of vacuum pumps reduces pressure by a simple pumping process. An electronic bombardment at the same time heats the parts within the tube to brilliant reds and whites, driving forth occulted gases from deep within the metal. Without this bombardment process, these gases would be released, little by little, into the vacuum, soon rendering the tube erratic or inoperative. When pumping has reduced a certain degree of vacuum, the filament is lit. The idea of lighting the filament during evacuation, incidentally, first occurred to Thomas A. Edison and it enabled him to make the first vacuum electric lamp, twenty-five years ago. Finally, when a certain temperature is reached, the getter automatically flashes and strikes the final blow to any gas which has the temerity to remain within the confines of the glass bulb. All of this involves tremendous machinery, electrical and mechanical, and a battery of skilled engineers who watch the operation of testing, measuring and adjusting with unflagging vigilance.

While the glass is still warm, the elements of the tube are centered so as to give uniform appearance. The leads are connected to the pins in the base and the base fastened on to the bulb. The tube is then ready for a series of electrical operations to condition the filament and check operating characteristics. Filament seasoning treatment is an accurately determined program of applying voltages to terminals in a manner which secures maximum activation. During this process, the tubes are mounted on immense cylindrical racks. Hundreds of amperes are drawn from the power mains for the purpose. While inspection has continued throughout the process of manufacture step by step, the final inspections are both visual and electrical, assuring uniformity of the operation of the tubes in the hands of the user. Finally, comes labeling, packing and shipment.

With the Parts and Accessory Manufacturers

(*Continued from page* 113)

voltage transformer with which the instrument is equipped, this transformer being manufactured under licenses from the Ward Leonard Electric Company. This is an entirely new development which maintains a constant output irrespective of load within the limits of the transformer. By this means the output is maintained at fixed predetermined voltages, drawing on input line supply, ranging from 100 to 130 volts, keeping all readings constant irrespective of line fluctuations.

Two testing sockets are provided taking care of all four prong and five prong tubes. By means of a voltage selector switch filament voltages of 1.1, 1.5, 2.5, 3.2, 5 and 7.5 may be applied to either of these testing sockets.

By means of a toggle switch the necessary circuit changes are effected for testing either Triod or screen grid tubes.

An indication of the amplification factor is obtained by a direct reading on a dial and the mutual conductance indication is obtained in like manner on a separate dial.

A gas test is made by pressing a button, obtaining a direct reading on the meter, giving an indication of the gas content.

The emission qualities of the emitting elements are ascertained by pressing a button securing a direct reading on the meter.

By pressing a button a direct reading on the meter is secured on the second plate of the full wave thermionic rectifier tubes.

The instrument is equipped with a Weston Miliameter with three scales 100/25/1/0. The 100 mil. scale is normally in circuit; either of the other ranges, for the purpose of obtaining closer readings, may be thrown in the circuit by depressing push buttons.

The construction is in keeping with the highest standards of laboratory instruments, the assembly being contained in a hand polished case made of selected black walnut, surmounted with a 3/8 in. Bakelite panel which carries the meter, testing sockets and operating switches and dials.

The size is 7 5/16 x 10 9/16 x 5 1/8 in. and weight approximately 11 lbs.

Muter Invisal Aerial

MANUFACTURED by the Leslie F. Muter Co., 8440 S. Chicago Ave., Chicago, Illinois, is a new invisible indoor aerial, which is called the Muter Invisal.

According to the information accompanying the Invisal, the connector of the tape is attached to the antenna post on the radio set, the tape is then unwound about three feet at a time and the gummy side of the type is pressed to any floor, baseboard, wall or moulding on which the set owner wishes to install it.

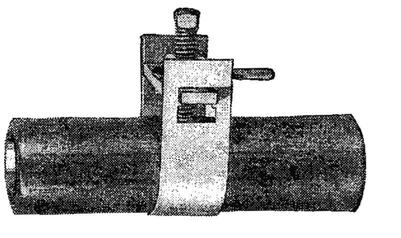
The mahogany color will be invisible on mahogany, walnut or any dark woodwork. The cream color will be invisible on the average floor or light wall.

Invisal is approximately fifty feet long, which is ample for almost any radio set. However, the length of the tape may be shortened by cutting, or by only partly unwinding the coil.

Potter Ground Clamp

A MODERN and simple ground clamp has been added to the line of condensers made by the Potter Co., 1950 Sheridan Rd., North Chicago, Illinois.

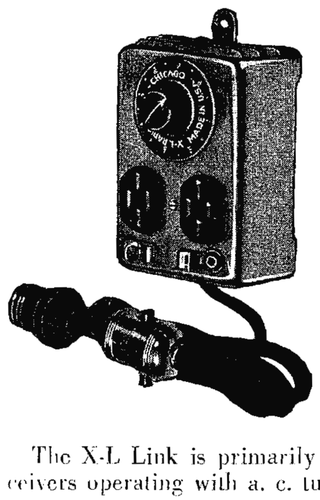
The ground clamp is illustrated in this column. The vice grip construction makes positive contact because the hardened clamping screw of special construction forces its way through paint, rust or foreign matter on pipe or ground rod, insuring perfect contact to clean, fresh metal. Each Potter ground clamp has a copper ground wire lug which gives the required method for attaching a ground wire. The clamp has been finished with the best known rust resisting material. It is durable and rigid and will not bend or lop over. The standard clamp fits one-half and three-quarter inch pipe. The Potter ground clamp can be furnished in larger sizes.



X-L Link

SEVERAL improved features have been added to the X-L Link manufactured by the X-L Radio Laboratories, 1224 Belmont Ave., Chicago, Illinois.

The unit is shown in the illustration. The new features of the Link are the fact that the pendant switch has been taken out of the cord and is incorporated in the box itself.



Another improvement is the fact that the Link is now made in two types, LD for sets drawing less than one ampere, and type HD for sets drawing one ampere or more. The Links are made to operate on direct current or alternating lines of any frequencies and from 110 to 130 volts.

A third change in the Link is the inclusion of a ground wire in the connector cable from the Link to the wall socket, this ground wire being attached to one of the screws holding the face plate of the wall socket receptacle.

The X-L Link is primarily a line voltage regulator for receivers operating with a. c. tubes, or sets using both A and B

(Continued on page 128)

(*Continued from page* 126)
eliminators. In addition it supplies an antenna from shielded light wires, convenient ground connections from grounded conduit, double socket outlet for set and dynamic speaker or A and B eliminators, if used, single control switch and complete fusing of instrument and receiver.

Supreme Service Stations

SUPREME INSTRUMENTS CORPORATION, Greenwood, Miss., announces the following authorized diagnometer service stations equipped with parts and laboratory facilities for efficiently servicing Supreme radio diagnometers:

Harrison Sales Company, 314 Ninth Avenue North, Seattle, Washington.

Arthur Honeychurch, 682 Mission Street, San Francisco, Calif.

Illinois Testing Laboratories, Inc., 111 West Austin Ave., Chicago, Ill.

Instrument Service Laboratories, 3645 McRee Street, St. Louis, Missouri.

Professional Radio Service, 429 Penn Avenue, Pittsburgh, Pa.

QRV Radio Service, 1400 Broadway, New York, N. Y.

Rubicon Company, 29 N. Sixth Street, Philadelphia, Pa.

Standard Laboratories, 1334 Oak Street, Kansas City, Missouri.

Supreme Makes Ohmeter

THE Supreme Instrument Corporation of Greenwood, Mississippi, announces as a part of its line of testing equipment, a new ohmeter known as Model 10.

The dial of the meter is directly calibrated in ohms and the meter is amply protected from damage against short circuits and a rheostat shunted across the meter provides for a zero adjujstment.

There are two test probe pin jacks on the panel and suitable test probes for convenience in connecting the instrument to the device to be measured are included with the instrument.

The unit contains a single cell of an ordinary flash light battery which provides the small amount of current required for actuating the meter movement. The battery will last for several months and is very easily and quickly replaced when the voltage gets too low for compensation by the zero corrector. The instrument is extremely simple and is designed for the rapid and direct indication of resistances. It will be found particularly helpful in checking apparatus and tracing circuits. Through its use it is not only possible to detect open and short circuits but also improper connections.

A particular feature is its small size and light weight. While representing the maximum efficiency in its field it is so small and compact that it can be very easily carried in the pocket, being only 2 x 2 5/16 x 4¾ in. and weighing only 12 oz.

Simplimus SAF3

DESIGNED for theatres equipped for sound, a mixer known as the SAF3 has recently been announced by Simplimus, Inc., 37 Winchester St., Boston, Mass. It is built according to Simplimus specifications by the Samson Electric Co. at Canton. Mass.. and marketed by Simplimus.

The SAF3 is placed in circuit between the fader and the amplifier. It can be compared to a triple valve or gate which can be set to stop sounds of a certain pitch without affecting others of another pitch.

The SAF3 mixer will work with all makes of amplifiers and all types of talking equipment. The engineering department of the designers will be glad to offer suggestions to theatre owners or operators.

On this instrument are located three switches marked respectively low, middle and high register, together wtih a knob marked "compensator." The unit is 12 by 6 inches.

According to the designers, where a speech is muffled and drummy, the words mushy and indistinct, the over accentuation of the lows may be remedied by throwing the switch on the SAF3 to low register and turning the compensator knob to the right. Gradually the lows will disappear, the voice will become more distinct, because the highs which were previously drowned out, will now stand out clear and sharp.

In cases where the theatre is resonant to a certain frequency, this can often be remedied by attenuating the frequencies which are most responsible for the resonance. In most cases speech will be greatly improved by the partial elimination of the lows.

Mid-Continent Amplifiers

TWO new amplifiers, one especially designed for talking picture and public address use known as the model M 10, and the other especially designed for reproduction of music and called model M 10 A, have been recently announced by the Mid-Continent Electric Co., Denver, Colorado.

The M 10 amplifier has been designed to solve the peculiar problems involved in accurate reproduction of voice. Reverberation makes it absolutely necessary to amplify the high frequencies up to 15,000 cycles at a volume within 20 DB of that obtained at 1000 cycles.

The M 10 consists of four stages, all resistance coupled, all push-pull. The characteristics of the amplifier are: Normal output load, 8000 ohms or two 4000 ohm speakers in series; output rating, normal speaker load 9.5 watts absolutely undistorted, 18 watts permissible distortion, 22 watts absolute limit; power supply, 100-130 volts, 60 cycles; power consumption 200 watts; voltage gain 4184; power gain 72 DB; tubes, six 226's, two 250's, two 281's; outside dimensions 16¼ by 24 ¼ by 7 in.; net weight 71 lbs.

For musical reproduction the model M 10 A amplifier made by the Mid-Continent interests also uses four stages, all resistance coupled and all push-pull, with the following characteristics: Normal output load 8000 ohms or two 4000 ohm speakers in series; output rating, normal speaker load 9.5 watts absolutely undistorted, 18 watts permissible distortion, 22 watts aboslute limit; power supply 100-130 volts, 60 cycles; power consumption 200 watts; voltage gain 4184; power gain 72 DB; tubes, six 226's, two 250's, two 281's; outside dimensions 16¼ by 24¼ by 7 in.; net weight 71 lbs.

Quite a bit of experiment work was done by Mid-Continent before they were able to present a circuit allowing the use of 250 tubes at random, with dependence upon their continued good behavior. The only transformer used in this amplifier and which appears to be necessary to couple a pickup or preceding tube to main amplifier is a special transformer capable of handling high frequencies in a presentable manner.

Another one of the products marketed by Mid-Continent is known as their moving coil microphone, operating on the same principle as the dynamic speaker.

The amplifier for the moving coil microphone is a two stage resistance coupled job and by a simple adjustment, namely that of changing leaks, it may be made suitable for either amplification of music or public address work. The amplifier proper is encased in a cast iron box and the subpanel on which the amplifier is mounted is hung by means of sponge rubber, thus reducing microphonic tendencies to the minimum. This cast iron box is mounted on the same metal base which also carries the power supply for the B and C of the amplifier tubes and furnishes excitation for the field of the microphone. A small storage battery is used for the filaments of these tubes.

(*Continued on page* 130)

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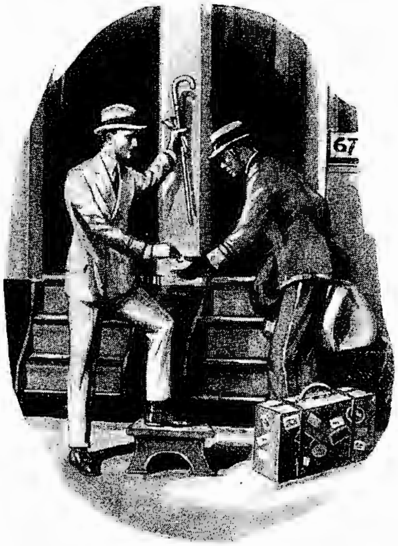

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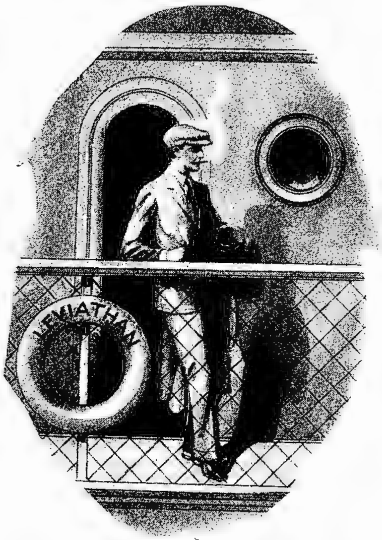

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Mr. F. A. Jewell, Gen. Mgr.
Projectionist Sound Institute, Easton, Pa.

Dear Mr. Jewell:

The training that I received from you has qualified me as an Engineer on Sound-Projection and I am now employed as an Installation Engineer of Sound Equipment, enjoying a nice income and getting a chance to travel over the country, with all expenses paid.

Recently I had the opportunity of accepting a position as Sound-Engineer for a chain of theatres, also a chance to go to England, in charge of installation over there.

I cannot speak too highly of your Institute as a medium for any one with ambition to achieve success in this field.

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Please send me, by return mail, full details of your Special Scholarship Proposition on Sound Projection.

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(Continued from page 128)

A New 224 Assembled Shield

THE perfection of radio reception can come only from infinite care in the development of every smallest detail, and the new assembled 224 shield, illustrated herewith, represents a case in point.

Even the casual observer will notice a decided improvement in appearance as compared with the shield it supersedes, but of course the invisible differences are still more important. These have to do with the seam in the cylinder and the manner of fastening the cylinder to the disc.

Formerly, these operations were accomplished by means of spot welding, a method which, although effective in preventing any coming apart, left the possibility of a certain looseness, lack of perfectly firm contact, in the spaces between the welded spots, and giving rise to microphonics.

But the new method prevents any possibility of this; for the screen is formed into a cylinder over a steel mandril and then the seam is solidly clinched. The completed cylinder is then clamped to the disc by expanding it under pressure into a seam ofrmed in the disc, resulting in an assembly that is the same as if it had all been made of a single nickel piece.

As the illustration shows, the cylinder is formed of mesh strip with selvaged edge, which so strengthens it that it will not fuse or split under high temperatures. The cylinder can also be made of plate nickel, perforated.

The improved assembly described has been developed by the engineers of Goat Radio Tube Parts, Inc., Brooklyn, New York, and is manufactured by them.

(*Continued from page 130*)

Hickok AC-47 Radio Tube Tester

THE AC-47 Radio Tube Tester is designed with the idea of supplying the radio dealer, jobber and service man with an inexpensive radio test unit, which actually tests radio receiving tubes in an efficient manner. This tester operates from light socket power, and indicates directly, the plate current and dynamic mutual conductance. This is the first of its kind, selling for a price within reach of all.

Among the new features found in the apparatus, is the construction whereby d. c. voltage is applied to the plate and the proper grid bias for every standard type tube. In most other methods of less expensive tube testers, raw a. c. is applied to the plate, the tube acting as its own rectifier. It is well known that any receiving tube cannot be accurately tested unless d. c. is applied to the plate and the proper grid bias used.

The method of indicating directly, the dynamic mutual conductance employed in the AC-47 Tube Tester is covered by patents owned by the Hickok Electrical Instrument Company, and in effect, indicates the mutual conductance by applying a low a. c. voltage to the grid, superimposed upon the proper grid bias, and reading the resultant a. c. component present in the plate circuit in micromhos.

The operation of the tester when used in testing the several kinds of receiving tubes now on the market is very simple, and consists of making one setting for the proper filament voltage, and a second setting to obtain the proper grid bias. Provision is also made for adjusting the apparatus so that the indications are the same, independent of line fluctuations.

After the above settings are made, all that is necessary to do is to insert the tube in the tester and read its values from the two meters.

The two values indicated of plate current and mutual conductance will be the same if the tube is normal in characteristics as the values supplied by the tube manufacturers. In other words, the instrument indicates the commonly accepted values of plate current and mutual conductance, which are used in the industry and employed by radio engineers.

The device contains suitable protection against injury which might result in attempting to measure tubes which are short circuited in either the plate filament or grid.

A suitable carrying case can be had at small extra cost.

Webster 250 Amplifier

THE Webster Company, 850 Blackhawk Street, Chicago, announce the addition of the R-250 Amplifiers to their present line of Electric Pickups, Power Amplifiers, Faders and associated accessories.

The Webster R-250 Amplifier represents the latest in audio engineering refinements.

The design is such that remarkable clarity and brilliance of tone is the result.

Presto Electro-Magnetic Pickup

A NEW electro-magnetic phonograph pickup is the latest development of the Presto Machine Products Co., Brooklyn, N. Y., which company has been a pre-eminent source of sound reproduction development in the independent phonograph industry for more than a decade.

It is pointed out that from the engineering conception to the detailed manufacturing process of every precise part this pick-up has been based on the highest practical efficiency factor that could be co-ordinated with a maximum quality of reproduction.

The complete line of Presto Pickups are available with either high or low impedance units to match given amplifiers.

Buzzless Oil Burner Now

THE day is fast passing when the complaint will be any longer heard that oil burners interfere with radio reception. Most of the leading companies have the matter of radio interference under advisement, and many of them have already available specially designed Filterettes to remove

radio interference from installations made before the filterizing became general. The service man is shown pointing to the special shielding of interference-carrying leads which, together with the Filterette (shown in the silver case) insure noiseless, clear radio reception.

Home "Talkie" Outfit in Production

FOR the benefit of those movie enthusiasts who now have home moving picture projectors, the Stevens Manufacturing Corporation of Newark, N. J., has designed a small home "talkie" outfit. This assembly incorporates an electric phonograph turntable, an electrical pick-up, a powerful audio amplifier, a Stevens super-dynamic speaker, and an a. c. power supply that furnishes current for the operation of the entire assembly. The equipment is in actual production.

Automobile Radio Receiver Data Included in New Polymet Leaflet

AMONG the interesting circuits discussed in Leaflet CL-1, the Polymet Manufacturing Corporation's new constructional booklet, is a practical and efficient automobile screen-grid superheterodyne receiver. Inasmuch as the automobile set is sweeping the country, this particular set should receive considerable attention from the radio amateurs and custom builders of the country.

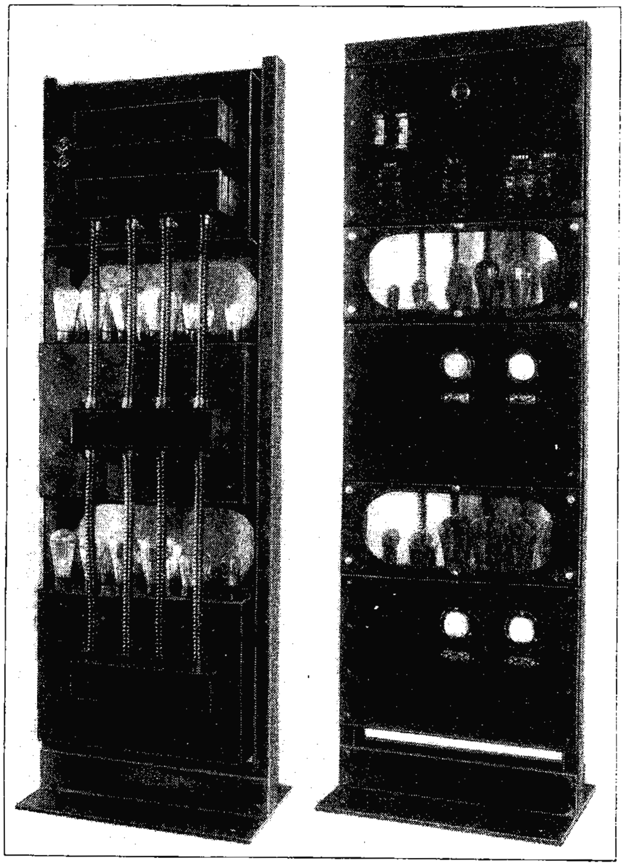
This particular hook-up was designed and perfected by one of the country's leading radio engineers for motor car use or as a lightweight and efficient portable.

There are other new and up-to-the-minute hookups discussed and diagramed, which should receive the attention of all wide-awake radio men. The Polymet Manufacturing Corporation, 829 East 134th St., Dept. H., will gladly send a copy of leaflet Cl-1 on request.

Dual Channel P. A. Job

SHOWN in this photograph is the Webster Double Channel Parallel 250, a two channel amplifier of twenty-five watts per channel, or where desired, the two channels can be paralleled and fifty watts of audio frequency energy used on one channel.

Meters are provided to enable the operator to read the plate current in any of the power tubes.



A unique feature of this equipment is remote control relays, which are provided, enabling the user to change to microphone, radio or phonograph from a distance.

This equipment is furnished with an output transformer so that a large variety of output conditions can be satisfied.

The amplifier is completely enclosed, all leads being run in flexible conduit.

Handy Booklet Describes Band Tuning

IN an unusually interesting manner, the story of the development of the Hammarlund "band filter" tuning method and its incorporation into the special Hammarlund receiver, the HiQ-30, is told in a 48 page booklet titled "HiQ-30 Manual" recently released by the Hammarlund Manufacturing Company, 424 West 33rd Street, New York City.

This manual, which is procurable at twenty-five cents the copy, is also replete with curves and pertinent circuit data, as well as descriptions of power supplies.

Line Voltage Regulation in 1930

By Charles Golenpaul

ONE of the most serious problems encountered in the proper operation of the all-electric A. C. radio receivers are designed to operate on 110 volts, and unless the electric current is exactly 110 volts at all times, the receiver, and particularly the vacuum tubes, can not function properly. During the past year many conflicting opinions have been voiced concernings the necessity of line voltage regulation. The fact remains, however, that 9 out of 10 receivers depend for perfect performance on a constant, unvarying line voltage.

Vacuum tubes are designed to operate within very definite limits, specified by the manufacturer. It will be readily appreciated, therefore, that when the house current fluctuates between 90 and 125 volts, as it often does, despite the claims of power companies to the contrary, the vacuum tubes are subjected to a severe strain. If the line voltage falls below 110 volts there is no strain, of course, but there is a considerable loss of volume, which is a serious inconvenience to the set owner located a considerable distance from available broadcasting stations. It is evident that some form of voltage compensation must be incorporated in a receiving set to unify its operation at all times. If line voltages only dropped, it would be a relatively simple matter to compensate for them by the use of properly designed low voltage transformers. Unfortunately, however, line voltage rises as frequently as it falls, making it totally impossible to use low-voltage transformers, since any increase above normal would seriously overload.

The tapped transformer with two voltage ranges, adopted by some manufacturers, is a half-way improvement. It is a relief but by no means a cure, since it is unable to cope with line voltage fluctuation. Regulation must of necessity be automatic and instantaneous for complete satisfaction. Rather than discuss further the qualifications of a voltage regulator, let us state now that such a device has been perfected, incorporating all the desirable features previously outlined. This device is known as a line ballast, since its action is really that of a ballast, throwing its weight one way or the other.

In the development of our line ballast or voltage regulator, we adhered to the automatic compensation idea. The principle of operation is that of a series resistor with a high temperature co-efficient, so wound and ventilated that a change in line voltage is compensated for by an accompanying change in the resistance value of the ballast. This system actually maintains a constant voltage on the transformer primary, even though the line voltage varies as much as 30 per cent, plus or minus. During this wide voltage fluctuation, the primary voltage and resultant secondary voltage varies less than the plus or minus 5 per cent limit specified by vacuum tube manufacturers. If the average line voltage to be dealt with is 110 volts, then the primary of the power transformer is designed for operation at 85 volts and the difference in voltage is developed across the line ballast. Then, even though the line voltage changes within the limits of 100 and 130 volts, the actual primary voltage will remain constant within plus or minus 4 volts. The ballast and transformer combination may be designed for voltage ranges and is by no means limited to the figures given. In any case the ballast must be designed for the specific transformer with which it is to be used. The transformer must likewise be designed to operate far below the level of the line voltage. From this it will be gathered that the line ballast is not an accessory that can be externally applied by the radio set owner desirous of correcting conditions in his receiver. The line ballast is essentially a manufacturers' proposition and, as in the case of certain types of automobile equipment, the best that the individual can do is to make sure that the receiver being purchased is equipped with them. This is by no means an impossibility, as the line ballast is as important to the radio set as shock absorbers are to the automobile. Just as no manufacturer would think of producing a good car without shock absorbers, so no good radio receiver manufacturer will think of producing a set without a line ballast, once public opinion has demonstrated that it expects the incorporation of this device as standard equipment.

In an effort to determine the actual voltages developed in a broadcast receiver within a wide range of voltages, as well as to check the efficiency of the line ballast when operating at greatly exaggerated loads, the Clarostat engineering staff plotted the curves of a popular make receiver operating with and without line voltage regulation. The results of this test were most gratifying since they checked quite accurately with the recent statements of a prominent vacuum tube manufacturer. This manufacturer stated in defense of his product, that the majority of tubes in use today are operating at nearer to 3 volts on the filament, than the specified 2½.

A number of standard tubes were used in the investigation. The voltage applied to the transformer varied from 99 to 129 volts. At 99 volts it was determined that the tubes were operating at 20 per cent under their normal rating with a consequent loss of volume since the specified limit is only 5 per cent. At 129 volts the tubes were found to be operating at 15 per cent more than normal. It will be readily appreciated that the useful life of the tube is greatly reduced when it is forced to operate at three times the allowable divergence from normal. When the transformer of the receiver was cut down to the 84 volt tap and a line ballast incorporated in the assembly, the results were instantly apparent. At 99 volts all of the tubes were receiving only 4 per cent less than their normal ration. It will be seen that this figure is well within the 5 per cent leeway. At 129 volts the tubes were operating at 3 per cent more than their allotted rating. During this test the plate voltage without the ballast never went below 200 volts and rose as high as 270 volts, whereas with the ballast, the plate voltage was 185 at 99 volts and never went over 217.

Although the line ballast is essentially a built in feature, and must therefore be designed to operate with a given transformer, it occasionally happens that the same ballast will operate with several makes of radio sets. For instance, the Clarostat line ballast No. 2179 is designed to operate with the Silver-Marshall receiver, as well as the Hammarlund Hi-Q 30 receiver. This ballast also is standard with several other receivers, and can be made on a large scale production.

There are several types of line ballasts, all intended for the same purpose, but different in design. The Clarostat line ballast has been designed with sturdiness in mind, so as to overcome costly and troublesome breakage. It has a perforated metal case, and contains no delicate filament, liquid, or chemicals to cause trouble. Furthermore, it has free-air circulation, providing prompt response to line voltage changes.

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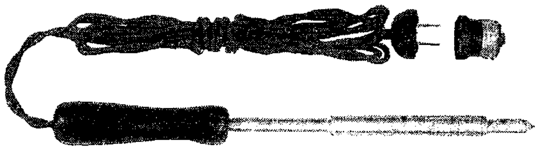

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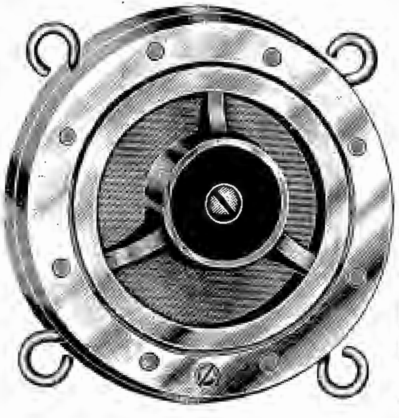
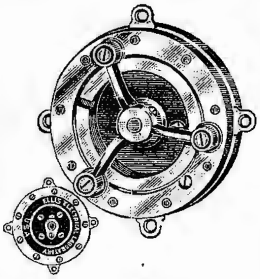


Model 20 Two-Button Microphone

A well known sound engineer recently said, "Every public address engineer should become acquainted with the Ellis No. 20 Microphone. It is the finest on the market for public address work." Built on the well known Ellis 3 pillar construction principle, this two-button microphone will give perfect reproduction of voice and music. Its frequency response is uniform and of wide range. May we suggest that you write today for detailed description and name of your nearest jobber. List Price **$45.00.**

Models 29 and 30



The Ellis Models 29 and 30 Microphones are of the two-button carbon granule type with stretched diaphragm and of rigid 3 pillar construction. They have been especially developed for installations requiring the finest microphones. Model 29 is especially recommended for voice only and Model 30 for the broadcast studio where voice and music are combined.

List Price **$75.00.**

Complete Line of Accessories

In addition to microphones, we can supply a complete line of microphone desk, floor and banquet stands, with or without covers, microphone transformers, springs, plugs and sockets and also 3 conductor shielded microphone cable in any desired lengths with or without terminals.

Complete detailed description of all items will be sent on request. We are particularly well equipped to aid you on all microphone problems. Write today for name of your nearest jobber. (*Jobbers:* Write for proposition and for name and address of our sales representative in your territory.)

District Sales Offices in All Principal Cities

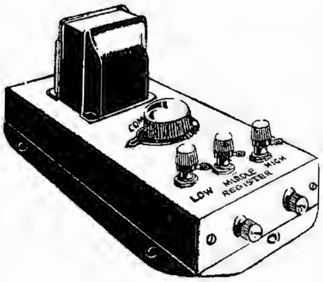
ELLIS ELECTRICAL LABORATORY

General Sales Office

333 W. Madison St. Chicago, Illinois

S-A-F 3 (SELECTOR OF AUDIO FREQUENCIES)

—Assures Complete Sound Control



Your patrons demand the **best** in "Talkies" —you can give it to them with **S-A-F 3** equipment. Inexpensive, easily installed, and simple to operate. A mere turn of a knob eliminates the unnaturalness in voice, the shrillness in notes and the unpleasantness and echoes of sounds. Your audience will be grateful for this improvement—and your box office will be busier.

S-A-F 3 was designed by Simplimus engineers—one of the oldest groups of engineers in the talking equipment industry—they have always led in offering improvements! Send the coupon below for complete information on S-A-F 3 and the course of sound lectures offered to the trade.

SAF Electrical Equipment Company, Boston, Mass.

Gentlemen: Kindly send me free bulletin on S-A-F 3 and place my name on your list to receive the course of lectures on the latest acoustical and electrical advances in sound recording and reproduction, written by leading engineers, professors and experts.

Name..

Address..

Occupation..

PILOT SUPER WASP RECEIVER

THE A.C. Short Wave set that works—has passed the rigid tests of CHI-RAD engineers and is recommended as the best short wave receiver by many other reliable authorities.

Screen Grid has increased its sensitivity and selectivity. There are absolutely no hand capacity effects. ALL METAL CHASSIS —***completely shielded.***

Wide Wavelength Range
Five pairs of PILOT plug in coils are supplied. Red coils for 14 to 27 meters; orange, 26 to 50; yellow, 50 to 100; green, 100 to 200; blue, 200 to 500.

A.C. Complete Kit..............**$34.50**
Power Pack 16.50
Assembled, ready for use with power pack, tubes and cable **$75.00**
Also D.C. Type (Battery) as follows:
Complete Kit of Parts..**$29.50**
Assembled 42.50
Tubes and Batteries Extra

1930 complete catalog SHORT WAVE SUPPLIES on request

CHICAGO RADIO APPARATUS CO. 417 S. Dearborn St. CHICAGO, U. S. A.
Phone Harrison 2276

Express Prepaid If Cash Is Sent With Order

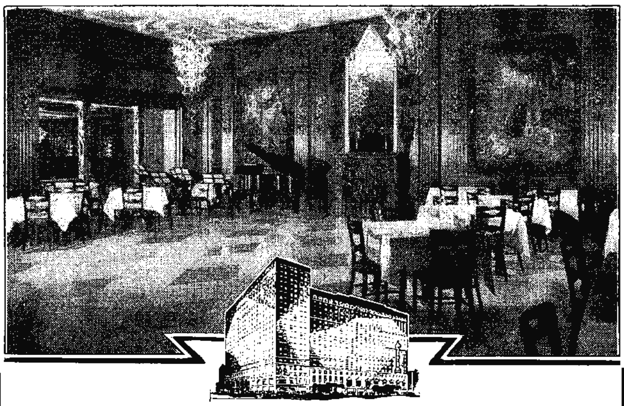
Deposit of 25% Required on All C.O.D. Orders

CHICAGO RADIO APPARATUS CO.
Gentlemen: CB-3
Please send FREE copy of your NEW 1930 CATALOG.

Name..

Address..

City.................................State..................



GOOD food, cheerful rooms, restful comfort and superior service will make your stay at the New Bismarck linger as a pleasant memory long after your departure.

European hospitality, American conveniences.

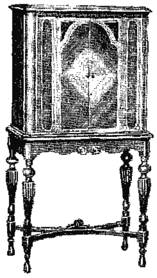
Rooms $2.50 up. With bath, $3.50 up.

NEW

BISMARCK

HOTEL CHICAGO

RANDOLPH AT LA SALLE



RADIO DEALERS WRITE

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Nelson AC Receiver

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Prompt Personal Service
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508 S. Dearborn St., Chicago, Ill.

Double Your Salary Selling Radio

Thousands of men are making $25 to $60 a week during their spare time evenings selling radios under my tested and proven plan. You can, too. No experience needed. I'll quickly train you and set you up in a business of your own. Start making money from the start. Send for my free book, THE WILL TO WIN, for complete story and positive proof that I can help you make more money. Address

J. MATHESON BELL, 138 AUSTIN AVE., CHICAGO, ILL.

One of Many Beautiful New Styles

FACTORY TO YOU—SAVE 50%

Try it 30 DAYS FREE BEFORE YOU BUY

Latest Screen Grid Push-Pull Electric MIRACO Radios

Steel Chassis

You needn't send a cent! Enjoy a powerful new Miraco 30 days in your home—at our risk. Send for latest literature and Amazing Special Wholesale Price Offer.

Screen Grid 9 $49.88

MIDWEST RADIO CORPORATION
531-HM Miraco Bldg. Cincinnati, Ohio

DIES—LIGHT STAMPINGS

B. L. NORTWED

MITCHELL -:- -:- SOUTH DAKOTA

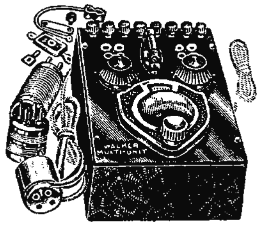
GEO. W. WALKER "MULTI-UNIT"

Well Deserves Its Popularity

Use Same Multi-Unit with Either A-C or Battery Type Receiver

The Only Device of Its Kind in the Radio Market —Anywhere

A RADIO RECEIVER IN ITSELF



SHORT WAVE RECEIVER
SHORT WAVE ADAPTER
Regular Broadcast Receiver—Screen Grid Pre-Amplifier—Radio Frequency Oscillator—Extra Stage Tuned R. F.—Radio Frequency Booster—Radio "Experimental" Unit—Wavemeter—Wavetrap—etc.

One of the most unusual radio instruments ever devised. Will perform any individual function of a complete receiver, and in addition, may be used for calibrating, testing or checking. Makes a wonderful broadcast receiver, short wave receiver or transmitter. Oscillates violently over the entire scale range from 550 meters down to 15. Uses all tubes 199 to 210 and all voltages, A.C., D.C., or rectified.

Nothing like it ever placed on the market before.

Serves as either an extra stage of tuned radio frequency or short wave adapter, by merely plugging into one of the tube sockets of the receiver. Tools or radio knowledge not necessary. The complete unit including four-lead plug-in adapter, plug-in coils, screen grid cap clip, etc., is housed in an attractive case, neatly finished. Complete non-technical instructions furnished. Box measures 7½x5x3½ in.

Ask Your Favorite Radio Magazine Editor About the Multi-Unit

Read What Enthusiastic Multi-Unit Fans Say—

"Using my Walker Multi-Unit for about 5 hours today and among others picked up was one Short Wave station at Paris, France."—Geo. H. Keller, 267 Delaware Ave., Albany, N. Y.

"Purchased one of your Multi-Units and am very pleased—using it as an Extra Stage of R.F. at present. I have found it to be a very good Short Wave Unit."—R. L. Colosky, 1032 Clackamas St., Portland, Ore.

"I bought a Multi-Unit and it's great. I am getting stations I never got before—it cuts down static."—James Woodrow, 2132 Lloyd St., Milwaukee.

"I have one of your Multi-Units. It worked fine. I got your town, Dallas, Chicago, Salt Lake City, Winnipeg."—Frank Becker, Box 36, Russel, N. Dak.

"Your Unit is wonderful. Lots of pleasure picking up Short Wave Broadcasting with unit applied to an old 6-tube Freshman."—Ed. H. Ehrham, 4740 Greenwood Ave., Chicago, Ill.

"I got a Walker Multi-Unit from you some time ago. I am very well pleased."—A. L. Demers, 2017 Ahlen Drive, Montrose, Calif.

"Have one of your very remarkable Multi-Units, and I wish to say that it has performed wonderfully. It works exceptionally well on Short Waves."—C. Hendon Baxter, 658 Marine St., Mobile, Ala.

"As a Radio Frequency Amplifier with a 199 tube, it certainly performed beautifully and added a lot of power to the Radiola 20."—Robert S. Alter, Cincinnati, Ohio.

"Have received Amateur Phone Stations, also Short Wave Broadcasts from KDKD, WLS, 2XZ (WABC), and 2XAL. Also heard WOO on board the 'Leviathan' talking to WSPN. Received this with sufficient volume on loud speaker to be heard in next room. Absolutely clear, no squeals, or hand capacity. I am more than pleased with the Unit."—A. F. Colton, 622 Evergreen St., Ashland, Ohio.

"Received several Short Wave stations right off the reel. I expect to receive Europe."—Patrick Curry, 203 14th St., Jersey City, N. J.

"I have been using your Multi-Unit as a one-tube receiver, employing a 201-A tube with very good results."—Nathan Edwards, 3453 Indiana Ave., Chicago.

"Your Walker Multi-Unit is a wonder in Radio achievement. I wouldn't take $25.00 for mine if I could not get another."—Wm. Honerman, Route 6, Kingfisher, Okla.

"I use the Unit as an R.F. Booster and the results are wonderful. Distance comes in like locals."—S. F. Kisco, 7511 Ridgeland Ave., Chicago, Ill.

"I have one of your Multi-Units and it has done everything as you have stated. I have also used it as a Modulator Oscillator and it has done as good as higher priced equipment. As a Short Wave with my Atwater Kent it reminded me of old times. The Radio Public don't know what they miss."—James M. Griffin, 2426 Fairview Ave., Wichita, Kansas.

"The 'Booster' works fine. I have been able to get a lot of stations in the daytime that I could not get before. Tried the one tube arrangement and can get WLW and WENR (Chicago)."—Edw. A. Schneider, 416 Capitol Bldg., Harrisburgh, Pa.

Should Your Dealer Be Unable to Serve You—Mail Your Remittance Directly to Factory

$16.00—NOW IS THE TIME TO BUY!—$16.00

FREE MULTI-UNIT FOLDER MAILED UPON REQUEST

One of America's Pioneer Radio Manufacturers

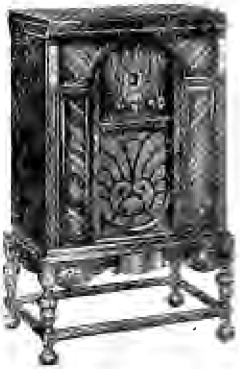
THE WORKRITE RADIO CORP.

1835 East 30th Street Cleveland, Ohio

BUY RADIO at WHOLESALE PRICES!

EVERYTHING at AMAZING DISCOUNTS

Here is your opportunity to buy standard Radio Equipment at TREMENDOUS DISCOUNTS. Greatest bargains ever offered on SCREEN GRID RADIO SETS, DYNAMIC SPEAKERS, LATEST KITS, PARTS, TUBES, ETC.



Screen Grid LAFAYETTE

All Electric A-C—9 Tubes

Wholesale presents the newest achievement in radio receivers—the 1930 LAFAYETTE. Screen-Grid, 245 Push-Pull. Dynamic Speaker. THE GENUINE LAFAYETTE CAN BE PURCHASED ONLY FROM WHOLESALE RADIO SERVICE COMPANY.

30 DAYS FREE TRIAL

You can try a genuine LAFAYETTE in your home for 30 days free trial. If it does not sell itself to you on sheer performance you are under no obligation to buy! Full details of this offer with our catalog.

Big FREE Catalog!

Every item listed in the 1930 Wholesale Catalog—the bargain book of the radio field—represents REAL VALUE. New, modern merchandise at startling reductions. No "closeouts" obsolete or distress merchandise! Everything you buy from WHOLESALE is unconditionally guaranteed.

Rush Coupon Today!

Mail the coupon below for a copy of the new 1930 WHOLESALE catalog. Yours for the asking. We guarantee prompt service, courteous co-operation and quick deliveries. Our Service Department will be glad to help you with your radio problems.

WHOLESALE RADIO SERVICE CO.
36 Vesey Street, Dept. D-19
New York, N. Y.

Please RUSH free copy of your new 1930 WHOLESALE catalog. This does not obligate me in any way.

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Address..

Town.............................. State..............................

Smashing Radio BARGAINS!

BUCKINGHAM 4

Screen Grid 8 Tube A-C Chassis

Here is a REAL BARGAIN. Genuine Buckingham 8 Tube A-C Chassis. 4 Screen-Grid Tubes. 245 Push-Pull Amplification. Utah Dynamic Speaker. Write for our special price.

Big Price Reductions:

HAMMARLUND HI-Q
Write for Our Special Price

NATIONAL MB-29
Write for Our Special Price

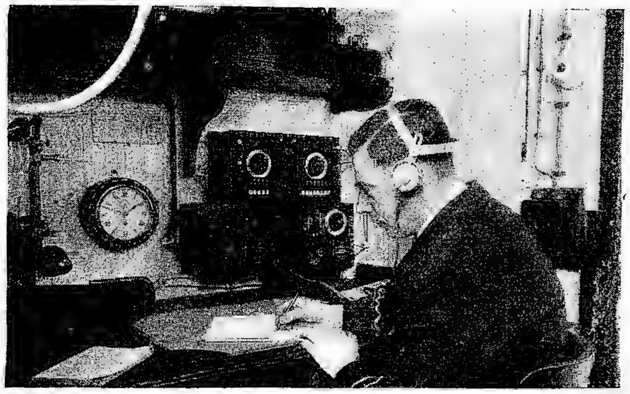
WEBSTER PICK-UPS
Write for Our Special Price

Public Address Systems with latest equipment. Racon and Wright DeCoster Exponential Horns. Pam Amplifiers. Jensen, Rola, Utah, Wright DeCoster, Magnavox Dynamic Speakers. Microphones. REL Short Wave Receiving and Transmitting Apparatus. Latest Type Set Analyzers, including Jewell, Readrite, Weston, and new Supreme Diagnometer. Everything at bargain prices.

Special Offerings in Consoles

Write for special bargains now available in consoles.

WHOLESALE RADIO SERVICE CO. INC.
36 VESEY ST. *Dept.* D-19 NEW YORK



RADIO OPERATORS WANTED

IN THE next five years the number of trained radio operators required for commercial stations and ships will be *double the present available supply*. This is the conservative estimate of the U. S. Department of Commerce and other authorities.

For this interesting, well-paid work, thousands of young men are needed, just as soon as they can get the necessary training. Land communication by radio is rapidly expanding. New airports are being built, which must have radio stations. An international agreement, effective in July, 1931, will require all ships of medium and large tonnage to carry two radio operators instead of one.

Here is one of the finest occupations a young man can choose. It offers an opportunity to enter a great modern industry with untold future possibilities—and to make a good salary from the start.

The International Correspondence Schools Radio Course is new, complete and up to date — abreast of the latest radio developments. It has been specially prepared for home study by nationally known radio authorities.

You can learn at home

In your spare hours, right at home, this great I. C. S. Radio Course will give you the technical knowledge of the subject you must have if you plan to become an operator, or enter one of the many other radio fields. Hundreds of I. C. S. trained men are now making big money as radio experts.

It will pay you to find out — at once — just what this course offers. Mail the coupon today for our free booklet.

International Correspondence Schools **Box 8320-D, Scranton, Pa.**
Without cost or obligation, please tell me all about the
NEW RADIO COURSE

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*Street Address*__________
*City*__________ *State*__________
If you reside in Canada, send this coupon to the International Correspondence Schools of Canada, Ltd., Montreal.

Index to Advertisers

The Latest Achievement in Short Wave Tuning

18 to 120 Meters Without Changing Coils

Each Receiver Completely Wired and Tested at the Factory

THE "NECO SPECIAL" shown above has the smoothest regeneration control of any Short Wave Receiver known and is the only entirely self-contained AC Short Wave Receiver using a 224 Screen Grid Power Tube as a detector. For use on 110 volt—60 cycle AC only. Tubes used in this model are two UY224, one UY227, one UX245 and one UX280. PRICE (WITHOUT TUBES) NET **$67.85**

"NECO" SHORT WAVE RECEIVERS

Come in a beautiful Brown Finish Metal Cabinet which completely eliminates all hand capacity effects.

Enjoy reception from such stations as 2ME at Sydney, Australia; 5SW, Chelmsford, England, and PCJ, Hilversum, Holland, with ample loud speaker volume and remarkable tone quality.

"NECO" Receivers incorporate many new features, permitting extreme sensitivity and ease of operation. "NECO" Receivers are the first Short Wave Receivers to use Screen Grid Detection with a remarkably high gain and stability. Regeneration control is smooth and noiseless, permitting the novice to tune "NECO" Receivers with extreme ease.

"NECO" BATTERY MODEL

Using two UX222 Screen Grid Tubes, One UX-112A and one UX171A Tube. Batteries required are 6 volt A, 4½ and 45 volt C batteries and 180 volt B battery. PRICE (Without tubes) NET **$47.85**

"NECO" Receivers eliminate bothersome plug-in coils, by simply turning the switch. The operator can cover 19 to 35 meters, 31 to 67 meters and 63 to 115 meters. An extra set of jacks is also provided for coils covering broadcast wavelengths.

EXTRA COILS

13 to 19 Meters	$1.95 Net
120 to 200 Meters	1.95 Net
190 to 360 Meters	1.95 Net
350 to 600 Meters	2.10 Net

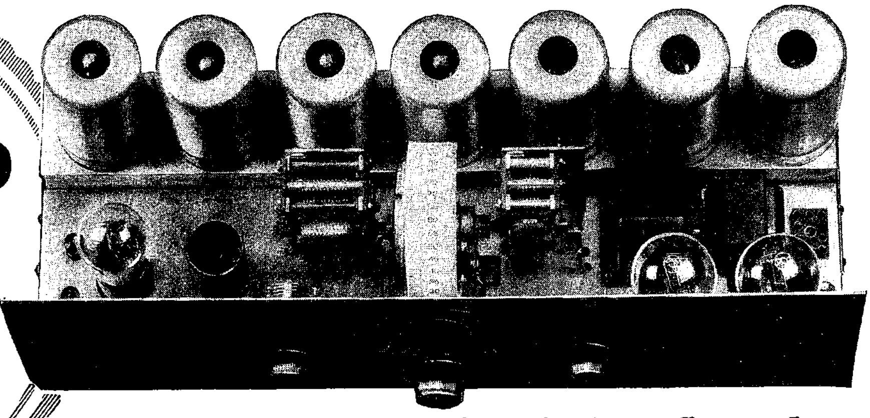
NEWARK ELECTRIC COMPANY

"Nothing But Radio"

228 West Madison Street -:- -:- -:- Chicago, Illinois

THE NEW H·F·L·MASTERTONE

11 Tubes A·C· Screen-Grid Receiver



Humless, Noiseless, Efficient Operation. A receiver that Incorporates Every Advanced Engineering Practice, Magnificent Tone, Tremendous Power Volume.

Completely Built, Wired *and* Assembled by H·F·L Engineers *Shipped Ready to Operate*

What Amazing Power

Amplification system built around the new AC Screen Grid tubes is especially adapted to intermediate frequency stages of superheterodyne receiver. No oscillation. Employs 5 screen grid tubes, the fifth being the detector, upon the plate of which is impressed 175 volts. This new system of power screen detection prevents overloading even at maximum volume.

Such Keen Sensitivity

Unlike any ever known, embracing every station, however weak or distant. Requires only wire screen or metal plate in cabinet for aerial to obtain coast to coast reception. Outside antenna may be used where louder signals or greater distances are desired.

Highly Developed Circuit

The intermediate employs four screen grid tubes with five tuned filter circuits, each one adjustable to peak of frequency to which they are tuned, assuring positive 10 kilocycle selectivity and defined clarity. The highly amplified signal is fed into the screen grid power detector, thence to the audio system. Most highly engineered receiver ever built.

Greatest *of all* RECEIVERS!

- **11 tubes operating at peak efficiency (5-224, 3-227, 2-245, 1-280)**
- **Single Dial Positive One-Spot Tuning**
- **Efficient, Humless AC Operation**
- **Uses 5 Screen Grid Tubes, 5 Tuned R. F. Circuits**
- **Fits practically all models of Consoles. Panel 7x21 inches. Depth, Chassis 7½ inches**
- **High Power Screen Grid Detector, with 175 Volts Impressed on Plate**
- **Automatic Line Voltage Control Inbuilt Holds Voltage Against Fluctuation**
- **100-Volt DC Dynamic Field Supply Incorporated**
- **All Metal Chassis—Completely Shielded Units**
- **3-Stage Phonographic Amplifier**
- **Finest Quality, Precision Made Parts: Thordarson, Carter, Mershon, etc.**

The New Audio System

Uniformity of amplification over entire musical scale is an outstanding achievement of Mastertone engineers. Absolutely free from hum. The first audio stage is followed by 245 tubes in push-pull arrangement. High plate voltage for these tubes is fed thru center tap push-pull impedence, permitting use of any type speaker. No actual B voltage feeds thru speaker. Operates with same efficiency with dynamic, magnetic or horn speakers.

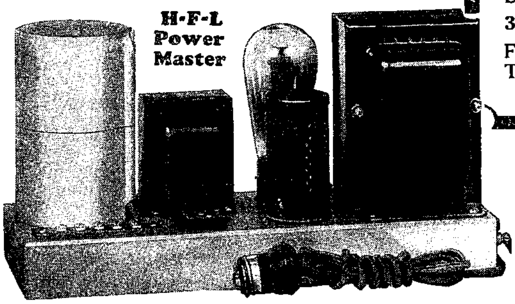
Phonograph Reproductions and Other Mastertone Features

Plug-in jack for instant attachment of electric phonograph pick-up. Three stages of audio system employed for this purpose. Entire receiver sturdily constructed of heavy cadmium plated steel and copper. All stages and tubes are shielded. Condensers, coils and wiring completely enclosed. Front panel is 7 x 21 inches. Depth of chassis, 7½ inches.

H·F·L Power Master

Designed to accommodate either AC or DC Dynamic. It is a specially developed unit of the Mastertone receiver built separately to simplify installation. Has large, oversized transformer. Filter system is equipped with a heavy choke and the new self healing type Mershon Condensers of 24 Microfarads capacity. Full wave type 280 rectifier tube. Automatic line ballast and regulator levels out all fluctuations in line voltage from 95 to 130 volts. Unit may be switched out if not desired.

H·F·L Power Master



A revolutionary achievement that sets up new standards of performance. After two years of painstaking research work and tests, the ultimate in receivers has been achieved—the H-F-L Mastertone—a receiver that awes and thrills with its great power, its sweetness of tone—each unit performing in its function with unfailing accuracy and precision.

Custom Built But Low in Price

Every Mastertone Receiver is built by hand in our own laboratories. This necessarily limits its production, yet the price is surprisingly low. Quality—not quantity—is our standard. We guarantee the Mastertone to be perfect in workmanship and materials, and to fulfill the claims we make for it. One demonstration will be proof conclusive that we have rightfully named it—MASTERTONE.

Write Today for Proposition

Postal or letter brings Complete Description and Price

HIGH FREQUENCY LABORATORIES
28 North Sheldon St. Dept. 13 Chicago, Ill.

JEWELL SET ANALYZERS
Pave the Way to Service Profits

No. 210 Tube Tester

Read these outstanding features of the Jewell Pattern 210 Tube Tester:

Gives direct readings, thereby increasing the speed and accuracy of tube testing.

Provides for variation in line from 100 to 130 volts so that checks can be made against standard charts without computing corrections. Another important factor in speed and accuracy of tube testing.

Tests all tubes, including rectifier tubes.

Special 100 milliampere scale is provided for accurate checking of rectifier tubes.

Gives individual readings of each plate of double wave tubes such as the 280.

Operates from A. C. service line.

Has sockets for 4 and 5 prong tubes.

List price	$65.00
Dealers' price	**48.75**

No. 199 Set Analyzer

The Jewell Pattern 199 Set Analyzer is the most popular set analyzer on the market because it—

Makes every practical radio field service test, including screen grid sets.

Is simple to operate—does not require a radio engineer to use it.

Is built to the highest standards throughout, and can be relied upon for accuracy as well as ability to stand the hard usage incurred in radio field service.

Is endorsed by leading radio engineers.

Is built throughout by manufacturers whose only business is the manufacture of precision instruments. Has push button switches that select desired scales in test service, eliminating troublesome rotary switches.

Is backed by a complete radio data service.

Is the lowest priced complete set analyzer on the market.

List price	$97.50
Dealers' price	**73.12**

No. 409 Set Analyzer

The Jewell Pattern 409 is built to the specifications of professional radio service men who want an instrument that gives filament, grid and plate voltages simultaneously. It makes every practical field test, including receivers with screen grid tubes.

It answers the requirements of the most expert service men for speed, yet it is so simple in operation that any service man can use it with facility.

It is built throughout to precision instrument standards.

The professional appearance of the Pattern 409 commands the confidence and respect of radio set owners as well as service men.

Push button selective switches assure speed in testing.

List price	$122.50
Dealers' price	**91.88**

Jewell Set Analyzers quickly pay for themselves. Service men who do not have good instruments pay for them over and over again in wasted time, costly service and loss of business. For sale by leading radio jobbers.

30 YEARS MAKING GOOD INSTRUMENTS

JEWELL

SET ANALYZERS

Jewell Electrical Instrument Company
1642-G Walnut Street, Chicago

Please send by return mail your booklet "Instructions for Servicing Radio Receivers" and the new Jewell bulletin on Radio Service Instruments.

Name --

Address --

LOCAL STATIC!

—end it NOW with

MUTER DEPENDABLE INTERFERENCE FILTERS

The JUNIOR

MEMBER R.M.A.

Produced by the manufacturers of the Muter Ultra-Dynamic Speaker—the new speaker of glorious tone. Replace that old magnetic speaker with a MUTER.

MUTER

CLEAR-TONED, perfect music coming from your speaker. Or a program to which you are listening intently for every word. Then, suddenly—crackle—sizzle—roar! The program distorted, cut up, ruined.

How many times has this happened to you? Probably only a nearby motor or electrical appliance, acting as a broadcasting station of its own, setting up local disturbance. But the end, just the same, of radio enjoyment.

End this nuisance of man-made static once and for all with the MUTER DEPENDABLE INTERFERENCE FILTER.

Made in two types

1. **The Junior:** For direct connection to radio set. Capacity type, with large factor of safety for use on 110 volt A. C. Priced at $5.00.
2. **The Senior:** For use in connection with electrical or mechanical devices causing local disturbances. Capacity inductance—rated for use on 110 volt A. C., on devices not exceeding 5 amp. current draw. The Senior may also be used in the same manner as the Junior, in direct connection with the radio set, offering an additional inductance to eliminate disturbances. Priced at $7.50.

If your dealer cannot supply you, send direct

LESLIE F. MUTER COMPANY

8440 South Chicago Avenue, Chicago