

*The*  
Institute of Radio  
Engineers

(INCORPORATED)

*Organized 1912*

YEAR BOOK  
1929



*Price \$1.50 per copy*

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Radio Advisory Committee, Bureau of Standards, Department of Commerce.....	L. M. HULL

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	L. M. HULL
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Component Parts and Wiring.....	W. P. POWERS
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	L. E. WHITTEMORE
	(Alternate)

Sectional Committee on Standards for Drawings and Drafting Room Practices.....	L. E. WHITTEMORE
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## GENERAL INFORMATION

### Institute History

Prior to the formation of the Institute of Radio Engineers, two other organized groups of radio enthusiasts held meetings in New York and Boston. These were the Wireless Institute and the Society of Wireless Telegraph Engineers.

On May 13, 1912, these two organizations were merged, taking the new name of the Institute of Radio Engineers. Headquarters were established in New York.

The Society of Wireless Telegraph Engineers had a membership of eleven on January 1, 1907, and forty-three on January 1, 1912. The Wireless Institute had fourteen members on January 1, 1909, and twenty-seven members on January 1, 1912. The Institute of Radio Engineers, at the time of its foundation, had less than fifty paid-up members.

Prominent in the early work of the Society of Wireless Telegraph Engineers were John Stone Stone, Lee DeForest, and Fritz Lowenstein. Those identified with the initial work of the Wireless Institute included: John S. Murphy, R. A. Somerville, Joseph D. Fountain, R. B. Respress, R. A. Cleva, John Gregg, E. Barnwell, Philip Farnsworth, Sidney L. Williams, R. H. Marriott, G. W. Pickard, Harry Shoemaker, and Eugene Thurston. The consolidation of these two societies and the initial work of organizing the Institute of Radio Engineers were done by J. V. L. Hogan, A. N. Goldsmith, and R. H. Marriott.

### Aims of the Institute

The Institute of Radio Engineers functions solely to advance the art and science of radio communication. It numbers among its members nearly all of the men who have been prominent in the development of radio in the United States, as well as many noted radio engineers and scientists in other countries.

The membership of the Institute consists of those persons who are qualified for any of its several grades of membership, either through their interest in radio communication, or by practice of some phase of radio engineering as a profession. The eligibility of an applicant to membership in any grade is finally determined by the Board of Direction of the Institute, in most cases on the recommendation of the Committee on Admissions.

Through the presentation and publication of original papers, by affording its members the opportunity of meeting to discuss radio problems, by awards of honors and prizes, and in other ways, the Institute fosters and encourages the development of this important means of communication, and particularly aids in the exchange of radio information of a technical and engineering nature.

### Publications

The papers presented at the meetings of the Sections and of the Institute in New York, together with the discussions and other papers submitted by Institute members, are printed in the PROCEEDINGS of the Institute of Radio Engineers, published monthly. The PROCEEDINGS thus constitutes a continually growing store of information on all phases of radio engineering. Since the first issue in 1913, 549 papers have been printed. The PROCEEDINGS is sent free to all Institute members of all grades. The subscription price to non-members is \$10.00 per year.

One of the most active Committees of the Institute in the past has been the Committee on Standardization. Standardization Reports giving definitions of terms and standard graphical symbols used in radio communication were issued in 1913, 1915, 1922, and 1926. The Standardization Report for 1928 appears in another portion of this Year Book. These Standardization Reports have become an important reference authority on terminology and symbols in radio practice.

This Year Book is the sixth one the Institute has published; the first appearing in 1914, the second in 1916, the third in 1926, the fourth in 1927, and the fifth in 1928.

### Institute Awards for Meritorious Achievement in Radio

The Institute each year makes two awards to radio investigators in recognition of noteworthy inventions or other developments in radio technique.

One award, the Institute Medal of Honor, is a gold medal suitably engraved. The Medal of Honor is awarded to that person who has made public the greatest advance in the science or art of radio communication, regardless of the time of performance or publication of the work on which the award is based.

The advance may be an unpatented or patented invention which has been completely and adequately described in a scientific or engineering publication of recognized standing, and must be in actual

operation. Preference will be given to widely used and widely useful inventions.

The advance may also be a scientific analysis or explanation of hitherto unexplained phenomena of distinct importance to the radio art, though the application thereof need not be immediate. Preference will be given analyses directly applicable in the art. Publication, in this case also, must be in full and approved form.

The advance may further be a new system of traffic regulation or control; a new system of administration of radio companies or of service of steamship, railroad, or other companies; a legislative program beneficial to the radio art, or any portion of the operating or regulating features of the art. It must be publicly described in clear and approved form and must, in general, be actually adopted in practice.

This medal has been awarded to the following:

E. H. Armstrong.....1918	John Stone Stone.....1923
E. F. W. Alexanderson.....1919	M. I. Pupin.....1924
G. Marconi.....1920	G. W. Pickard.....1926
R. A. Fessenden.....1921	L. W. Austin.....1927
Lee De Forest.....1922	Jonathan Zenneck.....1928

The other award is known as the Morris Liebmann Memorial Prize. This award was made possible through the generosity of Emil J. Simon, a Fellow of the Institute. It is given to perpetuate the memory of the late Colonel Morris N. Liebmann. The award consists of the sum of five hundred dollars which is the annual income derived from the principal of the gift of ten thousand dollars.

The award is made by a special committee, appointed annually by the Board of Direction, to that member of the Institute who, in the opinion of this committee, shall have made the most important contribution to the radio art during the preceding calendar year.

The Morris Liebmann Memorial Prize has been awarded to the following:

L. F. Fuller.....1919	J. R. Carson.....1924
R. A. Weagant.....1920	Frank Conrad.....1925
R. A. Heising.....1921	Ralph Bown.....1926
C. S. Franklin.....1922	A. Hoyt Taylor.....1927
H. H. Beverage.....1923	Walter G. Cady.....1928

All members of the Institute are eligible as candidates for these highly valued prizes. Each year's developments are carefully reviewed and examined by the Committees appointed, and by the Board of Di-

rection, the awards being made by vote of the Board in the case of the Institute Medal of Honor, and by vote of the committee appointed by the Board in the case of the Liebmann Memorial Prize.

The names of the engineers who have already been granted awards clearly show that the younger men as well as the pioneers, and the design, development and factory engineers as well as research engineers, have been given due recognition in the making of awards:

### Grades of and Qualifications for Membership

The several grades of membership in the Institute of Radio Engineers as well as the qualifications required for each, dues, fees, etc., are tabulated on page 12. Full details will be found in the Constitution under Articles II and III. All the benefits of membership are available at once to all new members of any grade, except that Juniors are not eligible to vote. Membership means, also, that one is enrolled with others having a similar interest in radio, and that one is on record as being among those who are interested and active in the development of this new and useful branch of the electrical engineering industry.

The grades of Fellow and Member require a much higher degree of technical training and experience than the grade of Associate. In order to maintain a high standard of membership, the Board of Direction in each case very carefully scrutinizes the applications for Fellow and Member grades.

Before applying for membership in any grade the applicant should carefully read the Constitution of the Institute to ascertain for which of the several grades he is eligible. An extract from the Constitution dealing with admissions, eligibility, fees, etc., is printed on the back of the application form obtainable from Institute Headquarters.

When filling in the application form, the applicant should submit the names of those persons who have knowledge of his professional experience, rather than those who have a high professional standing, but cannot vouch for him. The personal signatures of references are not required.

### Institute Badges

The authorized Institute badge is of 14-karat gold, finished in enamel and gold lettering. The Fellow's badge is of blue lettering on a gold background, Member's badge of gold lettering on a blue background, Associate's badge of gold lettering on a maroon background, and Junior's badge of gold lettering on a white background. The

## MEMBERSHIP REQUIREMENTS, FEES, ETC.

Grade	Minimum Age	Years Active in Radio Engineering	References Required	Entrance Fee	Transfer Fee to Next Grade	Annual Dues
Fellow.....	30	7	Five Fellows	\$10	—	\$15
Member.....	25	4	Five Fellows or Members	\$5	\$5	\$10
Associate.....	21	A Person Who is Interested in or Connected with the Radio Arts.	†Five Fellows, Members or Associates	\$3	\$4	\$6
Juniors.....	16*	A Person Interested in the study of Radio.	†Five Fellows, Members or Associates	\$1	\$2	\$4

\*The maximum age of a Junior member is 20 years. Upon attaining the age of 21, the Junior member is transferred to the grade of Associate.

†In the case of the Junior or Associate applicant who is unable to supply the names of five members of the required grade, it is sufficient, usually, if the names of five business associates or friends are given. These should preferably be persons engaged in engineering or scientific work.

badge is made in three different forms: a screw-back lapel button, a lapel pin, and watch charm. The lapel button is approximately one-half the size of the emblem shown here, and sells for \$2.75 (any grade). The lapel pin and watch charm are approximately of the size of the illustration. The charm is finished on both sides and is provided with a ring for suspending the charm from a watch chain or fob. The lapel pin is priced at \$3.00 (any grade) and the watch charm is supplied at \$5.00 (any grade). Any of these may be ordered through the office of the Secretary.

Members of the Institute of Radio Engineers are authorized to indicate their grade of membership in the Institute only in the following manner:

Fellow I. R. E.  
Member I. R. E.  
Associate I. R. E.

#### Certificates of Membership

Upon application to the Secretary's office membership cards are sent to all members each year, and diplomas are supplied to Members and Fellows. The membership cards are signed by the Secretary and the diplomas are signed by the President and the Secretary.

#### Meetings

New York meetings of the Institute of Radio Engineers are held on the first Wednesday of each month (except during July and August) at the Engineering Societies Building, 33 West 39th Street, New York City. On these occasions engineering papers are presented. These papers describe recent developments in radio, and are the subject of general discussion on the part of those in attendance.

#### Sections

The following Sections of the Institute, which in most cases meet once a month, have been organized in localities where there is a sufficient number of Institute members:

ATLANTA—Walter Van Nostrand, Chairman, George Llewellyn, Secretary, P. O. Box 1593, Atlanta, Ga.

BOSTON—George W. Pierce, Chairman, Melville Eastham, Secretary, 30 State St., Cambridge, Mass.

BUFFALO-NIAGARA—L. C. F. Horle, Chairman, P. S. March, Secretary, 428 Richmond Ave., Buffalo, N. Y.

CHICAGO—H. E. Kranz, Chairman, John H. Miller, Secretary, Jewell Electrical Instrument Co., 1650 Walnut St., Chicago, Ill.

CLEVELAND—Bruce W. David, Chairman, D. Schregardus, Secretary, Ohio Bell Tel. Co., 750 Huron Road, Cleveland, Ohio.

CONNECTICUT VALLEY—Q. A. Brackett, Chairman, F. C. Beekley, Secretary, 96 South Main St., W. Hartford, Conn.

DETROIT—A. B. Buchanan, Chairman, W. R. Hoffman, Secretary, 615 W. Lafayette Blvd., Detroit, Michigan.

LOS ANGELES—T. F. Mc Donough, Chairman, W. W. Lindsay, Jr., Secretary, 1348 Club View Drive, Los Angeles, Calif.

NEW ORLEANS—Pendleton E. Lehde, Chairman, Anton A. Schiele, Secretary, 1812 Masonic Temple, New Orleans, La.

PHILADELPHIA—J. C. Van Horn, Chairman, John C. Mevius, Secretary, 5135 N. Fairhill St., Philadelphia, Pa.

PITTSBURGH—L. A. Terven, Chairman, T. D. Cunningham, Secretary, 513 Holmes Street, Wilkinsburg, Penna.

ROCHESTER—A. B. Chamberlain, Chairman, Arthur L. Schoen, Secretary, 3 Kodak Park, Rochester, N. Y.

SAN FRANCISCO—Donald K. Lippincott, Chairman, Paul Fenner, Secretary, Custom House, San Francisco, Calif.

SEATTLE—Austin V. Eastman, Chairman, Abner R. Willson, Secretary, 8055-14th Ave. N. E., Seattle, Washington.

TORONTO—A. M. Patience, Chairman, C. C. Meredith, Secretary, 110 Church St., Toronto, Ontario, Canada.

WASHINGTON—F. P. Guthrie, Chairman, T. McL. Davis, Secretary, 4302 Brandywine St., Washington, D. C.

#### Procedure to be Followed in Forming a Section

In forming a Section of the Institute, the following is the approved procedure:

a. Carefully read the "By-Laws Governing Sections" found on page 40 of this book.

b. Make a tentative canvass of the members residing within the territorial limits of the proposed Section. If at least twenty-five (preferably thirty-five) Associates, Members, or Fellows favor and will support a Section, if established, obtain from Institute Headquarters a petition form. In making this tentative canvass effort should be made to obtain applications from desirable and eligible non-members. Wherever there are less than twenty-five members of the Institute but it is felt that applications can be obtained from the necessary number of eligible non-members, this

tentative canvass may be made and the membership applications forwarded to the Institute's Offices. In making this tentative canvass consideration should be given to the probable permanent Chairman and other officers of the Section, if formed. Much of the success of a Section depends on the calibre of the Chairman and the interest taken by him in the affairs of the Section. Institute Headquarters, therefore, would like information as to the probable candidates at the time the request is made for the petition forms.

c. On receipt of the petition forms and list of members residing within the territorial limits, an organization meeting should be called for the purpose of obtaining signatures to the petition, and to form a temporary organization.

d. The petition form, properly signed by the required number of members and accompanied by the minutes of the temporary organization meeting, should then be forwarded to the Institute Headquarters for presentation to the Board of Direction.

e. Upon receipt of the approval of the Board of Direction of the Institute, a meeting should be called for the purpose of forming the permanent organization. At this meeting the officers of the Section should be elected and the several standing Committees organized.

f. Thereafter not less than five meetings shall be held annually.

g. A full report of each meeting must be made to the Headquarters of the Institute on the form supplied by the Institute.

#### American Standards Association

The American Standards Association serves as a national clearing house for engineering and industrial standardization and acts as the official channel of cooperation in international standardization. It conducts its work through the activity of Sectional Committees, the responsibility for each of the several hundred standardization projects being in the hands of one or more cooperating agencies known as "sponsors."

The Institute of Radio Engineers and the American Institute of Electrical Engineers are joint sponsors for the Sectional Committee on Radio. The Institute of Radio Engineers is also cooperating in the formulation of standards on five other subjects, its representatives on all of these Sectional Committees being given on page 7.

The Sectional Committee on Radio is composed of representatives from nineteen cooperating organizations. The Executive Committee

## GENERAL INFORMATION

of the Sectional Committee on Radio consists of the following officers and Chairmen of Technical Committees:

ALFRED N. GOLDSMITH, *Chairman*  
 C. H. SHARP, *Vice-Chairman*  
 L. E. WHITTEMORE, *Acting Secretary*

Chairmen of Technical Committees:

Transmitting and Receiving Sets and Installations.....	A. F. VAN DYCK
Component Parts and Wiring.....	L. G. PACENT
Vacuum Tubes.....	C. B. JOLLIFFE
Electro-Acoustic Devices.....	LLOYD ESPENSCHIED
Power Supply and Outside Plant.....	L. W. CHUBB

## REPORT OF THE BOARD OF DIRECTION INSTITUTE OF RADIO ENGINEERS

1928

TO THE MEMBERS OF THE INSTITUTE:

The following constitutes a brief summary of the principal activities of the Institute during the year.

**General.** Progress in all Institute activities during the year 1928 has been very gratifying. The steady and healthy growth of the Institute's membership has been maintained without intensive membership campaigns. Meetings have been held regularly throughout the year with better attendance and more interesting types of technical programs. The annual three-day Convention in New York City was attended by over seven hundred members. Two new Institute Sections were organized. Tours to Sections by prominent engineers were arranged. Additional financial assistance was given each Section. The editorial pages of the PROCEEDINGS were increased by some sixty-eight per cent, at the same time, it is felt, maintaining the aim of the Institute to publish only the best in radio engineering. A number of new departments in the PROCEEDINGS were introduced. A preliminary standardization report was issued. A number of new committees were formed and adopted policies covering procedure and courses of action. On several occasions the Board of Direction of the Institute was consulted by the Federal Radio Commission for assistance in its technical problems. The headquarters office of the Institute was removed to more spacious and fitting quarters. The office staff was increased to take care of the additional duties involved in the operation of the Institute.

**Directors' Meetings.** The Board of Direction held ten regular meetings in New York City. The average attendance was eight, with an average of four hours' time devoted to each meeting. The Board considered and acted upon all of the major problems which are involved in the management and operation of the Institute. The business transacted at these meetings has been duly recorded in the minutes thereof. Matters of general information to the Institute membership have been published, from time to time, in the Institute Notes section of the PROCEEDINGS. During April an invitation from the Federal Radio Commission to send representatives to an informal conference to consider technical problems arising in connection with the allo-

cation of broadcast channels to zones and States was received by the Institute. A special meeting of the Board of Direction was called to formulate suggestions and to appoint a committee of the Board to attend the conference. The allocation plan put into effect by the Commission on November 11, 1928 is closely related, in its main engineering aspects, to that recommended by the Board of Direction. During November a special meeting of the Board was called to consider the proposed revised draft of the Institute's Constitution prepared by the Committee on Constitution and Laws.

**Address of President before Manufacturers' Association.** On June 7th President Goldsmith presented an address, "Cooperation between the Institute of Radio Engineers and Manufacturers' Associations," before the annual convention of the Radio Division of the National Electrical Manufacturers' Association at Chicago. This address was published in the August 1928 issue of the PROCEEDINGS.

**Annual Convention.** The Third Annual Convention was held in New York City on January 9th to 11th, with headquarters in the Engineering Societies Building. Douglas Rigney served as chairman of the Convention Committee. Following the Installation of 1928 officers the 1927 Morris Liebmann Memorial Prize was presented. During the Convention ten technical papers were read. Three hundred and fifty members visited eight radio organizations on trips of inspection. The second conference of Section representatives was held, attended by delegates from twelve Sections. On the last evening of the convention a banquet at the Hotel Roosevelt, in which four hundred and fifty members and guests took part, brought the convention to a close. The registration for the convention was almost one hundred per cent greater than that of the previous year.

**New York Meetings.** Ten regular technical meetings were held in New York City in the Engineering Societies Building. On the occasion of the presentation of the 1928 Institute Medal of Honor the Institute was fortunate in having Professor Jonathan Zenneck of Munich, Germany present to receive the award and to address the Institute on "The Importance of Radio Telegraphy in Science." The average attendance at New York meetings during the year was over three hundred. The available meeting room was always over-crowded; however, arrangements have been completed to secure a room of adequate size in the future.

**Headquarters.** Early in the year the headquarters office was removed to the Engineering Societies Building in which are located the

headquarters of a large number of the national engineering societies. Increased office space of approximately fifty per cent was secured to provide satisfactory facilities for the increased office staff. A members' conference room was made available for letter-writing, members' informal meetings, and committee and Board meetings. Three additional members to the office staff were secured. The duties incidental to the publication of the PROCEEDINGS, handling of general and Section correspondence, and general office operation have necessitated the addition of nine employees to the office force during the past two years. Much new office furniture and equipment has been purchased.

#### COMMITTEES

The major activities of the Institute proper are sponsored by and accomplished through the voluntary work of the many Institute committees. Without the continued assistance of its committees none of the functions of the Institute could be carried out. During 1928 all Institute committees have been engaged steadily in their work. Committee membership is rightly considered a direct contribution to the radio art.

**Meetings and Papers.** While it was thought that the Committee on Meetings and Papers, J. H. Dellinger, Chairman, would carry on its duties mainly through correspondence and the work of its individual members, four meetings of the Committee were held during the year. The Committee established policies and procedures for the review and handling of papers for the PROCEEDINGS which were subsequently formally approved by the Board of Direction. The Committee inaugurated the Publication of a page in the PROCEEDINGS "Suggestions to Contributors," designed to assist contributors in following an approved style in the preparation of papers submitted for publication. During the year the Committee reviewed one hundred and eleven papers, approving ninety-nine of these for publication after many had been revised by the authors. The Committee made all tentative plans for the technical sessions of the forthcoming annual convention to be held in Washington, D. C. on May 13-15, 1929. In addition to these duties the Committee was responsible for the arrangement of all New York meeting programs.

**Board of Editors.** In November it became evident that it would be necessary to establish a Board of Editors to assist in the greatly increased technical editorial duties required in the publication of the PROCEEDINGS. Such a Board was appointed with membership as fol-



lows: Alfred N. Goldsmith, Chairman, Stuart Ballantine, Ralph Batcher, W. G. Cady, Carl Dreher, and Greenleaf W. Pickard. All extensive technical editing is being carried on by this Board.

**Committee on Broadcasting.** To assist the Federal Radio Commission and the general public in the multiplicity of technical problems confronting the whole art, a Committee on Broadcasting was created in November. Its membership is: Lewis M. Hull, Chairman, Arthur Batcheller, Carl Dreher, Paul A. Greene, C. W. Horn, R. H. Marriott, and E. L. Nelson. The Committee is active in the solution of various technical problems brought to its attention, both through correspondence and holding of meetings at frequent intervals.

**Committee on Awards.** A standing Committee on Awards was appointed in June to make recommendations to the Board of Direction as to candidates for the Institute Medal of Honor and the Morris Liebmann Memorial Prize. J. V. L. Hogan is Chairman of this committee. The Committee recommended candidates for the 1928 Liebmann Prize, and early in 1929 will recommend the names of the recipients of the 1929 Institute Medal of Honor and the Liebmann Prize.

**Committee on Admissions.** The Committee on Admissions of which R. A. Heising is Chairman held eleven meetings during the year, considered and referred to the Board of Direction for final action applications from two hundred and forty-seven persons for direct election or transfer to the higher grades of membership in the Institute. The recommendations of the Committee were as follows:

	Acted Upon	Approved
Transfer to Fellow grade.....	8	7
Recommended by the Committee on Membership for transfer to the Fellow grade.....		15
Election to the Fellow grade....	2	2
Transfer to the Member grade...	81	41
Recommended by the Committee on Membership for transfer to the Member grade.....		26
Election to the Member grade...	89	56

The high standard of membership in the election or transfer of members during the year has been due to the thorough and careful consideration of each application by the Committee. During 1928 the plan of publishing in the PROCEEDINGS the names of all applicants for membership, prior to action by the Committee or the Board, was inaugurated to further assist in the maintenance of a high standard of Institute membership.

**Committee on Sections.** Four meetings of the Committee on Sections, Donald McNicol, Chairman, were held during the year. New Sections were organized in Pittsburgh and New Orleans. Preliminary work looking to the formation of Sections in four additional territories has been completed. The Committee arranged for tours on the part of prominent engineers during the year to provide one or more programs for the following Sections: Atlanta, Buffalo-Niagara, Chicago, Cleveland, Connecticut Valley, Detroit, Los Angeles, New Orleans, Philadelphia, Pittsburgh, Rochester, San Francisco, and Washington. Members of the Committee visited several Sections to establish better personal contact between the Section officers and the Committee.

The table below indicates the scope of Section activities during this and immediate past years:

Section	Membership on			Average Attendance 1928
	December 15, 1928	1926	1927	
Atlanta	24	—	6	30
Boston	218	—	1	124
Buffalo-Niagara	72	—	7	77
Chicago	309	5	5	157
Cleveland	126	—	6	96
Connecticut Valley	117	4	5	41
Detroit	95	—	10	100
Los Angeles	154	6	6	49
New Orleans	30	—	—	28
Philadelphia	191	5	10	78
Pittsburgh	80	—	—	32
Rochester	66	6	6	159
San Francisco	128	3	1	117
Seattle	53	7	8	35
Toronto	127	7	9	73
Washington (D.C.)	125	7	6	61

**Committee on Nominations.** A Committee on Nominations, J. H. Dellinger, Chairman, was appointed in June to prepare a suggested slate for 1929 elective officers and members of the Board of Direction, for consideration by the Board of Direction. Such a report was rendered to the Board of Direction on September 5th.

**Committee on Constitution and Laws.** The Committee on Constitution and Laws, R. H. Marriott, Chairman, was appointed in April. The Committee held five meetings during the year. Several drafts of a new Institute Constitution and By-Laws were prepared and revised, the Committee's immediate work being completed when the final revised draft was submitted to the Board of Direction for adoption at the special November meeting.

**Committee on Publicity.** The Committee on Publicity, of which W. G. H. Finch was Chairman, provided extensive publicity for all

New York meetings of the Institute, releases being given wide distribution through press associations, i.e. national wire services and being sent to two hundred and fifty newspapers monthly. During the 1928 Annual Convention news releases were sent to two thousand five hundred papers at regular intervals. The work of the Committee was, in a large measure, responsible for the excellent attendance at all Convention sessions, and has assisted materially in the duties of the Committee on Membership in bringing the Institute to the attention of desirable non-members.

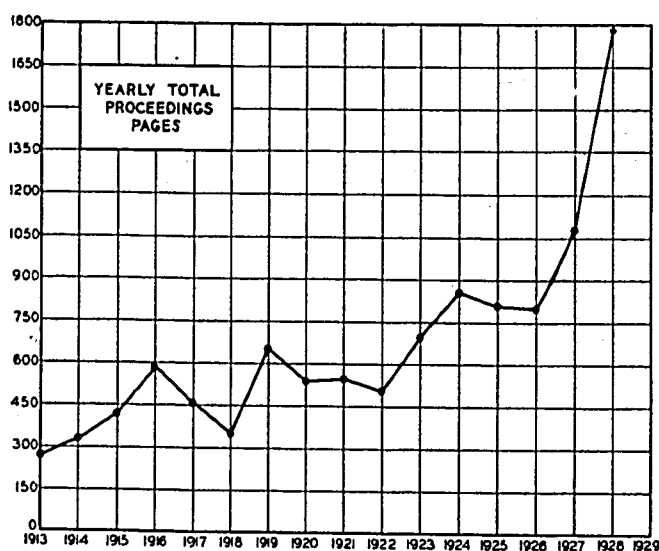
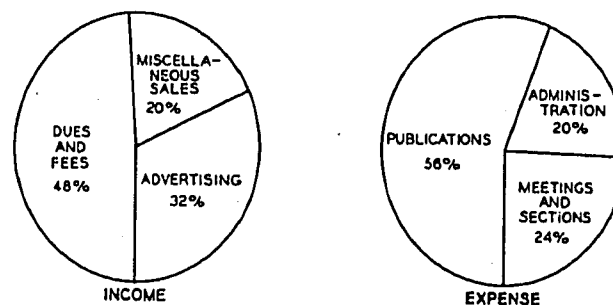


Fig. 1

**Committee on Membership.** The Committee on Membership, H. F. Dart, Chairman, held seven meetings during the year. The Committee sponsored the activities of the Membership Committee of Sections with whose aid applications for membership were received from one thousand and seventy-eight non-members during the year. The total net gain in membership during 1928 was seven hundred and fifty, bringing the Institute membership to five thousand. The Committee on Membership assisted the Committee on Admissions and the Board of Direction by recommending various Associates and Members for transfer to the higher grades of membership in the Institute.

**Committee on Standardization.** The Committee on Standardization, L. E. Whittemore, Chairman, has been very active in its work to complete the 1928 Standardization Report, with the assistance of

its sub-committees whose Chairmen are as follows: Vacuum Tubes, L. A. Hazeltine, 1927, C. B. Jolliffe, 1928; Receiving Sets, J. H. Dellinger, 1927, E. T. Dickey, 1928; Electro-Acoustic Devices, R. H. Manson; Circuit Elements, H. M. Turner; Power Supply, W. E. Holland; Radio Transmission (formerly Use of the Transmission Unit), J. V. L. Hogan; and Bibliography, the late C. A. Wright. Through correspondence and frequent meetings all of the sub-committees have completed drafts of reports for consideration by the Committee. The Committee has held four meetings since these drafts were completed in November and the final report for 1928 has been substantially completed to allow its being published in the 1929 Year Book.



**INCOME**

DUES AND FEES:-- MEMBERS' DUES, ENTRANCE, AND TRANSFER FEES.

ADVERTISING:-- PROCEEDINGS AND YEAR BOOK.

MISCELLANEOUS SALES:-- REPRINTS, SUBSCRIPTIONS TO PROCEEDINGS, EMBLEMS, BINDERS, ETC.

**EXPENSE**

PUBLICATIONS:-- PROCEEDINGS, YEAR BOOK, PRELIMINARY STANDARDIZATION REPORT, ETC.

MEETINGS AND SECTIONS:-- SECTION RE-FUNDS, CONVENTIONS, NEW YORK MEETINGS, PREPRINTS, ETC.

ADMINISTRATION:-- OPERATION EXPENSES AS SALARIES, RENT, OFFICE EQUIPMENT, POSTAGE, ETC.

Fig. 2

## MISCELLANEOUS

**Publications.** During 1928 ninety-nine technical papers, sixteen discussions to papers, fifteen book reviews, two reviews of current literature, and one hundred and thirty-three pages of Institute Notes, comprising a total of almost eighteen hundred pages, were published in the PROCEEDINGS. The chart of Fig. 1 shows the yearly total of editorial pages published in the PROCEEDINGS since 1912. The References to Current Radio Literature, prepared by the Bureau of Standards, were published monthly. The scope of the Institute Notes section of the PROCEEDINGS was widened to include a monthly section of personal notes, short semi-technical news notes, a monthly frontispiece of an officer or member of the Board of Direction of the Institute, monthly lists of members elected and applications received for membership, etc. Seven thousand copies of the PROCEEDINGS were published monthly.

In July seven thousand copies of a one hundred and seventy-five page Year Book were printed and distributed. In addition to the usual material of general information, past officers and members of the Board of Direction, Constitution and By-Laws, the 1928 Year Book contained a catalog of the Institute membership arranged both alphabetically and geographically.

One thousand copies of the preliminary draft of the report of the Committee on Standardization were printed and distributed to members and non-members interested in standardization.

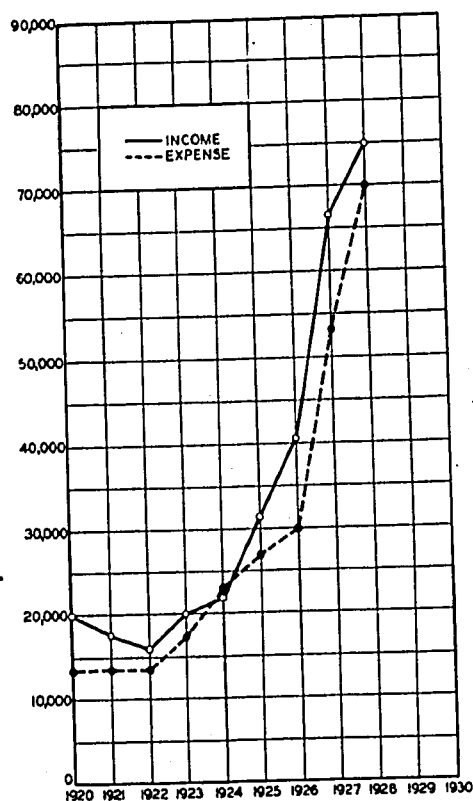


Fig. 3

**Advertising.** On the first of the year the handling of all advertising solicitation for Institute publications was transferred from an outside agency to the office of the Institute. The income from advertising, through this arrangement, was practically double that of the former year. The average number of advertising pages printed monthly in the PROCEEDINGS was increased from twenty-six to forty. Twenty-eight advertising pages were printed in the 1928 Year Book.

**Finances.** The financial management of the Institute has been such that for every dollar received from the membership in dues about two dollars and ten cents has been spent. This has been made possible through the large increase in revenue from sources other than membership dues. In Fig. 2 will be seen a chart showing the proportion between total income and the various major sources of income, and the proportion between total expenses and each general class of expense. The chart of Fig. 3 shows the yearly income and expense from 1920 to date. It will be noted that the yearly net surplus is not increasing, it being felt that the small surplus being set aside each year should adequately take care of any contingencies which may arise in future years requiring a source of reserve funds.

**Deaths.** The following members of the Institute died during 1928:

Chas. Allen Wright  
 H. M. Freeman  
 John H. Cuntz  
 Robert Loghry  
 Harry R. Knettles  
 William Le Queux  
 Harold D. Kent  
 Ernest Tyrman  
 E. L. Bernds  
 T. R. Bristol  
 C. W. Evarts  
 Gay H. Mead  
 Warren Ellsworth Balsdon  
 Chester Douglas Pederson  
 Frederick G. Simpson

GEOGRAPHICAL DISTRIBUTION OF INSTITUTE MEMBERSHIP ON  
 December 15, 1928

Continental United States	4,028
Alaska	3
Canal Zone	4
Philippine Islands	12
Australia	25
Belgium	2
Bermuda	2
British India	13
British West Indies	2
Canada	200
Central America	1
China	21
Colombia	1

Costa Rica.....	1
Cuba.....	3
Czechoslovakia.....	3
Denmark.....	8
Dutch East Indies.....	1
Egypt.....	2
England.....	296
Federated Malay States.....	5
France.....	14
Germany.....	10
Gibraltar.....	1
Haiti.....	1
Holland.....	8
Hungary.....	1
Ireland.....	5
Italy.....	2
Japan.....	47
Mexico.....	13
New Zealand.....	16
Palestine.....	1
Poland.....	1
Porto Rico.....	3
Portugal.....	1
Russia.....	3
Scotland.....	13
South Africa.....	22
South America.....	13
Spain.....	9
Straits Settlements.....	1
Sweden.....	3
Switzerland.....	2

JOHN M. CLAYTON  
Secretary.

THE INSTITUTE OF RADIO ENGINEERS, INC.  
COMPARATIVE BALANCE SHEET

December 31, 1928 and 1927

	Dec. 31, 1928	Dec. 31, 1927	Increase, Decrease	
<b>ASSETS</b>				
<b>CASH</b>				
On Deposit—Corn Exchange Bank.	\$14,203.82	8,886.34	5,322.48	
On Deposit—National State Bank, Newark.....	7.29	7.29		
On Deposit—Savings Account— National State Bank, Newark..	5,342.77	5,134.50	208.27	
Secretary's Imprest Fund, Corn Exchange Bank.....	417.18	1,010.00	1,192.82	
Secretary's Imprest Fund, Currency	175.00	175.00		
<b>TOTAL CASH</b>	<b>20,151.06</b>	<b>15,813.13</b>	<b>4,337.93</b>	
<b>ACCOUNTS RECEIVABLE</b>				
Juniors.....	133.00	120.50	12.50	
Associates.....	1,073.65	2,316.45	1,242.80	
Members.....	88.00	234.21	146.21	
Fellows.....		35.00	35.00	
Transfer Fees.....	30.00	22.00	8.00	
Advertising.....	1,501.67	1,106.67	395.00	
<b>TOTAL ACCOUNTS RECEIVABLE</b>	<b>2,826.32</b>	<b>3,834.83</b>	<b>1,008.51</b>	
<b>NOTES RECEIVABLE</b>				
	20.67	90.00	63.33	
<b>INVENTORY</b>				
Proceedings on Hand.....	5,141.20	2,705.06	2,435.24	
Bound Volumes on Hand.....	374.28	735.06	360.78	
Paper Stock on Hand.....	1,519.96	3,321.27	1,801.31	
Binders on Hand.....	36.75	205.62	168.87	
<b>TOTAL INVENTORY</b>	<b>7,072.19</b>	<b>6,967.01</b>	<b>104.28</b>	
<b>INVESTMENTS</b>	<b>31,192.50</b>	<b>26,990.00</b>	<b>4,202.50</b>	
<b>FURNITURE AND FIXTURES</b> .....\$5,541.36				
Less—Reserve for Depreciation.....	1,664.82	3,870.54	2,070.75	905.70
<b>ACCRUED INTEREST ON INVESTMENTS</b>	<b>618.33</b>	<b>540.00</b>	<b>78.33</b>	
<b>PREPAID EXPENSES</b>				
Unexpired Insurance Premiums....	54.54	65.04	10.50	
Stationery Inventory.....	300.00	250.00	50.00	
<b>TOTAL ASSETS</b>	<b>\$60,118.15</b>	<b>\$7,521.66</b>	<b>8,596.49</b>	
<b>LIABILITIES AND SURPLUS</b>				
<b>ACCOUNTS PAYABLE</b> .....	<b>\$ 4,687.40</b>	<b>3,015.83</b>	<b>1,671.57</b>	
<b>ACCRUED SALARIES PAYABLE</b> .....		207.00	207.00	
<b>SUSPENSE</b> .....	111.28	22.02	89.36	
<b>DUES, ETC., PAID IN ADVANCE</b>				
Juniors.....	24.00	23.00	1.00	
Associates.....	478.97	479.29	.32	
Members.....	116.70	81.15	35.55	
Fellows.....	75.00	45.00	30.00	
Subscriptions to PROCEEDINGS.....	2,723.70	2,053.26	70.44	
<b>TOTAL LIABILITIES</b>	<b>8,217.05</b>	<b>6,527.45</b>	<b>1,689.60</b>	
<b>MORRIS LIEBMAN MEMORIAL FUND</b>				
Principal.....	10,000.00	10,000.00		
Unexpended income.....	77.87	77.87		
<b>TOTAL LIEBMAN FUND</b>	<b>10,077.87</b>	<b>10,077.87</b>		
<b>SURPLUS</b>				
Balance January 1st.....	40,016.34	37,423.05	3,492.30	
Operating Profit for Year.....	6,906.89	10,892.03	3,986.04	
Adjustment of Inventory for Prior Years....		7,400.54	7,400.54	
<b>SURPLUS DECEMBER 31st</b>	<b>47,823.23</b>	<b>40,016.34</b>	<b>6,906.89</b>	
<b>TOTAL LIABILITIES AND SURPLUS</b>	<b>\$60,118.15</b>	<b>\$7,521.66</b>	<b>8,596.49</b>	

## CONSTITUTION

ADOPTED AT THE FIRST MEETING OF THE INSTITUTE OF RADIO ENGINEERS, MAY 13, 1912; AMENDED NOVEMBER 2, 1914, AND DECEMBER 5, 1915

### ARTICLE I

#### NAME AND OBJECT

SEC. 1—The name of this organization shall be the Institute of Radio Engineers.

SEC. 2—Its object shall be the advancement of the theory and practice of radio engineering and of the allied arts and sciences, and the maintenance of a high professional standing among its members. Among the means to this end shall be the holding of meetings for the reading and discussion of professional papers and the publication of such papers, discussions and communications as may seem expedient.

### ARTICLE II

#### MEMBERSHIP

SEC. 1—The membership of the Institute shall consist of:

a. Honorary Members, who shall be entitled to all rights and privileges of the Institute except the right to nominate, vote and hold office.

b. Fellows, who shall be entitled to all rights and privileges of the Institute.

c. Members, who shall be entitled to all rights and privileges of the Institute except the right to hold the office of President and Vice-President.

d. Associates, who shall be entitled to all rights and privileges of the Institute except the right to hold the office of President, Vice-President, and Editor.

e. Juniors, who shall be entitled to attend all meetings and to receive copies of all Institute publications.

SEC. 2—Honorary members may be chosen from among those who have rendered acknowledged eminent service to radio science, or the radio arts.

SEC. 3—A Fellow shall be not less than thirty years of age and shall be either:

a. A radio engineer by profession. As such he shall be qualified to design and take responsible charge of important radio work; he shall have been in the active practice of his profession for at least seven years, and shall have had responsible charge of important radio work for at least three years.

When the applicant holds in a principal national society of an allied branch of engineering, membership in a grade for which the qualifications indicate a standing equal to that required for the grade of Fellow herein, such membership shall be considered equivalent to three of the required seven years of active practice of the radio profession.

b. A professor of physical science or of electrical engineering. As such he shall have attained special distinction as an expounder of the principles of radio science and of radio engineering; he shall have had at least seven years experience as a teacher of physical or electrical subjects and shall have had responsible charge, for three years, in a radio course of a principal school of science and engineering. Any years of experience as defined in paragraph "a" that the applicant may have had as a radio engineer shall be considered the equivalent of the same number of years of experience as a "teacher of radio subjects."

c. A person who had done notable original work in radio science of a character to give him a recognized standing at least equivalent to that required for the Fellows under paragraphs "a" and "b".

d. A person regularly engaged in radio work for at least seven years, who, by inventions or special proficiency in contributions to the radio science or the radio arts or radio literature, has attained a standing at least equivalent to that required for Fellows under paragraphs "a" and "b."

SEC. 4—A Member shall be not less than twenty-five years of age and shall be either:

a. A radio engineer by profession. As such, under general direction he shall have designed and taken responsibility for important radio engineering work; he shall have been in the active practice of his profession for at least four years.

When the applicant holds in a principal national society of an allied branch of engineering, membership of a grade for which the qualifications indicate a standing equal to that required for the grade of

Member herein, such membership shall be considered equivalent to two years of the requisite four years of active practice of the radio profession.

b. A teacher of physical science or of electrical engineering. He shall have had at least four years experience as a teacher of radio subjects in a school of recognized standing. Any years of experience the applicant may have had as a radio engineer shall be considered the equivalent of the same number of years of experience as a "teacher of radio science or of radio engineering."

c. A person regularly employed in radio or closely allied work for at least four years, who, by invention or by proficiency in radio science, the radio arts, or radio literature, or as an executive of any radio enterprise of large scope, has attained a standing equivalent to that required for Members under paragraphs "a" and "b." In the case of such an executive the applicant must be qualified to take responsible charge of the broader features of radio engineering involved in the work under his direction.

d. A commissioned officer of the Army or Navy of the United States Government or of any foreign government, who has been regularly engaged in radio work for a period of at least three years, who shall have had responsible charge of important government radio work for at least one year and who shall have attained the rank of Captain in the Army or Lieutenant in the Navy.

SEC. 5—An Associate shall be not less than twenty-one years of age and shall be:

a. A radio engineer by profession.

b. A teacher of radio subjects.

c. A person who is interested in and connected with the study or application of radio science or the radio arts.

SEC. 6—A Junior shall be not less than sixteen years of age nor over twenty-one years of age, and shall be a person who is interested in the study or application of radio science or the radio arts.

On attaining the age of twenty-one years, Juniors shall be transferred to the grade of Associate.

SEC. 7—In all cases, graduation from the radio course or electrical course of a school of science or of engineering of recognized standing shall be considered the equivalent of one year's radio experience.

SEC. 8—Any person who is a Member at the time this group of amendments is adopted, shall not be barred from eligibility to the

grade of Fellow because of the age limitation, provided he shall otherwise be eligible as herein defined.

Any person who is an Associate at the time this group of amendments is adopted, shall not be barred from eligibility to the grade of Member because of age limitations, provided he shall otherwise be eligible as herein defined.

### ARTICLE III

#### ADMISSIONS AND EXPULSIONS

SEC. 1—Honorary Members shall be recommended by at least ten members of the Board of Direction, and upon unanimous vote of the Board shall be proposed to the membership for election. A person elected an Honorary Member shall be promptly notified thereof by letter. The election shall be cancelled if an acceptance is not received within six months after the mailing of notice.

SEC. 2—Applications may be made for admission or transfer to any grade of membership. Applicants shall give references to members of the Institute as follows:

For the grade of Fellow, to five Fellows.

For the grade of Member, to five Fellows, or Members.

For the grade of Associate, to five Fellows, Members or Associates.

For the grade of Junior, to five Fellows, Members or Associates.

Each application for admission or for transfer from one grade to another shall embody a concise statement, with dates, of the candidate's training and experience, and shall be in such form and such detail as may be prescribed by the Board of Direction. It shall be signed by the applicant and shall contain a promise to conform to the requirements of that grade of membership to which he may be elected.

Each of the members referred to by the applicant shall be requested by the Secretary to address a letter to the Board of Direction stating the extent of the writer's personal knowledge of the applicant and his training and experience. If at least a majority of the corporate members named as references do not furnish the requisite endorsement, the Secretary shall call upon the applicant for additional names, and not until written communications have been received from at least three members shall the application be considered by the Board of Direction.

The requirements of the foregoing paragraph may be waived in whole or in part where the applicant is well-known, either personally or by reputation, to the Board of Direction, or where the application is for Junior or Associate grade.



An applicant who is so situated as not to be personally known to the required number of members of any grade may give the names, occupations and addresses of responsible non-members to complete the required number of references.

SEC. 3—A list comprising the names, ages, addresses and occupations of all new applicants for admission or transfer shall be sent by the Secretary to each member of the Board of Direction.

The Board of Direction may consider applications for admission or transfer to the grade of Member at any regular meeting held at least two weeks after the list containing the applicants' names has been sent to each member of the Board of Direction.

The Board of Direction may consider applications for admission or transfer to the grade of Fellow at any regular meeting held at least four weeks after the list containing the applicants' names has been sent to each member of the Board of Direction.

A record affirmative vote, oral or written, of at least two-thirds of the Board members voting at any regular meeting, shall elect or transfer an applicant for any grade. A vote on any application shall stand, unless withdrawn by the Board member voting, until the application is finally acted upon.

SEC. 4—A rejected applicant may renew his application for membership at any time after the expiration of one year from the date of the ballot rejecting his previous application.

SEC. 5—All elected candidates shall be duly notified and shall subscribe to the Constitution and Rules of the Institute. Forms for this purpose shall be prescribed by the Board of Direction. If these provisions are not complied with within six months from the notification of election, such election shall be considered void, unless for special reasons the time shall be extended by the Board of Direction. Membership of any person shall date from the date of his election.

SEC. 6—Fellows, Members, Associates or Juniors, if found delinquent in their duties may be tried by the Board of Direction, and upon decision of the Board their names shall be submitted to the Institute to determine their suspension or expulsion. A three-quarters vote of the Institute shall be necessary to ratify such action of the Board.

SEC. 7—A member may resign his membership by a written communication to the Secretary, who shall present the same to the Board of Direction; when, if all his dues have been paid, his resignation shall be accepted.

## ARTICLE IV

## DUES

SEC. 1—The entrance fee, payable on admission to the Institute, shall be as follows:

Admission to the grade of Fellow, ten (\$10) dollars.

Admission to the grade of Member, five (\$5) dollars.

Admission to the grade of Associate, three (\$3) dollars.

Admission to the grade of Junior, one (\$1) dollar.

The transfer fee from one grade of membership to another shall be the difference between the corresponding admission fees.

The entrance fees shall be waived until January 1, 1927.

SEC. 2—The annual dues payable by members, whether resident or non-resident, shall be as follows:

a. By Fellows, ten (\$10) dollars.

By Members, seven dollars and fifty cents (\$7.50).

By Associates, four (\$4) dollars.

By Juniors, three dollars and fifty cents (\$3.50).

b. Honorary Members shall be exempt from all payments.

SEC. 3—The annual dues shall be payable on the first day of January, in advance of the ensuing year. It shall be the duty of the Secretary to notify each member of the amount due at the time of giving notice of the annual meeting.

SEC. 4—Persons elected after July 1st of any year shall pay only one-half of the dues for that year.

SEC. 5—Any person whose dues are more than three months in arrears shall be notified by the Secretary. Should his dues not be paid when they become six months in arrears, he shall lose the right to vote or to receive the publications of the Institute. Should his dues become nine months in arrears, he shall be again notified in form prescribed by the Board of Direction, and if such dues become one year in arrears, he shall forfeit his connection with the Institute. The Board of Direction may, however, for cause deemed by it sufficient, extend the time for payment and for the application of these penalties.

SEC. 6—The Board of Direction may, for sufficient cause, temporarily excuse from payment of annual dues any member; and the Board may remit the whole or part of dues in arrears, or accept in lieu thereof desirable additions to the library or collections.

SEC. 7—Every person admitted to the Institute shall be considered as belonging thereto and liable for the payment of all dues until he shall

have resigned, been expelled, or have been relieved therefrom by the Board of Direction.

## ARTICLE V

### OFFICERS

SEC. 1—The governing body of the Institute shall be a President, a Vice-President, a Secretary and a Treasurer and Editor of Publications, six elected Managers, and three appointed Managers who shall together constitute the Board of Direction.

SEC. 2—The terms of all officers, except the six elected Managers, shall be one year each, and shall begin at the close of the annual meeting at which election is made. The terms of all officers shall continue until successors are duly elected. The President and the Vice-President shall not be eligible for immediate renomination to the same office.

SEC. 3—Two Managers shall be elected each year and serve for three years.

For the year 1915 six elected Managers were voted upon as follows: The two candidates receiving the highest number of votes to serve three years; the two candidates receiving the next highest number of votes, two years; the two candidates receiving the next highest number of votes, one year.

SEC. 4—The three appointed Managers shall be chosen by the Board of Direction to serve for terms of one year. These appointed Managers shall have no vote in the election of their successors.

## ARTICLE VI

### MANAGEMENT

SEC. 1—The President shall have general supervision of the affairs of the Institute. He shall preside at meetings of the Institute and of the Board of Direction at which he may be present and shall be an ex-officio member of all committees. He shall deliver an address at the annual meeting.

SEC. 2—The Board of Direction shall manage the affairs of the Institute in conformity to the laws under which the Institute is organized and the provisions of the Constitution. It shall direct the investment and care of the funds of the Institute; make appropriations for specific purposes; act upon applications for membership as heretofore provided; take measures to advance the interests of the Institute; appoint

all its employees, and generally direct its business. The Board of Direction shall make an annual report at the annual meeting, transmitting the report of the Treasurer and of the other officers and of committees. Five members of the Board of Direction shall constitute a quorum.

SEC. 3—The Treasurer shall receive all moneys and deposit same in the name of the Institute. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Direction. He shall pay all bills, when certified and audited, as provided by this Constitution and by the rules to be prescribed by the Board of Direction. He shall make an annual report and such other reports as may be prescribed by the Board of Direction.

The Board of Direction shall secure a satisfactory surety for the faithful performance of his duties by the Treasurer, and shall renew the same during the month of January of each year.

SEC. 4—The Secretary will be expected to attend all meetings of the Institute and of the Board of Direction; prepare the business thereof, and duly record the proceedings thereof. He shall see that all moneys due the Institute are carefully collected, and without loss transferred to the custody of the Treasurer. He shall carefully scrutinize all expenditures and use his best endeavor to secure economy in the administration of the Institute. He shall personally certify the accuracy of all bills or vouchers on which money is paid, and shall countersign the checks drawn by the Treasurer against the funds of the Institute when such drafts are known to him to be proper, and duly authorized by the Finance Committee. He shall have charge of the books of account of the Institute, and shall furnish, when required by the Board of Direction, a statement of receipts and expenses under their several headings, and also a statement of monthly balances. He shall present annually, to the Board of Direction, a balance sheet of his books as of December 31st and shall furnish from time to time such other statements as may be required of him. He shall conduct the correspondence of the Institute and keep full records of the same. He shall perform all other duties which may from time to time be assigned to him by the Board of Direction.

SEC. 5—The Board of Direction may also, if they deem it necessary, appoint an Assistant Secretary, who shall aid the Secretary and be under his immediate direction in all matters.

SEC. 6—The President, as soon as expedient after the annual

meeting, shall appoint from the membership, with the advice and consent of the Board of Direction, the following standing committees:

Committee on Papers.

Committee on Standardization.

Committee on Publicity.

Members appointed shall serve until their successors are appointed or the Committees dissolved.

#### ARTICLE VII

##### NOMINATION AND ELECTION OF OFFICERS

SEC. 1—Two months before the annual meeting, nominations for the offices of President, Vice-President, Secretary and Treasurer and two Managers, shall be called for from the membership qualified by this Constitution. Before nominees' names are submitted to the membership for final vote, each nominee shall be consulted and if he so requests, his name shall be withdrawn and the next ranking name substituted.

For the year 1915, nominations for six Managers were called for.

One month before the annual meeting, the Board of Direction shall submit to the entire membership excepting Honorary Members and Juniors, a list of all nominees, which list shall consist of the pairs of names receiving the largest number of nominations for each office. In the event of ties in nominations the Board of Direction shall select the name of the man in its opinion best fitted for that office. The membership shall then submit written ballots in plain sealed envelopes enclosed within mailing envelopes marked "Ballot," and bearing the members' signature, voting for officers from the list of nominees. A majority vote received up to the time of the closing of the polls (twenty-four hours before the opening of the annual meeting) shall elect, and no votes by proxy shall be counted. The method of balloting herein described shall be used for nominating as well as for voting, except the outer envelope shall be marked "Nomination" in the former case. In nominating, as in voting, no proxies or ballots within unsigned outer envelopes shall be opened for counting. Ballots, whether for nomination or voting, shall be checked, opened and counted by a quorum of the Board of Direction, at a regular meeting of the Board. At the time of call for nominations, the Board of Direction shall submit to qualified voters a list of suggested nominations containing at least two names for each office.

SEC. 2—The Editor of Publications shall be elected by vote of the Board of Direction as soon as possible after May 1st.

#### ARTICLE VIII

##### MEETINGS

SEC. 1—There shall be an Annual Meeting, at which the annual reports for the year ending December 31st previous shall be presented, and the Ballot for officers reported. At this meeting fifteen (15) members shall constitute a quorum.

SEC. 2—Business meetings shall be held as prescribed by the by-laws.

SEC. 3—In addition to the Annual Meeting, meetings for the reading and discussion of papers shall be held as ordered by the Board of Direction.

SEC. 4—Special meetings may be called by the Board of Direction, and shall be so called upon request of ten members, which request shall state the purpose of such meeting. The call for such meeting shall be issued ten days in advance, and shall state the purpose thereof, and no other business shall be taken up at such meeting. At these meetings ten members shall constitute a quorum.

SEC. 5—The Institute may adopt, from time to time, rules for the order of business at its meetings.

SEC. 6—Meetings of the Board of Direction shall be held at the time of the annual meeting and at such other times as the Board may determine, but only on notice to all members of the Board by the Secretary. Notices of time and place of meeting are to be mailed in New York at least two days in advance.

#### ARTICLE IX

##### AMENDMENTS

SEC. 1—Proposed amendments to this Constitution must be reduced to writing and signed by not less than twenty Fellows, Members or Associates, and be submitted to the entire membership, except Honorary Members and Juniors, who shall vote by letter ballot. The amendment shall be adopted if seventy-five per cent of the votes received are in favor of such action, the polls having been open for at least one month after mailing to the qualified membership, notices of the proposed amendments. Votes upon the adoption of proposed amendments shall be checked, opened and counted by a quorum of the Board of Direction at a regular meeting of the Board.

## AMENDMENTS

## INCREASE OF MEMBERSHIP DUES

In October 1919, in accordance with the provision of Section 1, above, the membership approved adoption of an amendment to the Constitution authorizing increasing the dues as follows:

	Per Year
Fellows.....	\$15.00
Members.....	10.00
Associates.....	7.50
Juniors.....	5.00

At the Board meeting held in January 1920, it was decided to defer advancing the dues to the full amount authorized until a later date. The dues adopted were:

	Per Year
Fellows.....	\$12.00
Members.....	9.00
Associates.....	5.00
Juniors.....	4.00

On January 1, 1926, the dues were advanced as follows:

	Per Year
Fellows.....	\$15.00
Members.....	10.00
Associates.....	6.00
Juniors.....	4.00

This leaves the annual dues for Associate and Juniors below the amount authorized by the membership in October, 1919.

On January 1, 1927, the entrance fees were reinstated. These are:

Fellow.....	\$10.00
Member.....	5.00
Associate.....	3.00
Junior.....	1.00

## NOMINATION AND ELECTION OF OFFICERS

In January, 1921, the membership by letter vote approved change in Article VII of the Constitution to read as follows:

Article VII, Section 1 of the Constitution to read:

"Sec. 1—Six weeks before the annual meeting, the Board of Direction shall submit to the entire membership, excepting Honorary Members and Juniors, a list of candidates (nominees) for the offices

of President, Vice-President, (Secretary, Treasurer) and two Managers. This list shall comprise at least one name and not more than three names for each office, the names being proposed either by Petition as hereinafter provided, or by (a quorum of) the Board of Direction, at one of these stated meetings. The list shall contain no indication as to whether the candidate has been proposed by Petition or by the Board of Direction.

"Nomination by Petition shall be made by letter, addressed to the Board of Direction, setting forth the name of the proposed candidate and the office for which it is desired he be nominated. For acceptance, a letter of Petition must reach the Board of Direction on or before October 15th of any year, and shall be signed by at least thirty-five Fellows, Members or Associates.

"The list of nominees shall contain the names of all candidates proposed by formal Petition or by the Board of Direction, but before this list is submitted to the membership for final vote, each candidate should be consulted and if he so requests, the fact that he has withdrawn from election shall be stated after his name.

"The entire membership, excepting Honorary Members and Juniors, shall vote by written ballots in plain sealed envelopes, enclosed within mailing envelopes marked "Ballot" and bearing the member's signature, for the officers whose names appear on the list of candidates. A majority vote received up to the time of the closing of the polls (twenty-four hours before the opening of the annual meeting, the date of which shall be stated in the election notice) shall elect, and no votes by proxy shall be counted. No proxies or ballots within unsigned outer envelopes shall be opened for counting. Ballots shall be checked, opened and counted by a quorum of the Board of Direction, at a regular meeting of the Board.

"Sec. 2—The Treasurer, Secretary and Editor of Publications shall be appointed by majority vote of the Board of Direction as soon as practicable after January 15th of each year, for a term of one year or until their successor be appointed."

## BY-LAWS GOVERNING SECTIONS

*(The purpose of the Institute in furthering the establishment of Sections is to afford opportunity for members situated in various parts of the United States and other countries to meet in organized groups for the discussion of radio engineering topics.)*

1—A petition for the formation of a Section shall be signed by not less than twenty-five members (any grade except Juniors) residing within the territorial limits hereinafter prescribed. The Board of Direction may decline to authorize the formation of a Section when, in its judgment, such an organization would not be compatible with the interests of the Institute.

2—A Section shall be known as: The (name of place or geographical district) Section of the Institute of Radio Engineers.

3—The principal activity of a Section shall be the holding of periodical meetings (monthly or bi-monthly, but not less than five regular meetings annually) for the presentation of original papers already presented at New York meetings of the Institute, or at other Sections.

4—The territory of a Section shall be the territory naturally tributary thereto, but shall not include territory so remote or inaccessible that members cannot readily attend meetings. For the purpose of determining the maximum amount of money to which a Section is entitled under these by-laws, points more than sixty miles from the regular meeting place of the Section shall not be considered a part of the Section, except when special conditions warrant such action territory within a reasonable distance may be authorized by the Board of Direction. If adjacent Sections should be so situated that the sixty mile limit embraces common territory, the question as to which Section shall claim such members as reside within this common territory shall, if possible, be decided by agreement between the Sections concerned; otherwise by the Board of Direction. (Sections may carry on their mailing list for meeting announcements the names of members located outside of the prescribed Section territory.)

5—The Chairman, Vice-Chairman, Secretary and any other officers of each Section must be Fellows, Members or Associates of the Institute, and shall be elected for the term of one year beginning January 1, or May 1, and until their successors are elected.

6—The Board of Direction may at any time terminate the existence of any Section when in its judgment the interests of the Institute make such action desirable.

7—Papers and discussions presented before a Section and published in the PROCEEDINGS shall not be republished except with due acknowledgment of the original source.

8—Original papers presented before a Section, suitable for publication in the PROCEEDINGS may be presented to the Meetings and Papers Committee for consideration, which, in judging suitability, will be governed by the same considerations applied to similar matter offered from other sources.

9—The Secretary of the Institute will forward to the Secretary of each Section copies of all printed announcements of the regular meetings in New York, and shall forward also the Secretary of each Section, three complete sets of proofs, or three pamphlet form copies of each technical paper intended for presentation at New York or for publication in the PROCEEDINGS. This latter is for the purpose of supplying Sections with advance copies for Section discussion.

10—Each Section shall have a Meetings and Papers Committee and a Membership Committee, appointed by the Chairman.

11—Each Section shall conduct its affairs in such manner that no indebtedness shall accrue in excess of the amount due annually as per-member rebate, specified in paragraph 12.

12—The appropriation of Institute funds during any fiscal year for aid in Section maintenance shall be the sum determined as follows: one dollar for each Fellow, Member and Associate residing within the territory of the Section at the beginning of the administrative year, namely, January 1. Each year, beginning in 1926, the Treasurer will place to the credit of each Section the accrued rebate calculated from members' dues paid in the Section as of March 1 and September 1. Section Treasurers may draw upon this account quarterly; that is January 1st, April 1st, July 1st and October 1st.

13—Section Secretaries shall forward to the Secretary of the Institute a report of each meeting held by the Section for the presentation or discussion of papers, and on January 1 of each year a statement of the past year's accounts.

# The Institute of Radio Engineers

## REPORT OF THE COMMITTEE ON STANDARDIZATION

for  
1928

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## STANDARDIZATION REPORT FOR 1928

### PREFACE

The first Standardization Report of the Institute of Radio Engineers was issued in 1913. This was succeeded by revised reports issued in 1915, 1922, and 1926. Since the publication of the Report of the Committee on Standardization for 1926, the Committee has been engaged in a revision of that report, primarily through the work of sub-committees.

The Institute has had the cooperation, through membership on the Committee, of representatives of the American Institute of Electrical Engineers, the radio division of the National Electrical Manufacturers' Association and the Radio Manufacturers' Association.

The following plan has been evolved under which the field of radio standardization has been divided between the Institute of Radio Engineers on the one hand and the manufacturers' organization on the other. It is recognized, of course, that in this new field it is impossible at the present time to determine upon any hard and fast dividing line.

*Institute of Radio Engineers.* (1) Terms, definitions, and symbols, and (2) methods of testing materials and apparatus in order to determine their important characteristics. This work may consist of purely advisory discussion as to convenient forms of tests, precautions to be taken, etc., or it may include standardization of definite test procedures to serve as a common basis of comparison of the properties or performance of material or apparatus.

*Manufacturers' Groups.* (1) Standardization of size and characteristics of apparatus, to promote interchangeability of parts, either mechanical or electrical, and (2) setting of standard ratings for the properties or performance of material or apparatus.

The list of terms and definitions contained in this report has been divided into eight groups in order to facilitate reference to terms which are related to one another in meaning or in use. An alphabetical index is appended.

It has been the aim of the Committee to make the report descriptive and explanatory rather than to make the definitions rigorously exact in their phraseology.

### PREFACE

Several new sections have been added to the report dealing with standard methods of measuring and testing radio apparatus. One section contains a bibliography relating to radio measurements.

The Institute will welcome comments and criticisms which will be helpful in the work of the Committee on Standardization.

Communications relative to this report as well as to other Institute matters should be addressed to the Secretary of the Institute of Radio Engineers, 33 West 39th Street, New York City.

# The Institute of Radio Engineers

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## STANDARDIZATION REPORT FOR 1928

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H. A. Frederick	I. G. Maloff	W. C. White

\* Deceased

## DEFINITIONS OF TERMS USED IN RADIO ENGINEERING

### SECTION 1—GENERAL

1001. **Cycle**—One complete set of the recurrent values of a periodic phenomenon.
1002. **Frequency**—The number of cycles per second. (See 3007, Band of Frequencies.)
1003. **Kilocycle** (strictly kilocycle per second)—A thousand cycles per second.
1004. **Megacycle** (strictly megacycle per second)—A million cycles per second.
1005. **Audio Frequency**—A frequency corresponding to a normally audible sound wave. The upper limit ordinarily lies between 10,000 and 20,000 cycles.
1006. **Radio Frequency**—A frequency higher than those corresponding to normally audible sound waves. (See 1005, Audio Frequency.)  

Note—It is not implied that radiation cannot be secured at lower frequencies, nor that radio frequencies are necessarily above the limit of audibility.
1007. **Facsimile Transmission**—The electrical transmission of a copy or reproduction of a picture, drawing, or document. (This is also called picture transmission.)
1008. **Television**—The electrical transmission of a succession of images and their reception in such a way as to give a substantially continuous reproduction of the object or scene before the eye of a distant observer.
1009. **Transducer**—A transducer is a device actuated by power from one system and supplying power to another system. These systems may be electrical, mechanical, or acoustic.

- 1010. Passive Transducer**—A passive transducer is one in which the power supplied to the second system is obtained entirely from the power available from the first system.
- 1011. Active Transducer**—An active transducer is one in which the power supplied to the second system is obtained from a local source and is controlled by the power from the first system.
- 1012. Ideal Transducer**—An ideal transducer for connecting two specific systems is a passive transducer which converts the maximum possible power from the electrical system to the acoustic system or vice versa.
- 1013. Fidelity**—The degree to which a system, or a portion of a system, accurately reproduces at its output the signal which is impressed upon it.
- 1014. Distortion**—A change in wave form occurring in a transducer or transmission medium when the output wave form is not a faithful reproduction of the input wave form. The principal sources of distortion are:
- a. Non-linear relation between input and output at a given frequency.
  - b. Non-uniform transmission at various frequencies.
  - c. Phase shift not proportional to frequency.
- 1015. Power Level**—The power level at any point in a system is an expression of the power being transmitted past this point.
- 1016. The Overload Level** of a transducer is that power level (electrical input or output) at which a transducer ceases to operate satisfactorily as a result of distortion, heating, breakage, etc.
- 1017. Direct Capacitance (C)**—between two conductors—The ratio of the charge produced on one conductor to the voltage between it and the other conductor divided by this voltage, all other conductors in the neighborhood being at the potential of either conductor.

## SECTION 2—WAVES AND WAVE PROPAGATION

- 2001. Wave**—(a) A propagated disturbance, usually periodic; as an electric wave or a sound wave.  
 (b) A single cycle of such a disturbance.  
 (c) A periodic variation as represented by a graph.
- 2002. Wavelength**—The distance traveled in one period or cycle by a periodic disturbance. The distance between corresponding phases of two consecutive waves of a wave train. The quotient of velocity by frequency.
- 2003. Continuous Waves**—Alternating electric waves in space, of constant amplitude and frequency.
- 2004. Modulated Waves**—Continuous waves of which the amplitude or frequency is repeatedly varied in accordance with a signal wave.
- 2005. Key-Modulated Waves**—Continuous waves of which the amplitude or frequency is varied by the operation of a transmitting key in accordance with the characters of a communicating code.
- 2006. Interrupted Continuous Waves**—Waves obtained by interruption at audio frequency in a periodic manner of an otherwise continuous wave.
- 2007. Damped Waves**—Electromagnetic waves proceeding in wave trains in each of which the amplitude of successive cycles progressively diminishes.
- 2008. Signal**—The intelligence, message or effect conveyed in communication.
- 2009. Signal Wave**—A wave, the form of which conveys a signal.
- 2010. Carrier Wave**—The component of a modulated wave which has the same frequency as the original unmodulated wave. (See 3004, Carrier Current.)
- 2011. Radio Field Intensity**—The root-mean-square value of the electric or magnetic field intensity at a point due to the passage of

radio waves. It is usually expressed in terms of the electric field intensity, in microvolts per meter or millivolts per meter.

- 2012. Radio Noise Field Intensity**—A measure of the field intensity, at a point (as a radio receiving station) of electromagnetic waves of an interfering character. In practice the quantity measured is not the field intensity of the interfering waves, but some quantity which is proportional to or bears a known relation to the field intensity.
- 2013. Signal-Noise Ratio**—The ratio at a point of the field intensity of the radio wave to the radio noise field intensity.
- 2014. Strays**—Electromagnetic disturbances in radio reception other than those produced by radio transmitting systems.
- 2015. Static**—Conduction or charging current in an antenna resulting from physical contact between the antenna and charged bodies or masses of gas.
- In the United States this term has come to be used quite generally as a synonym for atmospherics.
- 2016. Atmospherics**—Strays produced by atmospheric conditions.
- 2017. Atmospheric Absorption**—A loss of power in transmission of radio waves due to a dissipation in the atmosphere.
- 2018. Transmission Loss**—The loss of power suffered by a transmitted wave in passing along a transmission path or through a circuit device. (See 6061, Transmission-Frequency Characteristic.)
- 2019. Attenuation**—The reduction in power of a wave or a current with increasing distance from the source of transmission. (See 6035, Attenuation Equalizer.)
- 2020. Fading**—The variation of the signal intensity received at a given location from a radio transmitting station as a result of changes occurring in the transmission path. (See 1014, Distortion.)
- 2021. Swinging**—The variation in frequency of a transmitted wave resulting from momentary changes in the transmitter circuits. This may be evidenced by

1. A variation in the beat note when a local oscillator is adjusted to the carrier frequency, or
2. A variation in intensity of the received signal.

### SECTION 3—TRANSMISSION

- 3001. Radio Transmission**—The transmission of signals by means of radiated electromagnetic waves originating in a constructed circuit.
- 3002. Broadcasting**—Radio transmission intended for general reception.
- 3003. Radiate**—To emit electromagnetic waves into space.
- 3004. Carrier Current**—An alternating current which is modulated by a signal. Ordinarily refers to wire transmission of high-frequency currents. (See 2010, Carrier Wave.)
- 3005. Carrier Frequency**—Frequency of a carrier wave or a carrier current.
- 3006. Carrier Suppression**—That method of operation in which the carrier wave or carrier current is not transmitted.
- 3007. Band of Frequencies**—A continuous range of frequencies extending between two definite frequencies. (See 3011, Radio Channel, and 1002, Frequency.)
- 3008. Side Bands**—The bands of frequencies, one on either side of the carrier frequency, produced by the process of modulation.
- 3009. Side Frequency**—The frequency on either side of the carrier frequency produced by the process of single-frequency modulation.
- 3010. Single-Side-Band Transmission**—That method of operation in which one side band is transmitted, and the other side band is suppressed. The carrier wave may be either transmitted or suppressed.

- 3011. Radio Channel**—A band of frequencies or wavelengths of a width sufficient to permit of its use for radio communication. The width of a channel depends upon the type of transmission. (See 3007, Band of Frequencies.)
- 3012. Radio Transmitter**—A device for producing radio-frequency power and modifying it in accordance with a signal.
- 3013. Vacuum-Tube Transmitter**—A radio transmitter in which vacuum tubes are utilized to convert the applied electric power into radio-frequency power.
- 3014. Oscillator**—A non-rotating device for producing alternating power, the output frequency of which is determined by the characteristics of the device. (See 3017, Radio-Frequency Alternator.)
- 3015. Master Oscillator**—An oscillator of comparatively low power so arranged as to control the frequency of the output of an amplifier.
- 3016. Alternator Transmitter**—A radio transmitter which utilizes radio-frequency power generated by a radio-frequency alternator.
- 3017. Radio-Frequency Alternator**—A rotating-type alternating-current generator which generates radio-frequency power. (See 3014, Oscillator.)
- 3018. Arc Converter**—An electric arc used for the generation of alternating or pulsating current.
- 3019. Spark Transmitter**—A radio transmitter which utilizes the oscillatory discharge of a condenser through an inductance and a spark gap as the source of its radio-frequency power.
- 3020. Spark Gap**—An arrangement of electrodes used for closing a circuit (usually oscillatory) at a predetermined voltage. Among the types of spark gaps are plain gap, rotary gap, synchronous gap, and quenched gap.
- 3021. Impulse Excitation**—A method of producing damped oscillatory current in a circuit in which the duration of the impressed voltage is short compared with the duration of the current produced.

- 3022. Frequency Changer**—A device delivering alternating current at a frequency which differs from the frequency of the supply current.
- 3023. Frequency Multiplier**—A frequency changer used to multiply by an integer the frequency of an alternating current.
- 3024. Modulation**—The process whereby the frequency or amplitude of a wave is varied in accordance with a signal wave.
- 3025. Double Modulation**—The process of modulation in which a carrier wave of one frequency is first modulated by the signal wave and is then made to modulate a second carrier wave of another frequency.
- 3026. Percentage Modulation**—The ratio of half the difference between the maximum and minimum amplitudes of a modulated wave to the average amplitude, expressed in per cent.
- 3027. Modulator**—A device to effect the process of modulation. It may be operated by virtue of some non-linear characteristic or by a controlled variation of some circuit quantity.
- 3028. Magnetic Modulator**—A magnetic device employed as a modulator and functioning by virtue of its non-linear magnetization characteristic.
- 3029. Vacuum-Tube Modulator**—A modulator employing a vacuum tube as a modulating element.
- 3030. Duplex Operation**—The operation of associated transmitting and receiving channels in which the processes of transmission and reception are concurrent.

## SECTION 4—RECEPTION

- 4001. Radio Receiver**—A device for converting radio waves into perceptible signals.
- 4002. Monitoring Radio Receiver**—A radio receiver arranged to enable an operator to check the operation of a transmitting set.



- 4003. Heterodyne Reception**—The process of receiving radio waves by combining the received voltage with locally generated alternating voltage. The locally generated frequency is commonly different from the received frequency, thus producing beats. This is called beat reception.
- 4004. Autodyne Reception**—A system of heterodyne reception through the use of a device which is both an oscillator and a detector.
- 4005. Homodyne Reception**—The process of detecting a wave by the aid of a locally generated wave of carrier frequency. (Sometimes called zero-beat reception.)
- 4006. Super-Heterodyne Reception**—A method of reception in which the received voltage is combined with the voltage from a local oscillator and converted into voltage of an intermediate frequency which is then amplified and detected to reproduce the original signal wave. (Sometimes called "supersonic reception" and "double detection.")
- 4007. Intermediate Frequency**—A frequency between that of the carrier employed in radio transmission and the frequency of modulation, and to which the carrier is converted in super-heterodyne reception.
- 4008. Reflex Circuit**—A circuit arrangement in which one or more amplifier tubes amplify the signal both before and after detection.
- 4009. Tuning**—The adjustment of a circuit or system to secure optimum value of a desired current; commonly, the adjustment of a circuit or circuits to resonance.
- 4010. Sensitivity**—The degree to which a radio receiver responds to signals of the frequency to which it is tuned. It is measured quantitatively by the reciprocal of the Normal Radio Field Intensity. (See page 107.)
- 4011. Selectivity**—The degree to which a radio receiver is capable of differentiating between signals of different carrier frequencies. This characteristic is not expressible by a single numerical value, but requires one or more graphs for its expression.

**4012. Detector**—That portion of the receiving apparatus which, connected to a circuit carrying currents of radio frequency, and in conjunction with a self-contained or separate indicator, translates the radio-frequency power into a form suitable for operation of the indicator. This translation may be effected either by the conversion of the radio-frequency power, or by means of the control of local power. The indicator may be a telephone receiver, relaying device, tape recorder, etc.

The most common type of detector is a vacuum tube operated on a non-linear portion of its characteristic curve, thereby converting a modulated radio-frequency current into a modulated direct current.

A tube which operates similarly to a detector tube, but the output of which does not operate an indicator, may properly be called a frequency converting tube. (See 6048, Rectifier.)

**4013. Interference**—Confusion of reception due to strays, undesired signals, or other causes; also that which produces the confusion.

## SECTION 5—VACUUM TUBES

**5001. Vacuum Tube**—A device consisting of a number of electrodes contained within an enclosure evacuated to such a degree that the characteristics are substantially due to electron conduction.

Note: Where it is desired to call particular attention to the number of electrodes, the terms diode (5003), triode (5004), and tetrode (5005) may be used.

**5002. Photoelectric Tube**—A form of vacuum tube in which the electron emission is produced by the illumination of the cathode. (Also called the photoelectric cell.)

Note: Except in the case of this term, the definitions in this Section relate to devices in which the electron emission is due to heating of the cathode.

**5003. Diode**—A type of vacuum tube containing two electrodes which passes current wholly or predominantly in one direction.

Note: A vacuum tube having a single cathode and two anodes which operate alternately may properly be called a double diode.

5004. **Triode**—A type of vacuum tube containing an anode, a cathode, and a third electrode, in which the current flowing between the anode and the cathode is controlled by the voltage between the third or control electrode and the cathode.
5005. **Tetrode**—A type of vacuum tube containing an anode, a cathode, and two additional electrodes (ordinarily the two additional electrodes are of the nature of grids).
5006. **Screen-Grid Vacuum Tube**—A type of vacuum tube in which the capacitance between certain electrodes (ordinarily the control grid and the plate) is substantially eliminated by the interposition of an additional electrode of suitable potential. (See 5026, Screen-Grid.)
5007. **Cathode**—The electrode from which the electron stream flows. (See 5009, Filament.)
5008. **Cathode, Indirectly Heated**—A cathode in which the heat is supplied from a separate heater element.
5009. **Filament**—A cathode in which the heat is supplied by current passing through the cathode.
5010. **Filament Voltage**—The voltage between the terminals of the filament.
5011. **Filament Current**—The current supplied to the filament to heat it.
5012. **Control Electrode**—The electrode, the voltage between which and the cathode controls the current flowing between the anode and the cathode.
5013. **Grid**—An electrode having openings through which the electron stream between cathode and anode may pass.
5014. **Grid Voltage**—The voltage between the grid and a specified point of the cathode. (See page 94.)
5015. **Grid Bias**—The direct component of the grid voltage.

5016. **Grid Current**—The direct current passing from the grid through the vacuous space.
5017. **Reversed Grid Current**—The direct current passing to the grid through the vacuous space.
5018. **Grid Conductance**—The ratio of the change in grid current to the change in grid voltage producing it, under the condition of constant plate potential. As most precisely used, the term refers to infinitesimal changes, as indicated in the defining equation
- $$\text{Grid conductance, } g_g = \frac{\partial i_g}{\partial e_g}, \quad e_p = \text{const.}$$
5019. **Grid Characteristic**—The graph plotted between grid voltage as abscissas and grid current as ordinates. (See 5031, Plate Characteristic; 5042, Mutual Characteristic; and 5045, Emission Characteristic.)
5020. **Grid Condenser**—A series condenser in the grid or control circuit of a vacuum tube.
5021. **Grid Leak**—A resistor used to affect or determine the grid bias.
5022. **Anode**—The electrode to which the electron stream flows. (See 5023, Plate.)
5023. **Plate**—The common name for the anode in a vacuum tube.
5024. **Plate Voltage**—The voltage between the plate and a specified point of the cathode. (See page 94.)
5025. **Plate Current**—The direct current passing from the plate through the vacuous space.
5026. **Screen Grid**—An electrode of suitable potential interposed between certain of the other electrodes of a vacuum tube to substantially eliminate the effect of the capacitance between them. (See 5006, Screen-Grid Vacuum Tube.)
5027. **Amplification Factor**—A measure of the effectiveness of the grid voltage relative to that of the plate voltage in affecting the plate

current; it is the ratio of the change in plate voltage to a change in grid voltage in the opposite direction, under the condition that the plate current remains unchanged. As most precisely used, the term refers to infinitesimal changes in the potentials as indicated in the defining equation

$$\text{Amplification factor } \mu = -\frac{\partial e_p}{\partial e_g}, \quad i_p = \text{const.}$$

(See 6030, Voltage Amplification.)

Note: See page 99.

**5028. Mutual Conductance**—The ratio of the change in plate current to the change in grid potential producing it, under the condition of constant plate voltage. As most precisely used, the term refers to infinitesimal changes, as indicated in the defining equation

$$\text{Mutual conductance, } g_m = \frac{\partial i_p}{\partial e_g}, \quad e_p = \text{const.}$$

The unit ordinarily used is the micromho.

Note: In rare cases, when the dependence of the grid current on the plate potential is to be considered, the following terms and symbols may be employed:

Inverse amplification factor

$$\mu_n = -\frac{\partial e_g}{\partial e_p}, \quad i_p = \text{const.}$$

Inverse mutual conductance

$$g_n = \frac{\partial i_g}{\partial e_p}, \quad e_g = \text{const.}$$

(See 5042, Mutual Characteristic.)

**5029. Plate Conductance**—The ratio of the change in plate current to the change in plate potential producing it, under the condition of constant grid potential. As most precisely used, the term refers to infinitesimal changes, as indicated in the defining equation

$$\text{Plate conductance, } g_p = \frac{\partial i_p}{\partial e_p}, \quad e_g = \text{const.}$$

**5030. Plate Resistance**—The reciprocal of the plate conductance.

$$r_p = \frac{1}{g_p} = \frac{\partial e_p}{\partial i_p}, \quad e_g = \text{const.}$$

Note: The following relations exist between the terms numbered 5027, 5028, 5029, and 5030.

$$g_m = \mu g_p = \frac{\mu}{r_p}$$

**5031. Plate Characteristic**—The graph plotted between plate voltage as abscissas and plate current as ordinates. (See 5019, Grid Characteristic; 5042, Mutual Characteristic; and 5045, Emission Characteristic.)

**5032. Filament Capacitance ( $C_f$ )**—The sum of the direct capacitances between the filament and all other conductors of a vacuum tube. (See 1017, Direct Capacitance.)

**5033. Grid Capacitance ( $C_g$ )**—The sum of the direct capacitances between the grid and all other conductors of a vacuum tube. (See 1017, Direct Capacitance.)

**5034. Plate Capacitance ( $C_p$ )**—The sum of the direct capacitances between the plate and all other conductors of a vacuum tube. (See 1017, Direct Capacitance.)

**5035. Grid-Plate Capacitance ( $C_{gp}$ )**—The direct capacitance between the grid and the plate. (See 1017, Direct Capacitance.)

**5036. Grid-Filament Capacitance ( $C_{gf}$ )**—The direct capacitance between the grid and the filament. (See 5035, Grid-Plate Capacitance; and 1017, Direct Capacitance.)

**5037. Plate-Filament Capacitance ( $C_{pf}$ )**—The direct capacitance between the plate and the filament. (See 5035, Grid-Plate Capacitance; and 1017, Direct Capacitance.)

Note: All capacitances are ordinarily understood to be taken with the vacuum tube in its completed form but not in its socket or other holder.

Note: The following relations exist between the capacitances defined in 5032-5037:

$$C_f = C_{gf} + C_{pf}; \quad C_p = C_{pf} + C_{ip}; \quad C_g = C_{gf} + C_{gp}.$$

**5038. Internal Output Impedance**—The ratio of the alternating voltage impressed on the output terminals of a vacuum tube to the alternating current thereby produced at these terminals, in the absence of impressed alternating voltages at other points.

Note: This is sometimes called simply "output impedance," but the prefix "internal" is preferred in order more surely to distinguish it from the impedance of the external output circuit.

**5039. Internal Output Admittance**—The reciprocal of internal output impedance.

**5040. Input Impedance**—The ratio of the alternating voltage impressed on the input terminals of the device to the alternating current thereby produced at these terminals, in the absence of impressed alternating voltages at other points.

**5041. Input Admittance**—The reciprocal of input impedance.

**5042. Mutual Characteristic (Grid-Plate Characteristic)**—The graph plotted between grid voltage as abscissas and plate current as ordinates. (See 5019, Grid Characteristic; 5028, Mutual Conductance; 5031, Plate Characteristic; and 5045, Emission Characteristic.)

**5043. Electron Emission**—The phenomenon of the liberation of electrons from the surface of a body into the surrounding space, usually under the influence of heat, illumination, x-rays, impact excitation, or chemical disintegration.

**5044. Total Emission**—The value of the current carried by electrons emitted from a cathode under the influence of a voltage such as will draw away all the electrons emitted.

**5045. Emission Characteristic**—The graph plotted between a factor controlling electron emission (such as the temperature, voltage or current of the cathode or filament) as abscissas and the total emission from the cathode or filament as ordinates. (See 5019, Grid Characteristic; 5031, Plate Characteristic; and 5042, Mutual Characteristic.)

**5046. Thermionic**—Relating to electron emission under the influence of heat.

## SECTION 6—CIRCUIT ELEMENTS AND PROPERTIES

**6001. Resonance Frequency (of a reactive circuit)**—The frequency at which the supply current and supply voltage of the circuit are in phase.

**6002. Frequency Meter**—An instrument for measuring frequency. (Frequency meters used in radio work are sometimes called wave-meters.)

**6003. Fundamental Frequency**—That frequency of which all component frequencies are integral multiples.

**6004. Harmonic**—A component of a periodic quantity having a frequency which is an integral multiple of the fundamental frequency. For example, a component the frequency of which is twice the fundamental frequency is called the second harmonic.

**6005. Oscillatory Circuit**—A relatively low resistance circuit containing both inductance and capacity, such that a voltage impulse will produce a current which periodically reverses.

**6006. Beating**—A phenomenon in which two or more periodic quantities of not greatly different frequencies react with each other to produce a resultant having pulsations of amplitude.

**6007. Beat**—A complete cycle of such pulsations.

**6008. Beat Frequency**—The number of beats per second. This frequency is equal to the difference between the frequencies of the combining waves.

**6009. Series Resonance**—A condition which exists in a circuit having inductance and capacity connected in series, when the supply current and supply voltage are in phase.

**6010. Parallel Resonance**—A condition which exists in a circuit having inductance and capacity connected in parallel, when the supply current and supply voltage are in phase.

**6011. Coupling**—The association of two circuits in such a way that energy may be transferred from one to the other.

6012. **Coupling Coefficient**—The ratio of the mutual or common impedance component of two circuits to the square root of the product of the total impedance components of the same kind in two circuits. (Impedance components may consist of inductance, capacity or resistance.)
6013. **Direct Coupling**—Association of two radio circuits by having an inductor, a condenser, or a resistor common to both circuits.
6014. **Inductive Coupling**—The association of one circuit with another by means of inductance common or mutual to both. (This term when used without modifying words is commonly used for coupling by means of mutual inductance, whereas coupling by means of self-inductance common to both circuits is called "direct inductive coupling.")
6015. **Capacitive Coupling**—The association of one circuit with another by means of capacity common or mutual to both.
6016. **Resistance Coupling**—The association of one circuit with another by means of resistance common to both.
6017. **Decremeter**—An instrument for measuring the logarithmic decrement of a train of waves.
6018. **Logarithmic Decrement**—The Napierian logarithm of the ratio of the first to the second of two successive amplitudes in the same direction, for an exponentially damped alternating current. The logarithmic decrement can also be considered as a constant of a simple radio circuit, being  $\pi$  times the product of the resistance and the square root of the ratio of the capacity to the inductance of the circuit.
6019. **Damping Constant**—The Napierian logarithm of the ratio of two values of an exponentially decreasing quantity separated by unit time.

The damping constant is the coefficient  $a$  appearing in the exponent of the damping factor,  $e^{-at}$ , which occurs in expressions of the following forms for damped currents.

$$i = I_0 e^{-at}$$

$$i = I_0 e^{-at} \cos 2\pi f_n t$$

In an oscillatory circuit containing resistance, inductance, and capacity in series,  $a = R/2L$ .

6020. **Alternating Current**—A current, the direction of which reverses at regularly recurring intervals, the algebraic average value being zero.
6021. **Damped Alternating Current**—An alternating current passing through successive cycles with progressively diminishing amplitude.
6022. **Free Alternating Current**—The damped alternating current which flows in a circuit following the cessation of an impressed voltage.
6023. **Forced Alternating Current**—The alternating current which flows in a circuit as the result of an impressed alternating voltage and which has the same frequency.
6024. **Pulsating Current**—A periodic current, that is, current passing through successive cycles, the algebraic average value of which is not zero. A pulsating current is equivalent to the sum of an alternating and a direct current.
6025. **Direct Current**—A unidirectional current. As ordinarily used, the term designates a practically non-pulsating current.
6026. **Hot-Wire Ammeter**—(Expansion type)—An ammeter dependent for its indications on a change in dimensions of an element which is heated by a current through it.
6027. **Thermocouple Ammeter**—An ammeter dependent for its indications on the change in thermo electromotive force set up in a thermo electric couple which is heated by the current to be measured.
6028. **Vacuum-Tube Voltmeter**—A device utilizing the characteristics of a vacuum tube for measuring alternating voltages.
6029. **Amplifier**—A device for increasing the amplitude of electric current, voltage or power, through the control by the input power

- of a larger amount of power supplied by a local source to the output circuit.
6030. **Voltage Amplification**—The ratio of the alternating voltage produced at the output terminals of an amplifier to the alternating voltage impressed at the input terminals. (This term should not be used to describe a process.) (See 5027, Amplification Factor.)
6031. **Current Amplification (of an amplifier)**—The ratio of the alternating current produced in the output circuit to the alternating current supplied to the input circuit.
6032. **Power Amplification (of an amplifier)**—The ratio of the alternating-current power produced in the output circuit to the alternating-current power supplied to the input circuit.
6033. **Relay**—A device by means of which contacts in one circuit are operated by a change in conditions in the same circuit or in one or more associated circuits.
6034. **Regeneration**—The process by which a part of the output power of an amplifying device reacts upon the input circuit in such a manner as to reinforce the initial power, thereby increasing the amplification. (Sometimes called "feed back" or "reaction.")
6035. **Attenuation Equalizer**—A device for altering the total transmission loss of a circuit for various frequencies in order to make substantially equal the total transmission loss for all frequencies within a certain range.
6036. **Transmission Level**—The radio field intensity or the signaling power amplitude at any point in a communication system, expressed either in some absolute unit or with reference to an arbitrary base value.
6037. **Loading Coil**—An inductor inserted in a circuit to increase its inductance but not to provide coupling with any other circuit.
6038. **Choke Coil**—An inductance coil inserted in a circuit to offer reactance to the flow of alternating-current components while allowing direct current to pass.

6039. **Banked Winding**—A form of coil winding in which single turns are wound successively in each of two or more layers, the winding proceeding from one end of the coil to the other, without return.
6040. **By-Pass Condenser**—A condenser used to provide an alternating-current path of comparatively low impedance around some circuit element.
6041. **Stopping Condenser**—A condenser used to introduce a comparatively high impedance in some branch of a circuit for the purpose of limiting the flow of low-frequency alternating current or direct current without materially affecting the flow of high-frequency alternating current.
6042. **Ripple Voltage**—The alternating component of unidirectional voltage from a rectifier or generator. Per cent ripple is the ratio of the r.m.s. value of the ripple voltage to the algebraic average value of the total voltage expressed in percentage.
6043. **Filter**—A selective circuit network, designed to pass currents within a continuous band or bands of frequencies or direct current, and substantially reduce the amplitude of currents of undesired frequencies.
6044. **Low-Pass Filter**—A filter designed to pass currents of all frequencies below a critical or cut-off frequency and substantially reduce the amplitude of currents of all frequencies above this critical frequency.
6045. **High-Pass Filter**—A filter designed to pass currents of all frequencies above a critical or cut-off frequency and substantially reduce the amplitude of currents of all frequencies below this critical frequency.
6046. **Band-Pass Filter**—A filter designed to pass currents of frequencies within a continuous band limited by an upper and a lower critical or cut-off frequency and substantially reduce the amplitude of currents of all frequencies outside of that band.
6047. **Ripple Filter**—A low-pass filter designed to reduce the ripple current while freely passing the direct current from a rectifier or generator.

**6048. Rectifier**—A device having an asymmetrical conduction characteristic which is used for the conversion of an alternating current into a pulsating current. Such devices include vacuum-tube rectifiers, gas rectifiers, oxide rectifiers, electrolytic rectifiers, etc.

Note: In dealing with rectification in the reception of radio signals the term "detector" is preferred to "rectifier". (See 4012 Detector.)

**6049. Half-Wave Rectifier**—A rectifier which changes alternating current into pulsating current, utilizing only one-half of each cycle.

**6050. Full-Wave Rectifier**—A double element rectifier arranged so that current is allowed to pass in the same direction to the load circuit during each half cycle of the alternating-current supply, one element functioning during one-half cycle and the other during the next half cycle, and so on.

**6051. Trickle Charger**—A device designed to charge a storage battery at a low rate continuously or during a major portion of the 24-hour day.

**6052. Resonance Transformer**—A transformer with condenser load, whose circuits are adjusted as a whole to have the same frequency as that of the alternating current supplied to the primary, thereby causing the secondary voltage to build up to higher values than would otherwise be attained.

**6053. Radio-Frequency Transformer**—A transformer for use with radio-frequency currents.

**6054. Audio-Frequency Transformer**—A transformer for use with audio-frequency currents.

**6055. Rheostat**—A resistor which is provided with means for readily adjusting its resistance.

**6056. Voltage Divider**—A resistor provided with fixed or movable contacts and with two fixed terminal contacts. Current is passed between the terminal contacts and the desired voltage is obtained across a portion of the resistor. The term "potentiometer" is often erroneously used for this device.

**6057. "A" Power Supply**—A power supply device which provides heating current for the cathode of a vacuum tube.

**6058. "B" Power Supply**—A power supply device connected in the plate circuit of a vacuum tube.

**6059. "C" Power Supply**—A power supply device connected in the circuit between the cathode and grid of a vacuum tube so as to apply a grid bias.

**6060. Protective Device**—A device for keeping currents or voltages of undesirably large magnitude out of a given part of an electrical circuit. For example, fuse, lightning arrestor.

**6061. Transmission-Frequency Characteristic**—A graph showing the transmission efficiency of a circuit or transmission path as ordinates and the frequency as abscissas.

#### SECTION 7—ANTENNAS

**7001. Antenna**—A device for radiating or absorbing radio waves.

**7002. Aerial**—An elevated conductor portion of a condenser antenna.

**7003. Unilateral Antenna**—An antenna having the property of radiating or receiving radio waves in larger proportion in some one angular region than in all other directions.

**7004. Beam Antenna**—A unilateral directive antenna such that its radiation is substantially confined to a narrow beam.

**7005. Bilateral Antenna**—An antenna having the property of radiating or receiving radio waves in larger proportion in angular regions 180 degrees apart than in all other directions.

**7006. Loop Antenna**—An antenna consisting of one or more complete turns of wire. This is also called a coil antenna.

**7007. Condenser Antenna**—An antenna consisting of two capacity areas.



**7008. Directional Antenna**—An antenna having the property of radiating or receiving radio waves in larger proportion along some directions than others. An antenna of this type used for transmitting is often called a directive antenna.

**7009. Multiple Tuned Antenna**—An antenna with connections to ground or counterpoise through inductances at more than one point, the inductances being so determined that their reactances in parallel present a total reactance equal to that necessary to give the antenna the desired natural frequency.

**7010. Feed Ratio (of a multiple tuned antenna)**—The value obtained by dividing the sum of the currents at all the antinodes by the current in the line feeding the antenna.

**7011. Series or Feed Resistance (of a multiple tuned antenna)**—The quotient of the power delivered to the antenna by the square of the current in the line feeding the antenna.

**7012. Wave Antenna**—A horizontal aerial the physical length of which is of the same order of magnitude as that of the signaling waves to be received, and which is so used as to be strongly directional.

**7013. Antenna Resistance**—An effective resistance which is numerically equal to the quotient of the average power in the entire antenna circuit by the square of the effective current at the point of maximum current.

Note: Antenna resistance includes: Radiation resistance, ground resistance, radio-frequency resistance of conductors in antenna circuit, equivalent resistance due to corona, eddy currents, insulator leakage, dielectric loss, etc.

**7014. Effective Height of an Antenna**—The height of an equivalent ideal antenna. As ordinarily defined, this ideal antenna is a vertical conductor carrying a uniform current equal to the maximum current existing at any point in the actual antenna.

Note: This applies most strictly to antenna systems producing or affected by a substantially vertical electric field.

**7015. Antenna Form Factor**—The ratio of the effective height of an antenna to its actual physical height.

**7016. Meter Amperes**—The product of the antenna current in amperes at the point of maximum current and the antenna effective height in meters for any radio transmitting station.

**7017. Radiation Resistance**—The ratio of the total power radiated by an antenna to the square of the effective current at the point of maximum current.

**7018. Radiation Efficiency**—The radiation efficiency of an antenna is the ratio of power radiated to the total power delivered to the antenna, at a given frequency.

**7019. Fundamental or Natural Frequency (of an antenna)**—The lowest resonant frequency of an antenna, without added inductance or capacity.

**7020. Lead-In**—That portion of an antenna system which completes the electrical connection between the elevated outdoor portion and the instruments or disconnecting switches inside the building.

**7021. Counterpoise**—A system of wires or other conductors, forming the lower capacity area of a condenser antenna elevated above and insulated from the ground.

**7022. Ground System (of an antenna)**—That portion of the antenna system below the antenna loading devices or generating apparatus most closely associated with the ground and including the ground itself.

**7023. Ground Wire**—A conductive connection to the earth.

**7024. Ground Equalizer Inductors**—Coils of relatively low inductance placed in the circuit connected to one or more of the grounding points of an antenna ground system, to divide the current between the various points in any desired way.

## SECTION 8—DIRECTION FINDING

**8001. Direction Finder (Goniometer)**—A radio receiving device which permits determination of the line of travel of waves as received.

8002. Radiocompass—A direction finder used for navigational purposes.
8003. Direction-Finder Calibration—The determination of the direction and amount of fixed local wave front distortion to the end that the correct bearing may be obtained.
8004. Radio Wave-Front Distortion—A change in the direction of advance of radio waves.
8005. Sense Finder—An addition to a direction finder which permits determination of the direction without 180 degrees ambiguity.
8006. Radiobeacon—A radio transmitting station in a fixed geographic location which emits a distinctive or characteristic signal for enabling mobile receiving stations to determine bearings or courses.
8007. Radio Range—A radiobeacon which transmits directed waves by means of which departures from a given course may be observed.
8008. Equisignal Radio Range—A radio range which transmits two distinctive signals which may be received with equal intensity only in certain directions.
8009. Equisignal Zone—A region in which two distinctive signals from an equisignal radio range are received with equal intensity.
8010. Radio Bearing—The angle between the direction of the advance of the incoming radio wave and an arbitrarily fixed line (such as the center line of a ship).
8011. Corrected Radio Bearing—A radio bearing to which the calibration correction has been applied.

## SECTION 9—ELECTRO-ACOUSTIC DEVICES

### 9001-9013 General

The Transmission Unit (the decibel—"db").\* The transmission unit is used below for expressing certain performance indices of

\* See "The Transmission Unit" (page 81).

electro-acoustic transducers. This unit is logarithmic in nature and possesses a unique relation with the physiological response of the ear; namely, over the usual range of sound intensities one transmission unit corresponds very closely to the minimum perceptible change in loudness. The interpretation of the significance of the performance indices in terms of what one may expect to hear is thereby facilitated by expressing them in transmission units.

9001. Electro-Acoustic Transducer—An electro-acoustic transducer is a transducer which is actuated by power from an electrical system and supplies power to an acoustic system or vice versa.
9002. Damped Impedance—The damped impedance of an electro-acoustic transducer is the impedance measured at the terminals of its electrical system when the impedance of the attached mechanical system is infinite or vice versa.
9003. Normal Impedance—The normal impedance of an electro-acoustic transducer is the impedance measured at the terminals of the electrical system when the mechanical system is connected to its load or vice versa.
9004. Motional Impedance—The motional impedance of an electro-acoustic transducer is the vector difference between the normal and the damped impedance.
9005. Force Factor—The force factor of an electro-acoustic transducer is a measure of the coupling between its electrical and mechanical systems. It is the ratio of the open circuit force or voltage in the secondary system to the current or velocity in the primary system.
9006. Compliance—The compliance of a mechanical element is its deflection per unit of force. This is the reciprocal of its stiffness. Compliance in a mechanical system is analogous to *capacitance* in an electrical system and is expressed in centimeters per dyne. Negative compliance (reciprocal of negative stiffness) occurs in a case of unstable equilibrium where a small displacement results in a force tending to give a further displacement in the same direction.

9007. **Mechanical Impedance**<sup>1</sup>—The mechanical impedance of a mechanical system is the complex quotient of the alternating force applied to the system by the resulting alternating linear velocity in the direction of the force at its point of application.

9008. **Mechanical Resistance**<sup>1</sup>—The mechanical resistance of a mechanical system is the real component of the mechanical impedance. It may also be expressed as the quotient of the power absorbed by the system by the square of the alternating velocity at the point of application of the force.

9009. **Mechanical Reactance**<sup>1</sup>—The mechanical reactance of a mechanical system is the magnitude of the imaginary component of the mechanical impedance. It may also be expressed as the component of the mechanical impedance of the system resulting from its effective mass or compliance.

9010. **Bar**—A pressure of one dyne per square centimeter is called a bar.

9011. **Acoustic Impedance**<sup>2</sup>—The acoustic impedance of a sound medium on a given surface is the complex quotient of the pressure (force per unit area) on that surface by the flux (volume velocity, or linear velocity multiplied by the area) through that surface. The acoustic impedance may be expressed in terms of mechanical impedance, acoustic impedance being equal to mechanical impedance divided by the square of the area of the surface considered.

9012. **Acoustic Resistance**<sup>2</sup>—The acoustic resistance of a sound medium is the real component of the acoustic impedance. This is the component of the acoustic impedance associated with the dissipation of energy.

9013. **Acoustic Reactance**<sup>2</sup>—The acoustic reactance of a sound medium is the imaginary part of the acoustic impedance. It is the component of the acoustic impedance resulting from the effective mass or compliance of the medium.

<sup>1</sup> A mechanical impedance, reactance, or resistance is said to have a magnitude of one unit when a force of one dyne produces a velocity of one centimeter per second.

<sup>2</sup> An acoustic resistance, reactance, or impedance is said to have a magnitude of one unit when a pressure of one bar produces a volume velocity of one cubic centimeter per second.

9014. **The Absolute Efficiency** of an electro-acoustic transducer for a given circuit condition is an expression in percentage or in TU determined from the ratio of the output of the transducer to the output of the ideal electro-acoustic transducer.

9015. **The Practical Efficiency** of one telephone receiver relative to another as observed in the sound medium at a specified point relative to the location of the two receivers is an expression in percentage or in TU determined from the following ratio:

$$\frac{E_2}{E_1} \sqrt{\frac{R_1}{R_2}}$$

Where  $E_1$  is a voltage in series with the first receiver and a resistance  $R_1$  equal to the impedance to which this receiver is designed to be connected;  $E_2$  is a voltage in series with the other receiver and a resistance  $R_2$  equal to the impedance to which this receiver is designed to be connected; and the values of  $E_1$  and  $E_2$  are such that the two receivers give the same loudness of sound at the observer's position as judged by the ear.

The practical efficiency of one microphone (with its associated connecting circuit) relative to another microphone (with its associated connecting circuit) when these are connected alternately to the grid-filament circuit of a vacuum tube is an expression in percentage or in TU determined from the following ratio:

$$\frac{E_{g1}}{E_{g2}}$$

Where  $E_{g1}$  is the voltage produced between the grid and filament of the tube by the first microphone;  $E_{g2}$  is a similar voltage produced by the second microphone;  $E_{g1}$  and  $E_{g2}$  resulting when the microphones are placed successively in the same sound field.

9016. **Response**—The response of a receiver at a specified frequency and under specified acoustic conditions is determined from the following ratio:

$$\frac{p}{E \sqrt{R}}$$

Where  $R$  is a resistance equal to the impedance to which the receiver is designed to be connected;  $E$  is a voltage (at the speci-

fied frequency) supplied to the receiver in series with the resistance  $R$ ; and  $p$  is the resultant pressure (at the specified frequency) at a specified point or the average of the resultant pressures at specified points in the medium relative to the receiver.

The response may be expressed by a value equal to the above ratio or may be expressed in TU relative to an arbitrary reference condition of 1 volt, 1 ohm, and 1 bar. Thus the response of a receiver in TU equals:

$$20 \log_{10} \frac{\frac{p}{\sqrt{R}}}{\frac{1}{\sqrt{1}}} = 20 \log_{10} \frac{p}{\frac{E}{\sqrt{R}}}$$

The response of a microphone (with its associated connecting circuit) at a specified frequency and in conjunction with a vacuum tube having a specified input capacitance is determined from the ratio:

$$\frac{E_o}{p}$$

Where  $p$  is the pressure in bars at the specified frequency on the microphone diaphragm; and  $E_o$  is the voltage produced by the microphone between the grid and filament of the associated vacuum tube when the microphone is connected thereto and operated in the manner for which it was designed.

The response may be expressed by a value equal to the above ratio or may be expressed in TU relative to an arbitrary reference condition of 1 volt per bar. Thus, the response in TU equals:

$$20 \log_{10} \frac{\frac{E_o}{p}}{\frac{1}{1}} = 20 \log_{10} \frac{E_o}{p}$$

**9017. A Response-Frequency Characteristic** of an electro-acoustic transducer is a curve showing its response over a range of frequencies and is usually defined by rectangular coordinates with

response values as ordinates and frequency values as abscissas. A logarithmic frequency scale is employed.

**9018. The Articulation** of an electro-acoustic transducer is a measure of its ability to transmit detached speech syllables and is expressed as a percentage of the total syllables spoken which are correctly understood by the listener at the output of a transmission system including the transducer as the only source of distortion of detectable magnitude.

**9019. A Current-Supply Loss Curve** is one which shows the changes in the practical efficiency or response of an electro-acoustic transducer which accompany changes in the direct-current supply.

#### 9101-9121—Telephone Receivers and Loud Speakers

**9101. Telephone Receiver**—A telephone receiver is an electro-acoustic transducer actuated by power from an electrical system and supplying power to an acoustic system, the wave form in the acoustic system corresponding to the wave form in the electrical system.

**9102. Loud Speaker**—A loud speaker is a telephone receiver designed to radiate acoustic power into a room or open air.

**9103. Driver Element**—The driver element of a telephone receiver is that portion of the receiver which receives power from the electrical system and converts it into mechanical power.

**9104. Acoustic Radiator**—An acoustic radiator is that portion of a transducer which facilitates the radiation of sound vibrations.

**9105. Free Radiator**—A free radiator is an acoustic radiator, the sound from which is originated in an unconstrained medium.

**9106. Constrained Radiator**—A constrained radiator is an acoustic radiator, the sound from which is originated in a constrained portion of the medium.

**9107. Horn**—A horn is a constrained radiator consisting of a tube of

varying sectional area for determining the shape of the constrained portion of the medium.

**9108. Throat of a Horn**—The throat of a horn is the end with the smaller cross sectional area.

**9109. Mouth of a Horn**—The mouth of a horn is the end with the larger cross sectional area.

**9110. Exponential Horn**—An exponential horn (sometimes called logarithmic horn) is a horn whose sectional area varies exponentially with its length. It is defined by the following relation:

$$\frac{S}{S_0} = e^{Tx}$$

where  $S$  = area of plane section of the horn normal to the axis at a distance  $x$  from the throat of the horn.  $S_0$  = area of plane section of the horn normal to the axis at the throat, and  $T$  = a constant which determines the rate of taper of the horn.

**9111. Conical Horn**—A conical horn is a horn whose equivalent sectional radius ( $\sqrt{S/\pi}$ ) has a constant rate of increase.

**9112. Diaphragm**—A diaphragm is a vibrating surface which produces sound vibrations.

**9113. Baffle**—A baffle is a partition which may be used with a free radiator to impede circulation from front to back.

**9114. Magnetic Loud Speaker**—A magnetic loud speaker is one in which the mechanical forces result from magnetic reactions.

**9115. Moving Coil Loud Speaker**—A moving coil loud speaker is a magnetic loud speaker in which the mechanical forces are developed by the interaction of currents in a conductor and the polarizing field in which it is located. This is sometimes called an Electro-Dynamic or a Dynamic Loud Speaker.

**9116. Moving Iron Loud Speaker**—A moving iron loud speaker is a magnetic loud speaker whose operation involves the vibration of a portion of the ferro-magnetic circuit.

**9117. Induction Loud Speaker**—An induction loud speaker is a moving coil loud speaker in which the current which reacts with the polarizing field is induced in the moving member.

**9118. Condenser Loud Speaker**—A condenser loud speaker is one in which the mechanical forces are obtained by varying the voltage between two electrodes of a condenser forming a part of an electrical circuit.

**9119. Piezo-Electric Loud Speaker**—A piezo-electric loud speaker is one in which the mechanical forces are obtained by use of a piezo-electric element.

**9120. Magnetostriction Loud Speaker**—A magnetostriction loud speaker is a magnetic loud speaker in which the mechanical forces are obtained by magnetostriction.

**9121. Thermal Receiver**—A thermal receiver is a telephone receiver in which the temperature of a conductor is caused to vary in response to the current input, thereby producing sound waves as a result of the expansion and contraction of the adjacent air.

#### 9201-9211—Microphones

**9201. Microphone**—A microphone is an electro-acoustic transducer actuated by power in an acoustic system and delivering power to an electric system, the wave form in the electric system corresponding to the wave form in the acoustic system. This is also called a telephone transmitter.

**9202. Carbon Microphone**—A carbon microphone is one using one or more carbon contacts.

**9203. Condenser Microphone**—A condenser microphone is one the operation of which involves a variation in the electrostatic capacity produced by a sound wave.

**9204. Magnetic Microphone**—A magnetic microphone is one whose electrical output is generated in a coil or conductor in a magnetic circuit or field.

**9205. Push-Pull Microphone**—A push-pull microphone is one which makes use of two functioning elements 180 degrees out of phase.

**9206. Burning** is a rapid, transitory and for the most part nonperiodic resistance fluctuation in a carbon microphone. It is evidenced by a frying or sputtering noise sometimes heard from a connected receiver.

**9207. Breathing** is a slow and for the most part periodic variation in the resistance (and microphonicness) of a carbon microphone. It may be of relatively large magnitude and is not in general audible.

**9208. Packing** in a carbon microphone is a condition caused by excess mechanical pressure between points of contact or by adherence between points of contact resulting from excessive voltages. It is evidenced by decreased resistance and sensitivity of the microphone.

#### 9301-9306—Electromechanical Devices

**9301. Phonograph Pickup**—A phonograph pickup is an electromechanical transducer actuated by a phonograph record and delivering power to an electrical system, the wave form in the electrical system corresponding to the wave form in the phonograph record.

**9302. Magnetic Pickup**—A magnetic pickup is a phonograph pickup whose electrical output is generated in a coil or conductor in a magnetic circuit or field.

**9303. Carbon Contact Pickup**—A carbon contact pickup is a phonograph pickup which depends for its operation upon the variation in resistance of one or more carbon contacts.

**9304. Piezo-Electric Pickup**—A piezo-electric pickup is a phonograph pickup whose electrical output is generated by varying mechanical stresses in the piezo-electric crystal.

**9305. Condenser Pickup**—A condenser pickup is a phonograph pickup whose electrical output is generated by a mechanical variation of its charged capacity.

**9306. Electrical Phonograph Recorder**—An electrical phonograph recorder is an electromechanical transducer actuated by power in an electrical system and supplying power to a recording mechanical system, the recorded wave form produced by the mechanical system corresponding to the wave form in the electrical system.

### THE TRANSMISSION UNIT

A transmission unit is a unit for the logarithmic expression of ratios of power, voltages, or currents, in a transmission system.

There are now in rather widespread use, internationally, two transmission units, a Napierian unit called the "Neper," and a decimal unit called the "Bel." Decimal multiples or sub-multiples of either of these units may be used, such as "decineper" and "decibel."

The number of units of transmission in the case of a ratio of two powers,  $P_1$  and  $P_2$  is:

$$\text{in the napierian system: } 1/2 \log_e \frac{P_1}{P_2}$$

$$\text{in the decimal system: } \log_{10} \frac{P_1}{P_2}$$

The number of units of transmission in the case of a ratio of two voltages  $E_1$  and  $E_2$ , of two currents  $I_1$  and  $I_2$ , if the squares of these ratios are equal to the power ratio, is:

$$\text{in the napierian system: } \log_e \frac{E_1}{E_2} \text{ or } \log \frac{I_1}{I_2}$$

$$\text{in the decimal system: } 2 \log_{10} \frac{E_1}{E_2} \text{ or } 2 \log_{10} \frac{I_1}{I_2}$$

The unit based on the decimal system and having a size one-tenth of that here defined is widely used in the United States. This unit is, therefore, the "decibel," (abbreviated "db") and has been generally referred to merely as "the transmission unit" or "TU."

The following table gives the numerical values of power, voltage, and current ratios corresponding to particular numbers in decibels:

POWER RATIO	TRANSMISSION UNITS IN DECIBELS (db)
1	0 (=10 log <sub>10</sub> 1)
1.259 (=10 <sup>0.1</sup> )	1 (=10 log <sub>10</sub> 1.259)
10 (=10 <sup>1</sup> )	10 (=10 log <sub>10</sub> 10)
100 (=10 <sup>2</sup> )	20 (=10 log <sub>10</sub> 100)
1000 (=10 <sup>3</sup> )	30 (=10 log <sub>10</sub> 1000)

VOLTAGE OR CURRENT RATIO	TRANSMISSION UNITS IN DECIBELS (db)
0.001	-60.00
0.005	-40.02
0.01	-40.00
0.05	-26.02
0.1	-20.00
0.2	-13.98
0.5	-6.02
1.0	0.00
1.5	3.52
2	6.02
5	13.98
10	20.00
20	26.02
50	33.98
100	40.00
500	53.98
1000	60.00

## STANDARD GRAPHICAL SYMBOLS USED IN RADIO COMMUNICATION

Aerial	
Ammeter	
Arc	
Battery (the positive electrode is indicated by the long line)	
Coil Antenna	
Condenser, Fixed	
Condenser, Fixed, Shielded	
Condenser, Variable	
Condenser, Variable (with moving plate indicated)	
Condenser, Variable, Shielded	
Counterpoise	
Crystal Detector	

Frequency Meter (Wavemeter)	
Galvanometer	
Glow Lamp	
Ground	
Inductor	
Inductor, Adjustable	
Inductor, Iron Core	
Inductor, Variable	
Jack	
Key	
Lightning Arrester	
Loud Speaker	
Microphone (Telephone Transmitter)	
Photo electric Cell	
Piezoelectric Plate	



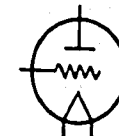
Resistor	
Resistor, Adjustable	
Resistor, Variable	
Spark Gap, Rotary	
Spark Gap, Plain	
Spark Gap, Quenched	
Telephone Receiver	
Thermoelement	
Transformer, Air Core	
Transformer, Iron Core	
Transformer, With Variable Coupling	
Transformer, With Variable Coupling (With moving coil indicated)	
Voltmeter	
Wires, Joined	
Wires, Crossed, not joined	

## Vacuum Tubes

Diode  
(or half-wave rectifier)



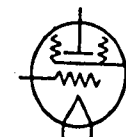
Triode  
(with directly heated cathode)



Triode  
(with indirectly heated cathode)



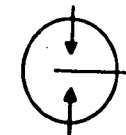
Screen Grid Tube  
(with directly heated cathode)



Screen Grid Tube  
(with indirectly heated cathode)



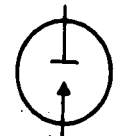
Rectifier Tube, Full-Wave  
(Filamentless)



Rectifier Tube, Full-Wave  
(with directly heated cathode)



Rectifier Tube, Half-Wave  
(Filamentless)

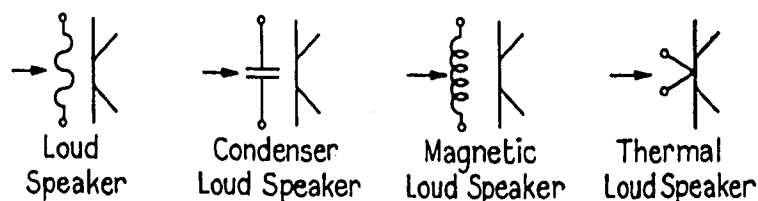
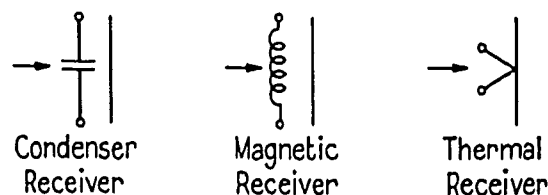
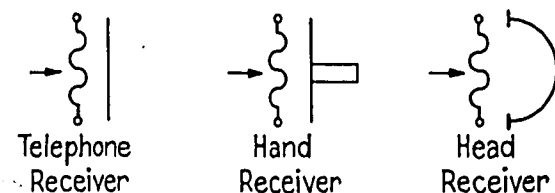


**SUGGESTED SYSTEM OF SYMBOLS  
FOR  
ELECTRO-ACOUSTIC DEVICES**

The accompanying system of symbols for electro-acoustic devices is suggested for trial use in order to determine whether these symbols are suitable for adoption as standard.

It should be observed that the complete symbol consists of a portion representing the electrical part of the system and another portion repre-

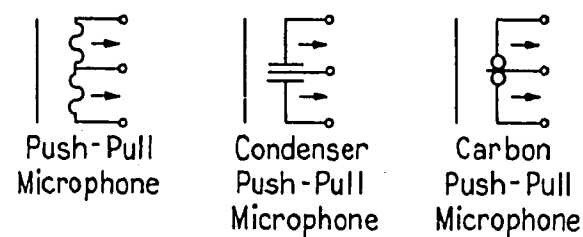
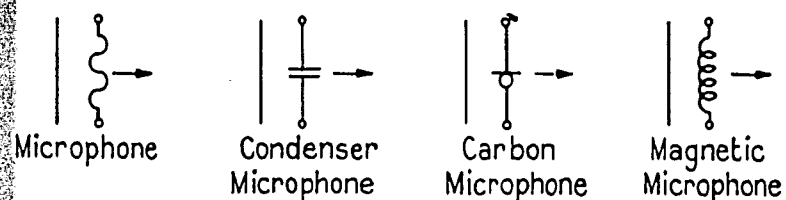
**TELEPHONE RECEIVERS**



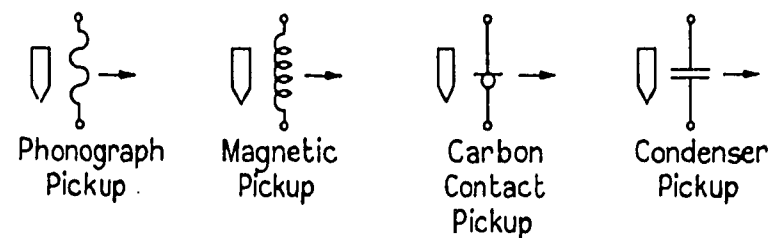
senting the acoustic or mechanical part of the system. An arrow associated with the electrical portion of the symbol is used to indicate whether the direction of energy flow is from the electrical to the

acoustic portion of the system or the reverse. The ordinary symbol for resistance, inductance, or capacity is used where appropriate, and a sine wave is used as a general symbol for impedance. The mechanical portion of the system is represented by a vertical line, modified in certain cases to indicate particular mechanical forms.

**MICROPHONES**



**ELECTRO-MECHANICAL DEVICES**



It is suggested that, when letter symbols are used to indicate electro-acoustic systems, the electrical terms be represented by capital letters *Z*, *X*, and *R*, and the mechanical terms be represented by small letters *z*, *x*, and *r*. It is suggested that "damped" impedance, reactance, or resistance be represented by the appropriate letter with the subscript small letter *d*, that "motional" impedance, reactance, or resistance be indicated by the subscript small letter *m*, and that "normal" impedance, reactance, or resistance be represented by the appropriate letter with no subscript.

## ABBREVIATIONS

All words, both technical and otherwise, should ordinarily be spelled out. Certain circumstances arise, however, such as the headings of columns, the tabulation of data, and a very limited number of other occasions when abbreviations are required. In such unusual circumstances, the following list of abbreviations may be used.

Many of the abbreviations are given in lower-case letters. Obviously, however, there will be occasions, such as when the abbreviations are used in titles of columns, where the original word would have been capitalized. In these cases, the abbreviations should be similarly capitalized.

A two-word adjective expression should contain a hyphen.

<i>Term</i>	<i>Abbreviation</i>
Alternating-current (adjective)	a-c
Alternating current	spell out
Ampere	a
Antenna	ant.
Audio-frequency (adjective)	a-f
Continuous waves	CW
Cycles per second	~
Decibel	db.
Direct-current (adjective)	d-c
Direct current	spell out
Electromotive force	e.m.f.
Frequency	f
Ground	gnd.
Henry	h
Intermediate-frequency (adjective)	i-f
Interrupted continuous waves	ICW
Kilocycles (per second)	kc
Kilowatt	kw
Megohm	MΩ
Microfarad	μf
Microhenry	μh
Micromicrofarad	μμf
Microvolt	μv
Microvolt per meter	μv/m

Millivolt per meter	mv/m
Milliwatt	mw
Ohm	$\Omega$
Power Factor	p.f.
Radio-frequency (adjective)	r-f
Volt	v

#### Abbreviations for Metric Prefixes

<i>Prefix</i>	<i>Abbreviation</i>
centi	c
deci	d
deka	dk
hecto	h
kilo	k
mega	M
micro	$\mu$
milli	m

#### LETTER SYMBOLS—VACUUM-TUBE NOTATION

The system of notation has been chosen with regard both to current practice and to convenience in printing and in typing. All special characters or signs have been avoided. The only character not ordinarily found on a typewriter is the Greek letter  $\mu$ ; and it has been suggested that in typing the letter u may be used as an alternative.

A subcommittee under the auspices of the American Standards Association is now at work on the general subject of symbols used in engineering. Among the recommendations tentatively adopted by this subcommittee are: (1) that *E*, *e* (never *V*, *v*) be used for voltage, including electromotive force and potential; and (2) that lower-case letters (never capitals) be used for the circuit properties: impedance, resistance, reactance, admittance, and conductance. This usage is followed in the report.

Table I gives the letter symbols for the important vacuum-tube quantities; and the following paragraphs state the rules to be followed, in the use of subscripts and the like, in distinguishing different quantities of the same kind.

1. When current, voltage, and power vary with time, lower-case italics should be used for instantaneous values and capital italics for constant or representative values. The root-mean-square value has no special designation, other than the use of capitals; other representative values are designated by subscripts which are placed as final subscripts, the subscript *m* being used for maximum value.
2. In alternating-current circuit equations, bold-face italics may be used for complex or vector quantities. In typing, where it is not desired to distinguish italics from Roman letters, underscoring may be employed to indicate bold-face letters.
3. Harmonic components should be indicated by numerical subscripts immediately preceding the letter, subscript 0 being used for the direct component and subscript 1 for the fundamental. However, when in any discussion, only fundamental sinusoidal quantities

are considered, then it is permissible to omit the subscript 1 for simplicity. The subscript 0 preceding the letters  $g$ ,  $\tau$ , etc., may be used to designate the respective conductance or resistance to direct current.

4. Different frequencies may be distinguished by letter or number subscripts, preceding the letter, and also preceding the subscripts denoting harmonics in case both are needed. To distinguish radio frequency and audio frequency, the subscripts  $r$  and  $a$  should be used.

5. Different vacuum tubes in the same discussion may be distinguished by letter or number subscripts immediately following the subscripts  $g$ ,  $p$ , etc.

The following examples illustrate the notation:

(a) Root-mean-square plate potential of vacuum tube No. 2, including direct component and all harmonic components,

$$E_{p2}$$

(b) Direct component of the plate potential in (a),

$${}_0E_{p2}$$

(c) Maximum value of third harmonic of the plate potential in (a),

$${}_3E_{p2m}$$

(d) Root-mean-square value of the fundamental plate potential in (a), the second form to be used only when it will not conflict with (a),

$${}_1E_{p2} \text{ or } E_{p2}$$

(e) Instantaneous value of the audio-frequency component of grid potential,

$${}_a e_g$$

(f) Root-mean-square value of third harmonic of the above.

$${}_a{}_3E_g$$

TABLE I

Quantity	Symbol
Grid potential	$E_g, e_g$
Grid current	$I_g, i_g$
Grid conductance	$g_g = \frac{\partial i_g}{\partial e_g}$
Grid resistance	$r_g = \frac{1}{g_g}$
Grid bias voltage	$E_c$
Plate potential	$E_p, e_p$
Plate current	$I_p, i_p$
Plate conductance	$g_p = \frac{\partial i_p}{\partial e_p}$
Plate resistance	$r_p = \frac{1}{g_p}$
Plate supply voltage	$E_b$
Emission current	$I_s$
Mutual conductance	$g_m = \frac{\partial i_p}{\partial e_g}$
*Inverse mutual conductance	$g_n = \frac{\partial i_g}{\partial e_p}$
Amplification factor	$\mu = \frac{g_m}{g_p}$
*Inverse amplification factor	$\mu_n = \frac{g_n}{g_g}$
Filament terminal voltage	$E_f$
Filament current	$I_f$
Filament supply voltage	$E_a$
Grid-plate capacity	$C_{gp}$
Grid-filament capacity	$C_{gf}$
Plate-filament capacity	$C_{pf}$
Grid capacity	$C_g = C_{gp} + C_{gf}$
Plate capacity	$C_p = C_{gp} + C_{pf}$
Filament capacity	$C_f = C_{gf} + C_{pf}$

\* These quantities are rarely used.

## STANDARD METHODS OF MEASURING IMPORTANT CHARACTERISTICS OF VACUUM TUBES

1. **Scope.** This section of this report concerns methods of measurement of the important characteristics of vacuum tubes.

2. **General Precautions.** Attention is called to the necessity, especially in tests of apparatus of low power, such as receiving-type vacuum tubes, of eliminating or correcting for errors due to the presence of the measuring instruments in the test circuit. This applies particularly to the currents taken by voltmeters and other shunt-connected apparatus, and to the voltage drops in ammeters and other series-connected apparatus.

Attention is also called to the desirability of keeping the test conditions, such as filament heating, plate potential, and plate current within the safe limits specified by the manufacturers. Otherwise the characteristics of the vacuum tube may be permanently altered and subsequent tests vitiated. When particular tests are required to extend somewhat beyond a specific safe limit (sections 5 and 7, pages 95 and 96) such portions of the test should be made as rapidly as possible and preferably after the conclusion of the tests within the specified safe limit.

3. **General Test Conditions.** Except when the nature of a test calls for varying or abnormal conditions, all tests should be made at the normal rated conditions specified by the manufacturers of the vacuum tubes. In case the manufacturer's rating is not specific, test conditions not specified should be selected in accordance with the best judgment of the tester (preference being given to the highest value of any quantity for which more than one value is specified) and should be clearly and fully stated as a part of the test data.

When a filament is rated in both voltage and current, the rated voltage should be employed in tests, except that in cases where filaments are to be used in series the rated current may be employed, this to be stated as a part of the test data. Direct current should be used

for filament heating, except where the normal operating condition is with alternating-current heating, in which case the use of the latter should be stated. When direct-current heating is employed, the negative filament terminal should be taken as the datum of potential; if the proper filament terminal to be used as the negative is not indicated by the manufacturer or specified in any recognized standard for a given vacuum-tube structure, then the terminal used as the negative should be stated with the test data. When alternating-current heating is employed, the mid-point (i.e., the center tap on the filament transformer secondary, or the mid-point on a resistance shunting the filament) should be taken as the datum. It should be noted that these two potential datum conditions are not equivalent and should not be expected to give equivalent readings. If substantially equivalent readings are desired as between the two cases (alternating and direct-current heating), the datum of potential for alternating-current heating must be taken at a point, whose direct potential is more negative than that of the filament mid-point by an amount numerically equal to half of the root-mean-square value of the filament voltage.

In testing screen-grid vacuum tubes (5006)\* the measurements may be made in the same way as on triodes, except that precautions must be taken due to the changed order of magnitude of some of the factors.

4. **Grid Characteristic (5019).** Readings of the grid current and grid potential are taken for the condition of constant plate potential, which should ordinarily be the normal rated value if only a single curve is to be obtained. The range in grid current ordinarily need not extend to reversed grid currents (5017), due to gas ionization, as such currents are relatively very small and are included in another test (section 14, page 102). The graph is plotted with grid voltage as abscissas and grid current as ordinates.

In case of two grids in a vacuum tube the voltage of one is kept constant while the voltage of the other is varied, thus giving two grid characteristic curves for one tube.

5. **Plate Characteristic (5031).** These curves are particularly informative and are most useful when plotted as a family of curves, each for a different value of grid potential. Readings of plate current

\* The numbers in parentheses refer to the numbered definitions in the first section of this Report.

and plate potential are taken for various values of grid potential. In taking these curves over the useful range, the vacuum tube may be overloaded as to voltage and power dissipated (see section 2, page 94). The graph is plotted with plate voltage as abscissas and plate current as ordinates.

For screen-grid vacuum tubes these characteristic curves are taken with the screen grid at a constant voltage.

**6. Mutual Characteristic Curve (5042).** Readings of plate current and grid potential are taken for the conditions of constant plate potential which should ordinarily be the normal rate value if only a single curve is to be obtained. The curve is plotted with grid potential as abscissa and plate current as ordinate. A family of these curves, each for a different value of plate potential, gives the same information as a family of plate characteristic curves, but not in as convenient form for most design purposes.

For screen-grid vacuum tubes this characteristic is taken with the screen grid at a constant voltage.

**7. Filament Characteristic Curves.** Readings of filament current and filament voltage are taken for the conditions of zero grid potential and zero plate potential. (Ordinarily the grid and plate electrodes may simply be left floating in potential.) The range should extend from a filament heating too low to give appreciable electron emission in service to at least the safe maximum heating (see section 2, page 94). Curves should be plotted with filament voltage as abscissa and filament current and filament power as ordinates.

**8. Emission Characteristic Curve (5045).** Readings of emission current and filament power (voltage and current) are to be taken and the curve is to be plotted with filament power as abscissa and emission current as ordinate. Emission current is measured with the grid or grids and the plate connected together and sufficient positive potential applied with respect to the filament, to obtain the full electron emission. Since the emission current at normal filament power would ordinarily be so great as to damage the vacuum tube, readings are taken at lower filament powers only, and normal emission current may be obtained by extrapolation. A suitable procedure is as follows, the values applying to ordinary receiving vacuum tubes. Readings are

taken with emission currents of 0.1, 0.2, 0.5, and 1.0 milliampere, with 25 volts positive potential applied to the grid and the plate. The results are plotted on a special "power-emission chart,"\* Fig. 1. The

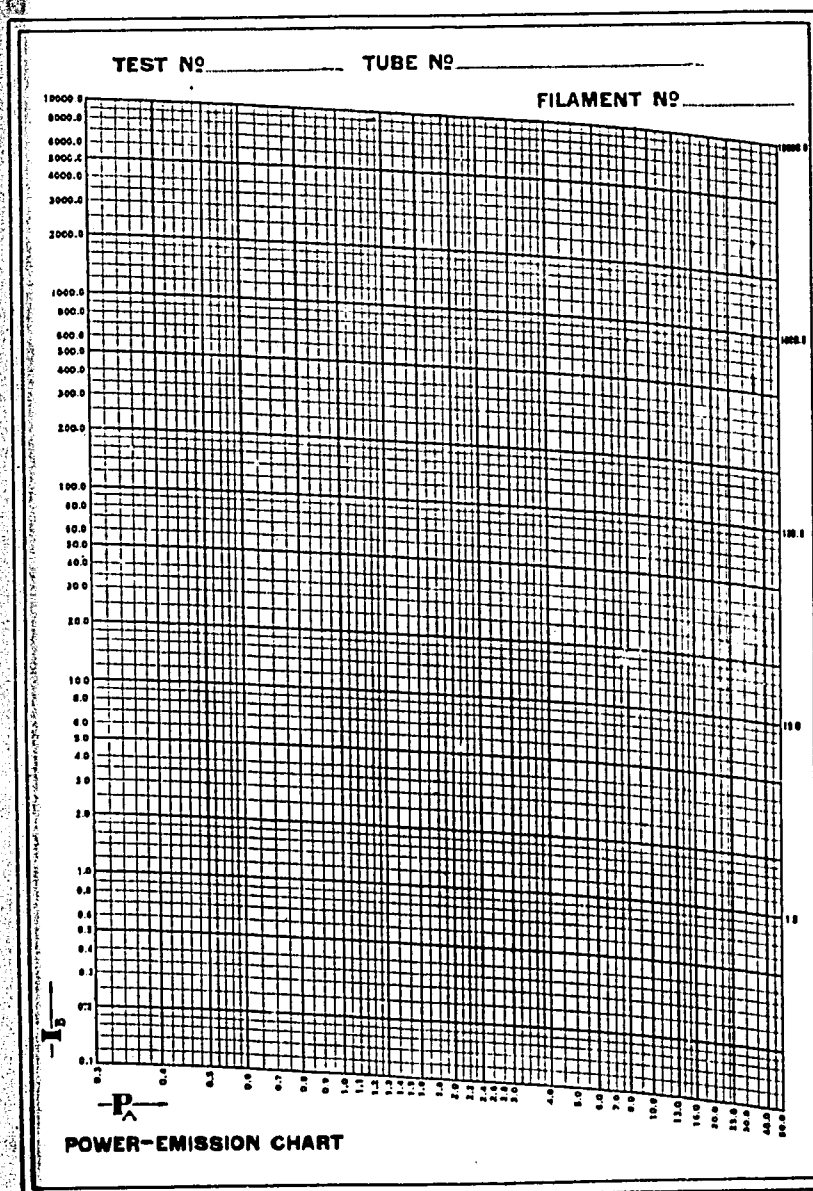


Fig. 1—Power Emission Chart.

\* Copies of this chart may be obtained from Institute headquarters or from the publisher, Keuffel & Esser Co., 127 Fulton Street, New York City.



four points should lie on a straight line, which may be extended to normal filament power. If the points tend to fall below a straight line with the larger currents, this is an indication that too low a potential has been used to obtain the true emission current, and the test should be repeated with 30 volts in place of 25 volts. On the other hand, if the points tend to lie above a straight line with the larger currents, the vacuum tube has not a sufficiently high vacuum for a reliable determination of its emission current by this procedure.

**9. Vacuum-Tube Constants in General.** The vacuum-tube properties or constants as used in circuit discussion and including internal conductances (or their reciprocals, resistances) and amplification factor may be obtained either (a) from the characteristic curves or (b) by direct measurements. The former method, the use of characteristic curves, is usually less precise and less suited to the rapid testing of a large number of vacuum tubes, but lends itself to more ready interpretation when the quantity to be measured varies rapidly with changing test conditions (see section 10 below). Both methods, when proper care and precautions have been taken, have been found to give concordant results.

Direct measurements are commonly made by balance methods employing a source of audio-frequency power and a telephone receiver with or without an amplifier as a null indicator. The magnitude of the impressed alternating voltage should be always low enough so that the results are not affected by a further lowering of the voltage. The sensitiveness is controlled by the amplification employed. Balance methods with alternating current require that consideration be given to the effects of stray capacities or inductances, which may render an exact balance difficult or may even cause a false balance and vitiate the results.

**10. Grid Conductance (5018).** On account of its rapid variation with grid potential, this quantity is ordinarily best determined from the slope of the grid characteristic curve (section 4, page 95) at a specified point, and is the rate of change of grid current with respect to grid potential. It should preferably be taken for several different values of grid potential. This quantity is negligible in practice, when a suitable negative grid bias potential is employed and the signal is not too strong. With a strong signal, its value ceases to have a definite significance.

In case the vacuum tube has appreciable dielectric loss, this will add to the grid conductance, which then should be measured at radio frequencies, if the vacuum tube is intended to be used at such frequencies.

**11. Amplification Factor (5027).** This is preferably determined by a balance method. If a single value is to be obtained, it should be for the conditions of normal rated plate potential and normal rated grid potential. When no rated grid potential is specified by the manufacturer, a value should be chosen so that the grid never swings positive in the cycle of the impressed alternating voltage.

This, like plate conductance, is preferably determined by a balance method. The conditions should be the same as in section 12, page 100.

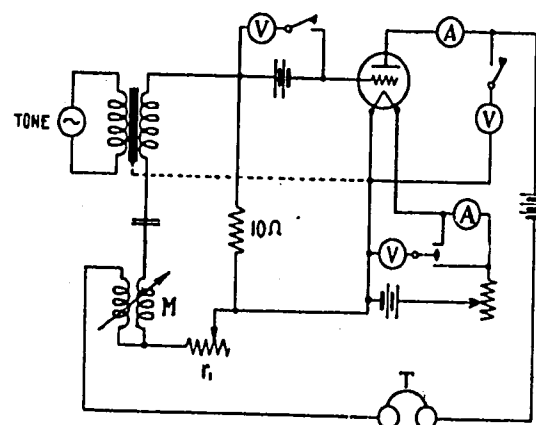


Fig. 2—Measurement of Amplification Factor.

One suitable balance method is illustrated in Fig. 2. Any convenient source of alternating current may be used for the tone supply, such as a vacuum tube or a mechanical oscillator, preferably supplying a current as nearly sinusoidal as possible. Any audio frequency may be used, 800 to 1000 cycles per second being preferred. The shielded transformer shown in the supply circuit is desirable though not absolutely necessary. The telephone receiver *T* (or input circuit of an amplifier, if this is used) should have a fairly low resistance. The small variable mutual inductance *M* compensates for any slight difference in phase of the currents, caused by vacuum-tube capacities or by slight residual reactances in the plate and grid circuits. The

procedure is as follows. The filament voltage\* (or current), the plate voltage, and the grid voltage are set at their proper values. Then the resistance  $r_1$  and the mutual inductance  $M$  are adjusted for a balance. The amplification factor is then

$$\mu = \frac{r_1}{10}$$

Amplification factor may alternatively be determined from a family of plate characteristic curves (section 5, page 95) at a specified plate current by dividing the difference in plate potential between two curves at that plate current by the corresponding difference in grid potential. (See also section 13, page 101.)

In triodes it is customary to measure the value of amplification factor, and to calculate from this and the plate resistance the value of mutual conductance. Due to the extremely high value of amplification factor it is not often considered advisable to measure this value on screen-grid tubes. Instead the mutual conductance of a screen-grid vacuum tube is measured directly.

**12. Plate Conductance (5029) or Plate Resistance (5030).** These quantities, like amplification factor, are best determined by a balance method. The conditions are the same as in section 11, page 99.

One suitable balance method is a simple Wheatstone bridge with audio-frequency source and detector. An alternative balance method employs the arrangement of Fig. 3 and is particularly suitable when amplification factor (see section 11, page 99) is to be determined at the same time, since the apparatus is the same and simple switching suffices to change the connections from one test to the other. The procedure is as follows. The filament voltage (or current), the plate voltage, and the grid voltage are set at their proper values and the resistance  $r_1$ , at the value found in the test for amplification factor (section 11, page 99). Then the resistance  $r_2$  and the mutual inductance  $M$  are adjusted for a balance. The plate resistance is then

$$r_p = 100r_2;$$

\* See second paragraph under "General Test Conditions." If it is desired to read both filament voltage and filament current, the two-way key for the filament voltmeter may be pressed down or up according as the filament is of relatively high or low resistance, to minimize the errors due to the presence of the instruments; or preferably, the key may be pressed up in any case and the voltmeter current subtracted from the filament ammeter reading.

and the plate conductance is

$$g_p = \frac{1}{r_p} = \frac{1}{100r_2}$$

For screen-grid vacuum tubes the bridge used must be carefully designed and constructed for the measurement of resistances which may be greater than one megohm.

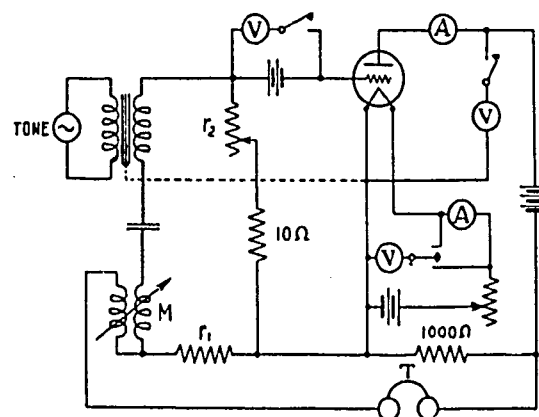


Fig. 3—Measurement of Plate Resistance.

The plate conductance may alternatively be determined from the slope of the plate characteristic curve (section 5, page 95) at a specified point and is the rate of change of plate current with respect to plate potential.

**13. Mutual Conductance (5028).** This is usually determined from the two preceding tests, being the product of plate conductance by amplification factor. Sometimes, as with certain power vacuum tubes, it is more convenient to determine the two conductances directly by measurements and then to compute the amplification factor as their ratio. In any case the conditions should be the same as in section 12, page 100.

Mutual conductance may be determined from a family of plate characteristic curves (section 5, page 95) at a specified plate potential, by dividing the difference in plate current between two neighboring curves at that plate potential by the corresponding difference in grid potential.

It is preferable to measure directly the mutual conductance for screen-grid vacuum tubes. This is done by means of a balance method using the circuit shown in Fig. 4. This method is similar to that described in section 11, page 99. The procedure is as follows: The filament voltage (or current), the plate voltage, the grid voltage, and the screen-grid voltage are set at their proper values and the resistance  $R$  adjusted until there is silence in the phones. When this is obtained then

$$\lambda_m = \frac{r_1}{r_2 r_3}$$

It is convenient to make  $r_2 = 1000$  ohms and  $r_3 = 100$  ohms, then  $g_m$  (micromhos) =  $10 r_1$  ohms.

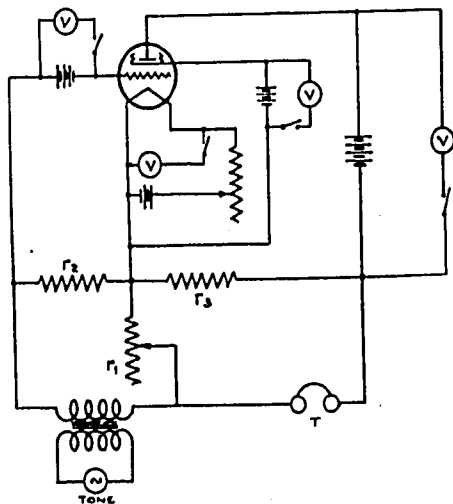


Fig. 4—Measurement of Mutual Conductance of Screen-Grid Vacuum Tubes.

**14. Ionization Current.** This is the reversed grid current and is usually measured with a microammeter or galvanometer under normal conditions of filament heating, plate potential, and negative grid potential. If leakage current is appreciable (section 15, page 102), it should be subtracted from the current read, to give the true ionization current. Ionization current is used as a qualitative measure of the presence of residual gas in a vacuum tube.

**15. Leakage Currents.** These should be measured with a voltage impressed between each two electrodes of the vacuum tube in turn

with the other electrodes floating. Measurements should be made immediately after the filament has been turned off, so that the parts will be at their operating temperatures, excepting the filament itself. The vacuum tube should be in its complete form, with its base but without socket or holder. A voltage equal to the normal operating potential difference between the two electrodes in question is suitable. From the readings, the three corresponding insulation resistances may be computed.

**16. Capacitance (5032 to 5037).** These should be measured with the filament unlighted and with no direct voltages present. The vacuum tube should be in its complete form with its base, but without socket or holder. For most precise results, it is necessary to mount the vacuum tube in a specified way, as with a form of shielding plate. A plate for this purpose has been standardized by the Radio Division of NEMA—Standard No. 340-511.

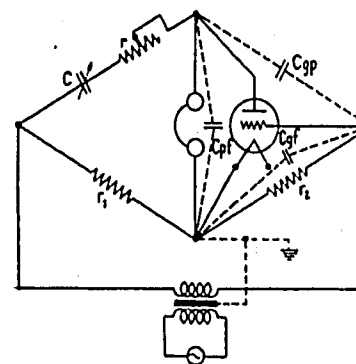


Fig. 5—A Bridge Method of Measuring Grid-Plate Capacitance.

It is recommended that direct capacitances be measured, rather than total capacitances, which are each the sum of two direct capacitances (see the definitions referred to in heading). It is particularly recommended that capacitances be not measured with one electrode floating in potential, as such capacitances are likely to be misleading of themselves and the calculation from them of the direct capacitances is indirect and laborious. The three direct capacitances of a triode are grid-plate capacitance ( $C_{gp}$ ), grid-filament capacitance ( $C_{gf}$ ), and plate-filament capacitance ( $C_{pf}$ ). The first of these is the most important, as it determined stability in an amplifier; its measurement is illustrated specifically in Figs. 5 and 6. The other two direct capacitances are measured in the same way, with the appropriate interchanges among the electrodes.

Fig. 5 illustrates one balance method for measuring grid-plate capacitance  $C_{gp}$ , using audio-frequency source and indicator. The resistance  $r$  balances the capacitance  $C_{gf}$ , which is in parallel with  $r_2$ ; and also corrects any accidental phase shift present elsewhere in the bridge. It is small and does not enter into the calculation; so it may be replaced by other phase correcting means, such as a capacitance in parallel with  $r$ ; when the bridge is balanced, the grid-plate capacity is

$$C_{gp} = \frac{Cr_1}{r_2}.$$

Fig. 6 illustrates one substitution method for measuring grid-plate capacitance  $C_{gp}$ , using a radio-frequency oscillator as a source and a thermoelement  $Th$  and galvanometer  $G$  as an indicator. The shielded

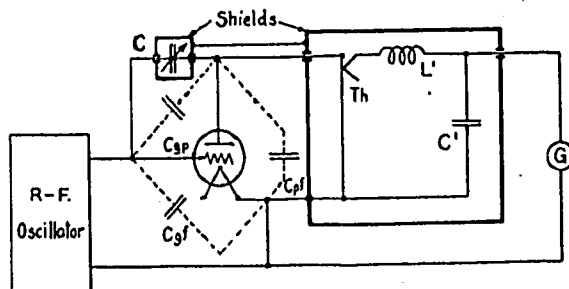


Fig. 6—Substitution Method of Measuring Grid-Plate Capacitance.

condenser  $C$  is calibrated to read capacitance above an arbitrary zero point and should have a range as great as the largest capacitance to be measured. With  $C$  set at this zero point and the vacuum tube in circuit, the galvanometer is read. The vacuum tube is then removed and  $C$  is adjusted until the galvanometer reading is the same as before. The added capacitance of  $C$  is then equal to the grid-plate capacitance  $C_{gp}$ . The radio-frequency oscillator should maintain constant voltage and frequency (or at least a constant product of these quantities). The connection from the plate of the vacuum tube through the thermoelement  $Th$  to the filament should be short, if it is not shielded. The condenser  $C'$  and coil  $L'$  constitute a filter system to keep radio-frequency current from flowing through the lead to the galvanometer  $G$ .

The arrangement of Fig. 6 may be modified to give a direct deflection method by omitting the condenser  $C$ . The galvanometer  $G$  is read before and after inserting the vacuum tube, the first reading

(which may be negligibly small, with proper shielding of the plate lead) being a measure of the direct capacitance present between the wiring to the grid and plate terminals and the second reading being a measure of this capacitance plus the desired grid-plate capacitance  $C_{gp}$ . To verify that the oscillator is maintaining a constant product of voltage times frequency, a thermoelement with galvanometer and filter may be connected in series with a small capacitance across the oscillator terminals.

**17. Undistorted Power Output.** This is the alternating-current power output obtainable in the plate circuit of a vacuum tube under conditions as specified below without the introduction of substantial harmonic components due to the non-linear characteristics of the vacuum tube.

**(a) Maximum Undistorted Power Output.** This is determined with an external non-reactive resistance in the plate circuit, having a value specified by the manufacturers for this rating, or, if the value of resistance is not specified, then with a resistance equal to *twice* the normal plate resistance of the type of vacuum tube under test. A sinusoidal alternating voltage and a grid bias equal to the maximum alternating voltage are impressed in the grid circuit and are increased together until the harmonic components in the plate resistance reach 5 per cent of the total alternating current. (If, with this procedure, the plate current should exceed its normal safe value, then the alternating grid voltage and the grid bias potential should be adjusted to the values corresponding to this normal safe plate current and the external plate resistance should be increased until the harmonics fall to the 5 per cent limit.) The alternating-current power in the external plate resistance is then taken as the maximum undistorted power output.

**(b) Conventional Undistorted Power Output.** This is determined with an external non-reactive resistance in the plate circuit equal to the normal plate resistance of the type of vacuum tube under test and with the grid bias potential specified by the manufacturers. A sinusoidal alternating voltage is impressed in the grid circuit and is increased until either the grid potential reaches zero at the positive maximum or (as will usually happen first) the harmonic components in the plate resistance reach 5 per cent of the total alternating current. The alternating-current power in the external plate resistance is then taken as the conventional undistorted power output.

## STANDARD TESTS OF BROADCAST RADIO RECEIVERS

## A. General

The purpose of the standard tests here proposed is to provide by general agreement a basis upon which the complete normal performance of any broadcast radio receiver may be reasonably predicted. It is believed that no simple "figure of merit" can properly be derived that will by itself give an index of complete performance. This follows from the varying weights that may be applied at different times and in different services, to the fundamental properties of Sensitivity, Selectivity, and Fidelity. Consequently it is believed to be essential to define and to provide for the separate measurement of each of these fundamental properties. Such information is of a somewhat too highly technical nature to appeal directly to the average user of broadcast radio receivers, but is thought to be useful to radio distributors and dealers in guiding their selection of apparatus for specific service conditions, and to engineers and manufacturers in aiding the comparison and improvement of their products.

It is recognized that the tests do not comprehend the entire range of service conditions that may be met in practice, and that peculiarities of design not reflected in the test data may in special cases affect the deductions properly to be made from the test results. It is also recognized that the three basic properties of Sensitivity, Selectivity, and Fidelity are in some radio receivers dependent upon adjustments that will change the relative prominence of each, and consequently the three factors should be invariably measured at the same settings of the radio receiver adjustments. Nevertheless, it is thought that acceptance of the procedure outlined, together with proper interpretation and correlation of the results obtained by the tests, will serve to permit a standard comparison of normal radio receiver performance.

## B. Definition of Terms

1. **Sensitivity.** The degree to which a radio receiver responds to signals of the frequency to which it is tuned. It is measured quantitatively by the reciprocal of the Normal Radio Field Intensity (definition, page 107).

2. **Selectivity.** The degree to which a radio receiver is capable of differentiating between signals of different carrier frequencies. This

characteristic is not expressible by a single numerical value, but requires one or more graphs for its expression.

3. **Fidelity.** The degree to which a system, or a portion of a system, accurately reproduces at its output the signal which is impressed upon it. As applied to a radio receiver, fidelity is measured by the accuracy of reproduction at the output terminals of the modulation of the received wave.

4. **Normal Test Output.** As applied to the testing of a broadcast radio receiver, this term represents an audio-frequency power of 0.05 watt in a non-inductive resistor arranged to carry alternating current only and connected across the output terminals of the radio receiver (usually the loud speaker terminals), the resistance of the resistor having been adjusted to give maximum power output per volt input for the type of vacuum tube intended to be used in the radio receiver, with normal adjustments of this vacuum tube. If the radio receiver is not arranged to filter out direct current from its output circuit, then an external filter system shall be employed, of such character as to introduce negligible resistance to direct current, to have negligible loss, and to have negligible shunt admittance and negligible series impedance relative to the output resistor.

5. **Normal Radio Field Intensity.** As applied to the testing of a broadcast radio receiver, this term represents the radio field intensity of a received signal modulated 30 per cent at 400 cycles per sec., which results in Normal Test Output (definition 4, page 107) at resonance. If the radio receiver does not include a self-contained antenna, then the signal is to be impressed on a real or artificial Standard Antenna\* (definition 6, page 108).

For data on various methods of measuring the percentage modulation, the reader is referred to reference R275(b), page 137. The method described in this article has much to recommend it from the point of view of simplicity, and with proper care the method is sufficiently accurate and reliable for general use. The method involves calculation of the percentage modulation from measured values of the peak voltage on the radio-frequency oscillator output under modulated and unmodulated conditions. The voltage measurements are made with a

\* Experience has indicated that with some radio receivers, an artificial antenna adversely affects the stability. In such cases it is necessary to employ a real antenna.

vacuum-tube peak voltmeter. The author states that this method is capable of giving an accuracy of only about 4 per cent. For use in calibrating the percentage modulation of a radio-frequency oscillator for radio receiver measurement work, however, this accuracy is generally sufficient.

6. **Standard Antenna (Real or Artificial).** As applied to the testing of a broadcast radio receiver not having a self-contained antenna, this term represents an artificial antenna having in series a capacity of 200 micromicrofarads, a self-inductance of 20 microhenries, and a resistance of 25 ohms. In computing the radio field intensity of an impressed signal, the effective height is to be taken as 4 meters—that is, the radio field intensity (in microvolts per meter) is equal to the impressed radio-frequency voltage (in microvolts) divided by 4.

7. **Standard Test Frequencies.** In the testing of a broadcast radio receiver, the five standard carrier frequencies are 600, 800, 1000, 1200 and 1400 kilocycles per sec. When tests are required at only three carrier frequencies, the values 600, 1000, and 1400 kilocycles per sec. are recommended.

### C. Test Outlines

1. **Sensitivity.** This is determined by impressing a radio-frequency voltage in series with the self-contained antenna, or by impressing a known radio field intensity on the self-contained antenna, if the radio receiver is so provided, or otherwise in series with a Standard Antenna (definition 6, page 108), and measuring the Normal Radio Field Intensity, under the conditions stated in definitions 4 and 5, page 107, for carrier frequencies from 550 to 1500 kilocycles per sec. A graph is plotted with carrier frequency as abscissa and Normal Radio Field Intensity as ordinate. A uniform scale should be used for the abscissas, and either a uniform or logarithmic scale (or a uniform scale with transmission units) may be used for the ordinates, depending on the range of radio field intensities which the graph is required to cover.

2. **Selectivity.** This is determined by tuning the radio receiver to each Standard Test Frequency (definition 7, page 108), in succession, with the receiver in the same condition as in the Sensitivity Test, and measuring the radio field intensity necessary to give Normal Test Output at a series of carrier frequencies in steps not greater than 10 kilocycles per sec. at least up to 100 kilocycles per sec. on each side of resonance or until the radio field intensity has increased to at least 100

times its value at resonance. The conditions of modulation of the radio-frequency oscillator are to be the same as given under the definition for Normal Radio Field Intensity, (definition 5, page 107). For each Standard Test Frequency, a graph is plotted with carrier frequency as abscissa and radio field intensity as ordinate. The scale for ordinates should be logarithmic and the most accurate representation is secured by plotting the graphs for Selectivity with separate enlarged frequency scales, which should be uniform and alike.

3. **Fidelity.** This is determined by tuning the radio receiver to each Standard Test Frequency (definition 7, page 108) in succession, with the receiver in the same condition as in the Sensitivity and Selectivity tests, adjusting the impressed radio field intensity to the Normal Radio Field Intensity (definition 5, page 107) and then varying the modulation frequency from 40 to 10,000 cycles per sec. at 30 per cent modulation and constant radio field intensity throughout, taking readings of relative output voltage at convenient modulation frequencies. For each Standard Test Frequency, a graph is plotted with modulation frequency as abscissa and as ordinate the ratio of the output voltage at the modulation frequency of measurement to the output voltage at the modulation frequency of 400 cycles per sec. A logarithmic scale should be used for the abscissas and a uniform scale for the ordinates.

### D. Requirements and Characteristics of Testing Apparatus

The apparatus employed in testing radio receivers should be as simple as is consistent with accurate performance of the necessary functions. As far as possible, the same apparatus should be used in the different tests. The values of the electrical quantities and the calibrations should not change with time; or if some change is unavoidable, means for checking should be provided.

The required apparatus, for Tests of Sensitivity, Selectivity, and Fidelity, is indicated schematically in Fig. 7. Both frequency sources should be calibrated so that separate measurement of frequency is not needed. The requirements of the separate elements are stated in the following paragraphs.

1. **Audio-Frequency Source.** For Sensitivity and Selectivity Tests this may be a mechanical oscillator of fixed frequency (400 cycles per sec.); but a vacuum-tube oscillator having a frequency range at least



from 40 to 10,000 cycles per sec. is preferred and for the Fidelity Test is necessary. The total harmonic content in the output of this oscillator should not exceed 5 per cent. The audio-frequency oscillator is arranged to modulate the radio-frequency oscillator by a known amount and preferably should furnish the same degree of modulation without readjustment at all carrier frequencies and all modulation frequencies. Means should be provided for adjusting the degree of modulation for at least the normal value of 30 per cent.

**2. Radio-Frequency Source.** This consists of a vacuum-tube oscillator supplied preferably from batteries, either fully shielded in itself or so shielded from the radio receiver under test that there is no

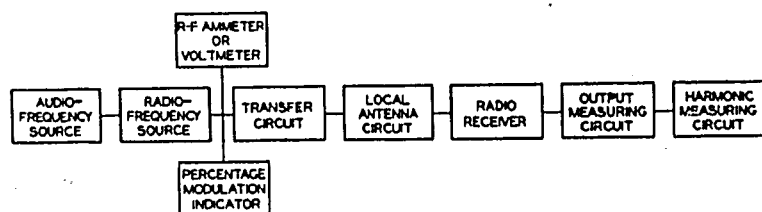


Fig. 7—Schematic Arrangement of Apparatus Used in Tests of Radio Receivers.

direct radiation to the receiver. If the power supply is external to the shielding system which encloses the oscillator, all ungrounded leads to the oscillator should pass through shielded low-pass filters. The frequency should be adjustable by an external control to any desired value between 500 and 1500 kilocycles per sec., and the frequency should not be affected by changes in output power. Means should be provided for varying the frequency in small steps immediately on each side of any specified frequency. A second external control should be provided for varying the modulated radio-frequency output supplied to the transfer circuit, and an instrument should be provided which indicates the effective value of this output. The oscillator in conjunction with the transfer system used (see part 3 below) should be capable of supplying in series with the receiving antenna system at least 200,000 microvolts at all carrier frequencies.

**3. Transfer Circuit.** The radio receiver under test is provided with a local antenna circuit consisting of either a loop antenna (which may be self-contained) or an artificial antenna. In determining the significant characteristics, as outlined in the preceding sections, modulated radio-frequency voltages of known value are impressed in the

local antenna circuit through the transfer circuit which should assume one of two forms as follows:

(a) A coupling coil fed from the radio source and mounted in inductive relation with the loop antenna or with the 20-microhenry inductance coil of the artificial antenna. In the latter case, the coupling coil is used as the primary of a calibrated mutual inductor, the secondary of which is the 20-microhenry coil.

(b) A calibrated attenuator of the resistance type terminating in a low impedance of known value (usually a resistance of about one ohm) which may be inserted in series with the artificial or loop antenna. This attenuator should be so constructed that all attenuation ratios are substantially independent of frequency within the broadcast band. It is preferably made variable in steps with additional provision for continuous variation between the steps. As an alternative to continuous variation within the attenuation network, provision may be made for continuously varying the measured current or voltage supplied from the source to the attenuator over a sufficient range to cover all values of receiver input voltage which lie between the steps of the attenuator. Design details of attenuators fulfilling these requirements are available in the literature. The combined range of ratios on the attenuator and variable currents from the source should be such as to allow a range of voltage across the terminal unit which feeds the receiving set of 1 microvolt to 200,000 microvolts.

**4. Output Measuring Circuit.** The components of the output measuring circuit should be as follows:

A non-inductive load resistor adjustable by calibrated taps and covering a range of 1 to 10,000 ohms and capable of dissipating 0.1 watt at any setting.

An output filter to be used with radio receivers normally having d.c. in their outputs. This filter should fulfill the requirements given under definition 4, and a recommended form consists of an inductance of not less than 100 henries (with 10 milliamperes d.c. in the winding) and a capacitance of not less than 8 microfarads arranged as shown in Fig. 11.

A vacuum-tube voltmeter or an equivalent device which will accurately measure the r.m.s. values of output voltage. At Normal



Test Output the voltage is of the order of from 10 to 20 volts for ordinary output vacuum tubes. For the Sensitivity and Selectivity Tests the output meter need be calibrated only at these values. For the Fidelity Test continuous calibration is required, and for Overload Level Test calibration for much higher values is needed.

### E. Test Procedures

1. Preliminary. The present day radio receivers vary so greatly in their manner of operation that it is difficult to set down a single test procedure for each fundamental characteristic and have the procedure include all the allowances that should be made for the peculiarities of different sets. It is simpler to describe in general the test setups and adjustments of input and output; the operating conditions; and the radio receiver adjustments as applied to any type of receiver, and then standard procedures for measuring Sensitivity, Selectivity, and Fidelity, can be outlined.

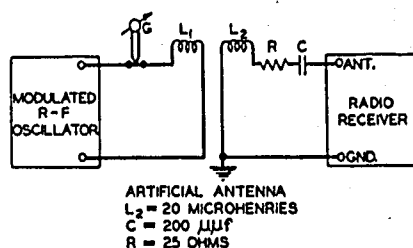


Fig. 8—Standard Input Circuit—Mutual Inductive Coupling.

### 2. Input Measurements.

#### (a) RADIO RECEIVER WITHOUT A SELF-CONTAINED ANTENNA

Standard input circuits are shown in Figs. 8 and 9. Either circuit may be used depending on whether an impedance device or a mutual inductance (see section D, page 109) is used to attenuate and introduce the radio-frequency voltage in the artificial antenna circuit.

The mutual inductor is used as shown in Fig. 8. The input to the receiving set is controlled by adjustment of either the coupling between coils  $L_1$  and  $L_2$  or the current through  $L_1$ . The assumed value of radio field intensity impressed on the radio receiver is determined from the formula.

$$\mathcal{E} = \frac{2\pi f M I}{h} \text{ microvolts per meter where,}$$

$f$  is the carrier frequency in kilocycles per sec.,  
 $M$  is the mutual inductance between  $L_1$  and  $L_2$  in millihenries;  
 $I$  is the current through  $L_1$  in microamperes;  
 $h$  is the antenna height in meters (4 meters for the standard antenna).

The circuit for use with an impedance coupling device is shown in Fig. 9. The voltage impressed in series with the artificial antenna is brought to the desired value by selecting the proper degree of attenuation and accurately adjusting either the current or the voltage

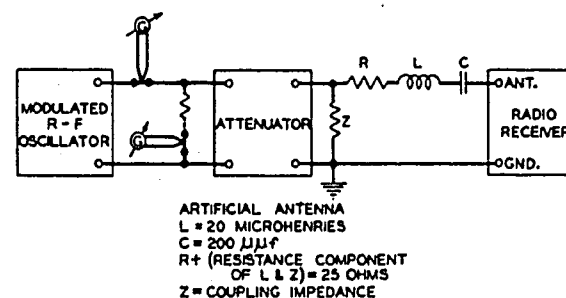


Fig. 9—Standard Input Circuit—Impedance Coupling.

input to the attenuator. If the attenuator is calibrated in terms of current, the radio field intensity impressed in the artificial antenna may be expressed as,

$$\mathcal{E} = \frac{KZI}{h} \text{ microvolts per meter;}$$

where,

$K$  is the attenuation factor;

$Z$  is the impedance of the coupling device;

$I$  is the measured value of current fed to the attenuator in microamperes; and

$h$  is the assumed antenna height in meters (4 meters for the standard antenna).

If the attenuator is calibrated in terms of voltage and includes the impedance  $Z$  then,

$$\mathcal{E} = \frac{KV}{h} \text{ microvolts per meter:}$$

where,

$K$  is the attenuation factor;  
 $V$  is the measured voltage input in microvolts;  
 $h$  is the assumed antenna height in meters. (Four meters for the standard antenna.)

### (b) RADIO RECEIVER WITH A LOOP ANTENNA

An arrangement of apparatus as shown in Fig. 10 is recommended.

A known radio field intensity is impressed on the loop antenna by adjusting the distance  $X$  and the current through the coil  $L$ . The coil and loop antenna centers are kept on a common axis, and the distance  $X$  kept large as compared with the dimensions of the loop antenna.

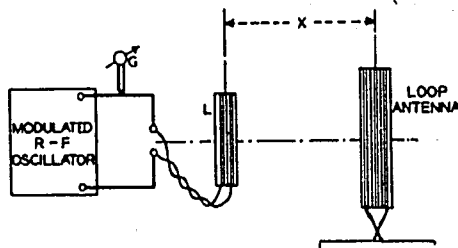


Fig. 10—Radio Receiver with Loop Antenna.

The radio field intensity is,

$$\mathcal{E} = \frac{18,850 NA^2 I}{(A^2 + X^2)^{3/2}} \cos B \text{ microvolts per meter}$$

where,

$N$  is the number of turns in the coupling coil  $L$ ;  
 $A$  is the radius of the coupling coil, in centimeters;  
 $I$  is the ammeter reading in microamperes;  
 $X$  is the distance in centimeters between the center of the coupling coil and the center of the loop antenna; and  
 $B$  is the angle, if any, between the axis of the loop antenna and the line between coil centers.

The radio-frequency voltage may be introduced in the loop antenna by inserting the terminal impedance of a resistance type at

an attenuator in series with the loop at a point of ground potential in a manner similar to that shown for an artificial antenna in Fig. 9. In this case, the equivalent radio field intensity is given by the expression,

$$\mathcal{E} = \frac{E}{Q}, \text{ in microvolts per meter,}$$

where  $E$  = the voltage across  $Z$  in microvolts, and

$Q$  = reception factor in meters of the loop antenna employed.

The factor  $Q$  may be calculated approximately for a rectangular loop from the relation,

$$Q = 2NH \sin \frac{\pi fs}{300,000}, \text{ where,}$$

$N$  = the number of turns;

$h$  = the height of the loop in meters;

$s$  = the length of the loop in meters; and

$f$  = the frequency in kilocycles.

It is not appropriate to specify a standard loop reception factor because the loop antenna is frequently a characteristic element of the radio receiver under test.

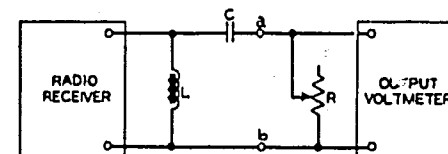


Fig. 11—Radio Receiver with Direct Current in Its Output.

The method first described adapts itself best to the testing of loop receivers because it leaves the loop circuit in its normal form. If the second method is applied to the testing of a loop radio receiver, the output terminal unit of the attenuator should be of low impedance and have a resistance which is low compared with that of the loop.

### 3. Output Measurements.

#### (a) RADIO RECEIVER WITH D. C. IN ITS OUTPUT

If the radio receiver is not equipped to filter direct current from its output, the circuit which should be used in making output measurements is as shown in Fig. 11.

The specifications for the components of the above circuit are given in Section D, page 109.

The value for  $R$  is dependent on the operating conditions of the output tube used in the radio receiver and is arbitrarily taken as the plate resistance value given by the tube manufacturer for that tube under the given conditions. In the case of a radio receiver having an output transformer,  $R$  is taken as the reflected value of the tube resistance, or

$$R = \frac{R_p}{A^2}$$

where,

$A$  = the transformer ratio of primary to secondary turns; and  
 $R_p$  = the value of tube plate resistance.

The voltage across  $R$  for Normal Test Output is,

$$V_n = \sqrt{(0.05) \times R}.$$

#### (b) RADIO RECEIVER WITH NO D. C. IN OUTPUT

If the radio receiver has a device eliminating direct current from its output, (referring to the circuit of Fig. 11)  $L$  and  $C$  are removed and the points  $a$  and  $b$  connected directly to the output terminals of the receiver.

#### (c) RADIO RECEIVER WITH EXTRANEIOUS VOLTAGES IN THE OUTPUT

The voltages due to a-c hum, tube noises, etc., that may exist across the output of some radio receivers must be considered where the output voltage to be measured is small. For example, if these voltages are comparable with the Normal Test Output Voltage, let the voltage across the resistor  $R$  for Normal Test Output be,

$$V_1 = \sqrt{V_1^2 + V_2^2}, \text{ where}$$

$V_1$  is the r.m.s. voltage due to extraneous effects, and

$V_2$  is the value for Normal Test Output Voltage which gives 0.05 watt power in  $R$ .

In any case, if the extraneous voltage is appreciable, the measured voltage across  $R$  (see Fig. 11) should be considered as the vector sum of the extraneous voltage and that due to the desired signal.

### 4. Operating Conditions.

#### (a) BATTERY-OPERATED RADIO RECEIVERS

The "A" and "B" battery voltages supplied to the radio receiver should be held constant at the values specified for the receiver. If a battery cable is not furnished with the receiver, the leads to the batteries should be as short as possible. The batteries used should be in good condition.

#### (b) SOCKET POWERED AND ELECTRIC RADIO RECEIVERS

The a-c or d-c voltage input to the radio receiver should be held constant at the value specified for the set or at 115 volts. If the receiver is provided with adjustments for reducing hum or ripple in the output, such adjustments should be made.

#### (c) TUBES

The tubes used should have characteristics which represent the arithmetical mean value as regards filament emission, plate current, plate resistance, amplification factor, and mutual conductance for that type of tube.

### 5. Radio Receiver Adjustments.

#### (a) GENERAL

The Test Frequency adjustment is normally obtained by adjusting all the external tuning and volume controls, with which a radio receiver is equipped, until maximum response is had at its output for a given signal impressed on its input.

#### (b) REGENERATIVE RADIO RECEIVERS

All tests should be made for each of the following conditions:

- (1) With the radio receiver adjusted as in part (a) without causing oscillation at radio or audio frequencies to occur within the receiver.

(2) With the receiver adjusted as in part (a) with the minimum of regeneration that can be obtained by adjustment of the external controls only.

#### (c) STABILIZED RADIO RECEIVERS

If a radio receiver is provided with external stabilization controls that are to be used in the normal operation of the receiver, it should be tested as a regenerative receiver. No other modifications of the general instructions of part (a) are necessary for the testing of stabilized radio receivers.

#### (d) SUPER-HETERODYNE RADIO RECEIVERS

If a super-heterodyne radio receiver has a separate control of its oscillator frequency, all tests should be made with the oscillator adjusted to the higher frequency above the signal, unless the instructions accompanying the receiver specify other conditions for operation. Selectivity tests should include the response at the lower frequency. In making selectivity tests the radio-frequency oscillator should be moved over twice the intermediate frequency. If this falls outside the broadcast band it should not be ignored. Otherwise, tests are to be in accordance with part (a).

### 6. Sensitivity and Tuning Range Tests.

#### (A) SENSITIVITY TEST

The radio-frequency source with 400-cycle, 30 per cent modulation is adjusted to a given Test Frequency, the receiver tuned to the signal and the input radio field intensity adjusted until Normal Test Output is had. The value of radio field intensity is noted and the same process is repeated at the remaining Test Frequencies. A graph is plotted with Normal Radio Field Intensity as ordinate and carrier frequency as abscissa. A linear ordinate scale is ordinarily used, although in comparing receiving sets of widely different sensitivities it is sometimes advantageous to use a logarithmic ordinate scale. The abscissa scale used should be linear.

#### (B) TUNING RANGE TEST

In conjunction with the sensitivity test it is convenient to make a test of the tuning range of the radio receiver. Using the same test conditions as for the sensitivity test, the radio receiver tuning ad-

justment should be set for the lowest carrier frequency it is capable of receiving under normal operation. The radio-frequency oscillator is then adjusted in frequency until it is at that frequency which gives maximum output in the output meter. The output signal used should be approximately Normal Output, to avoid inaccuracies due to overloading. The radio-frequency setting of the oscillator is then recorded as the lower frequency limit of the tuning range. If the radio-frequency oscillator is incapable of reaching the low limit frequency of the receiver, the oscillator should be set at its minimum frequency and the receiver tuned to it. The dial scale reading of the radio receiver is then recorded for that frequency. The process is then repeated at the high-frequency limit of the range. The maximum and minimum frequency settings of the tuning control will generally correspond to the maximum and minimum dial scale markings. If they do not, the dial settings corresponding to the limit frequency settings should be recorded.

If a calibration of dial setting versus carrier frequency is desired, it can be obtained by adding to the limit values a set of readings of the dial settings for each of the Standard Test Frequencies used in the sensitivity test. The dial calibration is plotted in the form of a graph with carrier frequency as abscissa and dial setting as ordinate, both to a linear scale.

**7. Selectivity Test.** The radio-frequency source with 400-cycle, 30 per cent modulation is adjusted to a given Test Frequency, the radio receiver tuned to the signal and the input radio field intensity adjusted until Normal Test Output is had. The value of radio field intensity is noted and the radio-frequency oscillator is adjusted in steps of at most 10 kilocycles on either side of the Test Frequency and at each setting of the radio-frequency oscillator the radio field intensity necessary to give Normal Test Output is determined and recorded. The readings are taken until the radio-frequency input is at least 100 times its value at resonance or until a range of 100 kilocycles either side of the Test Frequency setting has been covered. The same procedure is repeated at the remaining Test Frequencies. A graph is plotted for each Test Frequency using the radio-frequency input as ordinate to a logarithmic scale and carrier frequency as abscissa on a linear scale. The scales used for each graph for a given radio receiver should be uniform and alike.

**8. Fidelity Test.** The radio-frequency source with 400-cycle, 30

per cent modulation is adjusted to a given Test Frequency, the receiving set tuned to the signal, and the input radio field intensity adjusted until Normal Test Output is had. Then the modulation frequency is varied from 40 to 10,000 cycles continuously or in steps, the modulation percentage being maintained constant at 30 per cent and the outputs recorded for each modulation frequency. This procedure is repeated for each Test Frequency, and then curves are plotted with the per cent of the voltage output at 400 cycles as ordinate to a linear scale and modulation frequency as abscissa on a logarithmic scale.

#### F. Additional Tests

The tests outlined in this section are to be regarded as tentative only. They are included for the purpose of bringing before the industry the need for tests of certain other factors of performance, in addition to the major radio receiver tests which have been outlined in the preceding sections.

In some of the following tests, limits have been set in a somewhat arbitrary manner for the purpose of providing a basis for experimentation and further development. After some general experience has been had in making these additional tests, it is intended that definite standards for procedure in investigating these factors of radio receiver performance shall be drawn up. The Committee will be greatly assisted to this end if those laboratories finding a use for such tests will try out the methods outlined, and send in their comments and criticisms.

The tests which have appeared necessary thus far under this heading include:

1. Tests for overloading of radio receivers.\*
2. Tests for volume controls of radio receivers.
3. Tests for hum produced in radio receivers.

\* In the opinion of the Committee overload tests are considered worthy of a place among the preceding standard tests, but it is felt that there has not been sufficient experience with this test by various laboratories to warrant the setting up of a definite standard test for this characteristic of radio receivers. The following paragraphs on "Overloading of Radio Receivers" are therefore placed in the section on "Additional Tests," pending the collection of further data. It is expected that the material will be revised in further editions of this report.

1. **Overloading of Radio Receivers.** It is conceded that the effect of distortion on the human ear is highly variable, and dependent upon many conditions which cannot be specified in any manner which shall be standard practice for any length of time. There is a basis on which overloading can be defined from the technical viewpoint, however, that may be used for the purpose of comparing radio receivers with respect to this factor of performance. A radio receiver can be said to be overloaded when distortion is manifested in the output, i.e., when the electrical output differs in wave form from the electrical input by a specified amount. The output of the radio receiver should be tested for the introduction of spurious frequencies, that is, those not present in the input.

Because of the fact that an amplifier may, and usually does, overload at one or more frequencies more readily than at others, the overload test should be conducted either at all frequencies over the audio range, or at those particular ones where overloading occurs with least input. Determination of this point, or points, is therefore the first step in the test. To do this, it is recommended that the output be examined with a cathode ray oscillograph by a method such as that described in "Notes on the Testing of Audio-Frequency Amplifiers."\* The two voltages applied to the deflection plates of the oscillograph would be the a-f voltage used to modulate the r-f oscillator, and the radio receiver output voltage, respectively.

When the critical overloading frequencies have been found they are to be used to measure the overload level of the receiver, as follows:

The test apparatus will be that used for the "Fidelity" test, except that a harmonic measuring instrument is to be connected across the standard output load, and this instrument so chosen as to constants, that it exerts negligible effect on the load circuit. For this purpose the instrument described in "The Alternating Current Bridge As a Harmonic Analyser"\*\*\* is recommended.

The radio-frequency input (with the modulation adjusted to the critical overload frequency and 30 per cent modulation) is to be increased in steps until a value is reached, which causes the output voltage to contain 10 per cent of total harmonics.

\* See reference R342.7 (b), page 138.

\*\* See reference (R800) 537.7(a), page 142.

When this input value has been reached, the output voltage is to be measured (as in Fidelity test) and the power in the output circuit calculated. The overload level of the radio receiver shall then be considered to be that value of power output.

## 2. Volume Control Tests.

Briefly, the most important of these are:

(a) Tests of the effect of the volume control on the sensitivity, selectivity, and fidelity of the radio receiver.

(b) Tests of the effect of the radio-frequency field to which the radio receiver is exposed (input signal not subject to the volume control in some radio receivers).

### (a) 1. EFFECT OF VOLUME CONTROL ON SENSITIVITY

The radio field intensity required to produce Normal Test Output should be measured at various volume control settings. These can be plotted in the form of a graph using percentage of maximum setting of volume control as abscissa, and Normal Radio Field Intensity in microvolts per meter as ordinate. This graph can be plotted on the same type of paper used for selectivity graphs with the logarithmic axis as ordinate. The graph should be taken all the way to the minimum end of the volume control unless impossible with the available equipment. In the latter case the graph should be taken at least to a radio field intensity of 50,000 microvolts per meter. This graph can be taken at any one or more of the Standard Test Frequency settings desired, and enough points should be taken to show the graph shape accurately.

### (a) 2. EFFECT OF VOLUME CONTROL ON SELECTIVITY

In addition to the usual inverse resonance graphs, a selectivity graph should be taken with a radio field intensity at resonance of 1000 microvolts per meter. This signal is to be reduced by means of the volume control until it gives Normal Test Output at the receiver output. One or more such selectivity graphs should be taken at reduced volume control as required in the opinion of the test engineer, and in cases of apparent erratic behavior of the volume control, graphs may be taken at higher values of radio field intensity.

### (a) 3. EFFECT OF VOLUME CONTROL ON FIDELITY

In addition to the usual fidelity graphs, one should be taken with a radio field intensity of 10,000 microvolts per meter, with the radio receiver output reduced by means of the volume control to give Normal Test Output at 400 cycles. Such curves should be taken at 600 and 1400 kilocycles, and at other standard test carrier frequencies if thought desirable.

### (b) EFFECT OF THE RADIO-FREQUENCY FIELD TO WHICH THE RADIO RECEIVER IS EXPOSED

It was intended that this test should evaluate the pickup by the radio receiver circuit, of radio-frequency fields through unshielded or poorly shielded coils or wires, within the radio receiver, and through the power line in the case of radio receivers deriving part or all of their power supply from that source, under conditions where the volume control was set at minimum. Such a test appears desirable, but the committee knows of no satisfactory way of making such a test quantitatively at the present time, and recommends that the various laboratories keep in mind the need for such a test. If a method is later developed which permits results of a useful quantitative nature to be obtained, it is requested that this be brought to the attention of the Subcommittee on Radio Receivers.

### 3. Tests for Hum.

Radio receivers of the type which derive their power from an a-c supply generally produce in the output circuit a certain amount of audio-frequency voltage, composed of a combination of various harmonics of the a-c supply frequency, and occasionally containing the fundamental. This voltage is commonly called the a-c hum voltage, and this section is intended to outline certain tests for evaluating it.

A measure of the r.m.s. hum voltage across the output terminals of the radio receiver is not an indication of its quantitative effect on the ear, since the audio response characteristics of a-f amplifiers and loud speakers, and of the human ear, cause the higher harmonics of the a-c power line to result in more sound response from the loud speaker than do the lower harmonics or the fundamental. Therefore it is desirable to evaluate the various harmonic components of the hum voltage in order to obtain a useful conception of the degree of un-



pleasantness which the hum from a particular radio receiver will create. A simple way of doing this would be to construct a filter network having an attenuation characteristic which would take account of the dropping off in loud speaker response and ear response below 1500 cycles. (It is felt that frequencies above 1500 cycles can be disregarded in the hum measurement.) This network should be connected between the radio receiver output, and the output voltmeter. If the voltmeter is calibrated in r.m.s. volts it will then measure the square root of the sum of the squares of the various hum harmonic voltages, each harmonic being attenuated to a percentage of its actual value, corresponding to its importance from the point of view of the loud speaker and ear response characteristics. Thus, a single voltage measurement is made to give a measure of the degree of unpleasantness

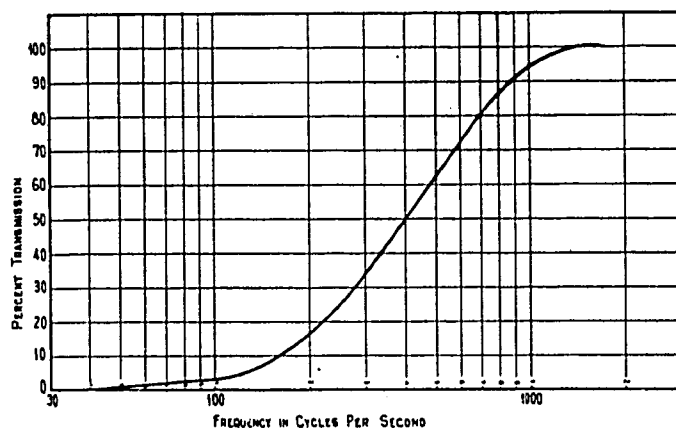


Fig. 12—Possible Attenuation Characteristic of Arbitrary Network for Use in Hum Measurement.

which the hum from a particular radio receiver would create with an average loud speaker. From this voltage measurement, and the value of the radio receiver output resistance, the hum power should be calculated.

While the ear characteristic is fairly well-known, the preparation of a network which would include the response characteristic of an average loud speaker would, of course, necessitate the measurement of all the loud speakers upon the market at the present time, and for some time past. It would also require the use of sound measuring equipment, and measurement conditions whose absolute accuracy has been proven. These requirements are impossible of complete realization at the present time, but it is felt that some valuable experience

in the field of hum measurement can be obtained by the adoption of an arbitrary network, having characteristics which appear, in light of present knowledge, to be of the general order of magnitude of the frequency attenuation factors involved, and to approximate an average loud speaker characteristic. A possible attenuation characteristic for such a network is shown in Fig. 12, and a network having approximately this characteristic is shown in Fig. 13.

It should be emphasized that the graph of Fig. 12 is not intended to include an accurate representation of an average loud speaker frequency response characteristic. The network characteristic is only tentative, and has been prepared as a guide for those desiring to make investigations in the field of hum measurement.

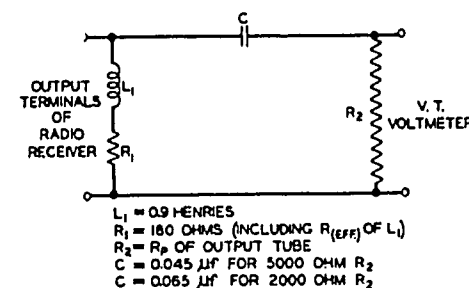


Fig. 13—Network Intended to Approximate An Average Loud Speaker Characteristic.

Other conditions which must be considered in connection with the measurement of hum from a radio receiver are:

- (1) Use of an a-c power supply having known and definitely limited harmonic characteristics.
- (2) Adjustment of any devices provided on the receiver for hum regulation, such as filament mid-tap potentiometers, for minimum hum.

In connection with condition (1) above, it is suggested that use be made of the differential distortion factor circuit, which has been used in the past in the electrical art in evaluating the harmonic content of a-c power lines. The circuit is shown in Fig. 14. The constants of the circuit are governed by the relation:

$$R = \frac{1}{2\pi fC}$$

where  $f$  is the fundamental frequency of the a-c line. The value of  $R$



can be chosen to suit the particular thermocouple meter available. The resistance of the thermocouple should be, of course, small compared with  $R$ .

The differential distortion factor is then given by the following relation:

$$d.d.f. = \frac{I_c}{I_r}$$

where  $I_c$  is current through condenser and  $I_r$  is current through resistance.

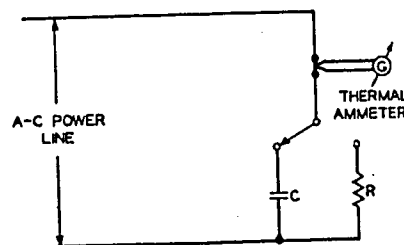


Fig. 14—Differential Distortion Factor Circuit.

It is recommended tentatively, in making measurements of hum on a-c radio receivers, that the power line have a differential distortion factor not greater than 1.05.

It should be noted that in some radio receivers, more hum will be produced when a carrier is tuned in. On this account it is necessary to measure the hum under two conditions of the radio receiver, unless only the value of the worst hum condition is desired, in which case that one of the following receiver adjustment conditions should be used which gives the greater hum:

(1) No incoming carrier frequency, and no other voltages such as static, induction, etc., in the output circuit. In radio receivers where the position of the volume control does not affect the hum with no incoming carrier, the last condition may be most easily complied with by setting the volume control to zero.

(2) With an incoming unmodulated carrier having a radio field intensity of 10,000 microvolts per meter impressed on the radio receiver input circuit, and with the volume control so set that were the incoming carrier to be modulated 30 per cent with 400 cycles, it would give normal output power in the radio receiver output circuit. Here, as in condition 1, static and induction voltages in the output voltage should be reduced to a negligible percentage.

METHODS OF MEASURING THE PROPERTIES OF RADIO CIRCUIT ELEMENTS (SEE NOTE 1)

UNIT	METHODS	FREQUENCY RANGE			
		DIRECT CURRENT	POWER FREQUENCIES 10-100 Cycles	SPEECH FREQUENCIES .50-10 <sup>4</sup> Cycles	RADIO FREQUENCIES 10 <sup>6</sup> -(3 X 10 <sup>7</sup> )
Frequency	Approximate		Read-Type Frequency Meter R800 (530)	Comparison Methods (Audio Tuning) (See Note 2)	Frequency (Wave) Meter R200b, R213a, Pico Crystals R214a, R214b
	Laboratory		Comparison Methods (See Note 2)	Comparison with Acoustical Standards (See Note 2)—Resonance Circuits R200b	Comparison with Harmonies of Acoustical Standards R213a—Resonant Circuits R200b
Voltage	Approximate	Voltmeter	Voltmeter	Vacuum-Tube Voltmeter R201b	V. T. Voltmeter (5) Thermovoltmeter R261b
	Laboratory	Potentiometer Methods R800 (530) or Precision Voltmeter	Precision Voltmeter Potentiometer R800 (530)	Standardized V. T. Voltmeter (5)	Standardized V. T. Voltmeter (5)
Electric Field Intensity	Approximate				Calibrated Radio Receiver R270c
	Laboratory				Comparison with Measured Voltages R270e
Current	Approximate	Ammeter	Ammeter	Thermoammeters R200b	Thermoammeters R200b
	Laboratory	Potentiometer R800 (530) or Precision Ammeter	Precision Ammeter	Standardized Thermoammeters R200b	Standardized Thermoammeters R200b
Resistance	Approximate	Wheatstone Bridge R-00 (530) Current-Voltage Measurement (See Note 3)	Wheatstone Bridge (DC) R800 (530) Current-Voltage Measurement (See Note 3)	H-F Bridge (14) Current-Voltage Measurement (See Note 3)	H-F Bridge (14) Reactance Variation Methods R200b Dielectric Loss R200b
	Laboratory	Wheatstone Bridge R800 (530) and Kelvin Double Bridge (17)	Wheatstone Bridge R800 (530) (DC)	H-F Bridge (14)	H-F Bridge (14) Resistance Substitution Methods R200b Dielectric Loss R200b
Impedance	Approximate		Current-Voltage Measurement (See Note 4)	Current-Voltage Measurement (See Note 4)	Current-Voltage Measurement (See Note 4)
	Laboratory		Current-Voltage Measurement (See Note 4)	Bridge-Current Voltage Measurement (See Note 4)	Measurement of Resistance and Reactance Components (See Note 5)

METHODS OF MEASURING THE PROPERTIES OF RADIO CIRCUIT ELEMENTS (SEE NOTE 1) (Continued)

UNIT	METHODS	FREQUENCY RANGE			RADIO FREQUENCIES 10 <sup>4</sup> - (3 X 10 <sup>7</sup> )
		DIRECT CURRENT	POWER FREQUENCIES 10 - 100 CYCLES	SPEECH FREQUENCIES 30 - 10 <sup>4</sup> CYCLES	
Capacity	Approximate		Ballistic Methods R800 (530) Bridge R800 (530) or Current-Voltage Frequency Determination (See Note 6)	Current-Voltage Frequency Bridge R800 (530)	Substitution in Resonant Circuit R200b (Dielectric Loss) R200b
	Laboratory		Ballistic Methods R800 (530) Bridge R800 (530) Current-Voltage Frequency Determination (See Note 6)	Bridge R800 (530)	Substitution in Resonant Circuit R200b
Inductance	Approximate		Bridge Methods R800 (530) Current-Voltage Frequency Determination (See Note 7)	Bridge R800 (530) Current-Voltage Frequency Determination (See Note 7)	Substitution in Resonant Circuit
	Laboratory		Bridge Methods R800 (530) Current-Voltage Frequency Determination (See Note 7)	Bridge Methods R800 (530) and (14)	Substitution in Resonant Circuit R200b (Distributed Capacity of Coils) R200b

Note 1—Numbers in parentheses refer to references in the bibliography which follow.

Note 2—Comparison with standard tuning fork. See reference R213a.

Note 3—Resistance may be determined from measured value of voltage drop and current

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

Note 4—Impedance may be determined from measured value of voltage drop and current  $Z = \frac{E}{I}$ . The vacuum-tube voltmeter may be used at the higher frequencies.

Note 5—Measurement of resistance and reactance components

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

See references R210(e), R240(d), R220(g), R230(d).  
Note 6—Capacity may be determined from measurements of current, voltage, and frequency

$$C = \frac{\omega E}{I}$$

Note 7—Inductance may be determined from measurements of voltage, current, and frequency  $L = \frac{E}{\omega I}$

## REFERENCES RELATING TO THE MEASUREMENT OF THE CHARACTERISTICS OF RADIO RECEIVERS AND ASSOCIATED APPARATUS

These references are classified according to the extension of the Dewey Decimal Classification to radio subjects contained in Circular 138 of the U. S. Bureau of Standards.\* An outline of this classification was published in the PROCEEDINGS of the Institute of Radio Engineers, 16, 1423; October, 1928.

Abbreviations for the titles of the publications referred to in these references are as follows:

Amer. Acad. Arts and Sci. Proc.	<i>Proceedings of the American Academy of Arts and Sciences.</i>
A.I.E.E. Jl.	<i>Journal of the American Institute of Electrical Engineers.</i>
A.I.E.E. Trans.	<i>Transactions of the American Institute of Electrical Engineers.</i>
<i>Archiv f. Elek.</i>	<i>Archiv für Elektrotechnik.</i>
<i>Bell Sys. Tech. Jl.</i>	<i>Bell System Technical Journal.</i>
Cir. B. of S.	Circular of the Bureau of Standards.
<i>Elec. Comm.</i>	<i>Electrical Communication.</i>
<i>Electrician</i>	<i>Electrician (London).</i>
<i>Exp. Wls. &amp; Wls. Engr.</i>	<i>Experimental Wireless and Wireless Engineer.</i>
Fr. Inst. Jl.	<i>Journal of the Franklin Institute.</i>
G. E. Rev.	<i>General Electric Review.</i>
I.E.E. Jl.	<i>Journal of the Institution of Electrical Engineers.</i>
I.E.E. Jl. (Japan)	<i>Journal of the Institution of Electrical Engineers, Japan.</i>

\* Copies of Circular 138 of the Bureau of Standards can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. for 10 cents per copy.

- LC. B. of S. Letter Circular of the Bureau of Standards.
- Mod. Wls. (Lond.)* *Modern Wireless (London).*
- Natl. Acad. Proc. *Proceedings of the National Academy of Sciences.*
- Jl. Opt. Soc. Am. & Rev. Sci. Ins.* *Journal of the Optical Society of America and Review of Scientific Instruments.*
- P.O.E.E. *Jl.* *Post Office Electrical Engineers Journal.*
- Phys. Rev.* *Physical Review.*
- Phys. Soc. Lond. Proc. *Proceedings of the Physical Society of London.*
- Phys. Zeits.* *Physikalische Zeitschrift.*
- PROC. I.R.E. PROCEEDINGS of the Institute of Radio Engineers.
- QST QST
- Radio Eng.* *Radio Engineering.*
- Radio Rev.* *Radio Review.*
- Roy. Soc. Lond. Proc. *Proceedings of the Royal Society of London.*
- Sci. Pa. B. of S. Scientific paper of the Bureau of Standards.
- Tech. Pa. B. of S. Technologic paper of the Bureau of Standards.
- Wls. Age* *Wireless Age.*
- Wls. Wld. & Radio Rev.* *Wireless World and Radio Review.*

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(530)

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(621.313.7)

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CATALOGUE of MEMBERSHIP

ARRANGED ALPHABETICALLY

*and*

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### NOTE

The following list of membership is divided into two sections; the first contains an alphabetical list of members of the Institute of all grades and the second comprises a geographical list of members. In the alphabetical portion, the letter and date immediately following the member's name indicate the grade of membership and date of election. Where more than one letter and date group follow the member's name, the subsequent notations refer to the grade and date of transfer to a higher grade. (F) denotes the grade of Fellow; (M) Member; (A) Associate; (J) Junior.

Where only one address is shown in the alphabetical list it is the mailing address.

The geographical list contains the state and town in which the member is located and his present grade of membership in the Institute.

## CATALOGUE OF MEMBERSHIP

January 1, 1929

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(See note on page 156)

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January 1, 1929

Arranged Geographically

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Waldo, George V. (A)

**Birmingham**  
Bell, John C. (A)  
Williams, G. H. (A)

**Mobile**  
Dockendorf, Joseph P. (A)

**Montgomery**  
Trum, Alexander D. (A)

**Pratt City**  
Hassler, W. Dan (A)

**University**  
Wagner, Raymond P. (J)

## ARIZONA

**Ajo**  
Kiernan, Earl F. (A)

**Phoenix**  
Wilburn, Frank (A)

**Tucson**  
Bannister, M. W. (A)  
Percy, F. W. (A)  
Warner, Earle H. (A)

## ARKANSAS

**Blytheville**  
Lintzenich, C. L. (A)

**Conway**  
Cordrey, E. E. (A)

**Fort Smith**  
Barry, James A. (A)

**Hot Springs**  
Peel, Delacy J. (A)  
Rockwell, Ronald J. (A)

**Little Rock**  
Beem, Raymond M. (A)  
Heim, Rupert A. (A)  
Hofstatter, F. H. (A)  
Williams, Joe (A)

**Siloam Springs**  
Chandler, C. G. (A)

## CALIFORNIA

**Alameda**  
Lubeke, Harry R. (A)  
Powell, Louis H. (J)  
Schlueter, Edward A. (A)

**Alhambra**  
Grimes, William F. (A)  
Harper, Harrauld R. (A)

**Altadena**  
Johnson, Paul F. (M)

**Artesia**  
Corcoran, Edward M. (A)  
Corcoran, George L. (J)

**Azusa**  
Holecomb, Clyde A. (A)

**Bell**  
Anderson, Edward R. (A)

## Berkeley

Albin, Frederick G. (A)  
Armer, Austin A. (A)  
Culley, Lester D. (A)  
Davis, Daryl D. (A)  
Greves, George L. (A)  
Hassell, Ralph L. (A)  
Howard, L. W. (A)  
Meissner, Earl R. (A)  
Morgan, Howard K. (A)

## Beverly Hills

Balsley, James R. (A)

## Bishop

Wheeler, Walter R. (A)

## Bolinas

Park, Charles W. (A)

## Burbank

Garretson, Oliver S. (A)

## Burlingame

Michalic, C. T. (A)  
Romander, Hugo (A)

## Catalina Island

Paggi, Martin M. (A)  
Mott, Lawrence (A)

## Corona

Campbell, William N. (A)

## Coronado

Pierce, Francis E. (M)

## El Centro

Cook, John W. (A)

## El Segundo

Hart, William J. (A)

## Fresno

Denny, R. C. (A)  
Foin, Owen F., Jr. (J)  
Gearhart, Erle J. (A)  
McKay, Wm. K. (J)

## Fullerton

Atherton, Malcolm J. V. (A)  
Finaeth, E. B. (A)  
Wickersheim, L. W. (A)

## Glendale

Bowles, Theodoro C. (A)  
Eilers, John (J)  
Engen, Ralph E. (A)  
Farnsworth, Earl S. (M)  
Shomler, H. B. (A)  
Tatreault, Leon E. (A)

## Hemet

Coe, Ernest W. (A)

## Hermosa Beach

Carter, Everett D. (A)

## Hollywood

Barnes, James C. (A)  
Breeding, Charles S. (A)  
Burns, C. Austin (A)  
Campbell, Howard E. (M)  
Cook, Robert O. (A)  
Cunningham, Lodge (A)  
Derling, Fred J. (A)  
Ellis, George D. (A)  
Fox, Bert M. (J)

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## Hollywood (Continued)

Hansen, Edmund H. (M)  
Harrington, Fred H. (A)  
Hart, Roy H. (M)  
Heinley, Paul P. (A)  
Hill, Arthur P. (M)  
Hilliard, John K. (A)  
Levinson, Nathan (M)  
Lindsay, W. W., Jr. (M)  
Sarver, Frank M. (A)  
Sawyer, Gordon E. (A)  
Sheldon, C. C. (A)  
Snyder, William R. (A)  
Stewart, Ronald B. (A)  
Van Why, Forbes W. (M)

## Independence

Parcher, Frank (A)

## Inglewood

Peters, Jay (A)  
Underwood, Ernest G. (A)

## Jackson

Van Thiel, Jan (A)

## La Canada

Benjoff, Hugo (A)

## La Cresenta

Robinson, Frederick (A)

## Livermore

Ryan, R. (A)

## Long Beach

Hancock, John W., Jr. (J)  
Moore, Raymond C. (A)  
Wallace, Donald C. (A)

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Alverson, James G. (A)  
Andersen, H. W. (A)  
Appleton, Harry (A)  
Barlow, Roy G. (A)  
Bell, Harold H. (A)  
Best, Gerald M. (M)  
Brown, J. Kenneth (A)  
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Cheney, John W. (A)  
Comyns, William L. (A)  
Dawson, W. Robert (J)  
Deming, Wilford, Jr. (A)  
Dewey, Fred L. (A)  
Edgcomb, A. J. (A)  
Eldridge, Robert H. (A)  
Felstead, Charles F. (A)  
Ford, Walter B. (A)  
Fraser, Graham (A)  
Fraser, William H. (M)  
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Hardy, William H. (A)  
Hauser, Carroll R. (A)  
Hayes, E. K. (A)  
Hill, Alfred L. (A)  
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Langrick, Paul D. (A)  
Leighton, Harold W. (A)  
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Madsen, Norman L. (A)  
Marshall, Cloyd, Jr. (A)  
Mason, Curtis W. (A)  
McCabe, William E. (A)  
McCreery, M. E. (A)  
McDonough, Thomas F. (A)  
McNamee, B. F. (A)  
Miller, Charles E. (A)

Moore, Raymond M. (A)  
Morris, James W. (A)  
Newman, William H. (A)  
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Pfleger, Robert A. (A)  
Power, Ralph L. (A)  
Ramsay, Alan N. (A)  
Rhodes, L. G. E. (A)  
Richards, Arthur H. (A)  
Riggs, Clare A. (A)  
Ringold, H. Russell (A)  
Silent, Harold C. (A)  
Smith, C. Bernard (A)  
Sorge, Barthold W. (A)  
Stevens, Sterling M. (A)  
Stratton, Ross A. (A)  
Stuedle, Emry C. (A)  
Taufenbach, Leslie E. (M)  
Threlkeld, Howard M. (A)  
Tobey, E. S. (A)  
Wainwright, Stuart F. (A)  
Ward, Jack (A)  
Whiston, R. William (A)  
Witt, Harold A. (A)  
Young, William G. (A)  
Yount, L. E. (A)  
Zweiger, Owen (J)

## Manhattan Beach

Tischer, Frank A. (A)

## Marshall

Lawrence, Lloyd H. (A)  
Reid, Irl H. (A)  
Wissmann, Joseph T. (A)

## Mayfield

Paul, Ernest E. (A)

## Monterey

Brokaw, Hal R. (A)  
Greene, Harry A. (A)

## Monterey Park

Alker, Charles (A)  
Nikirk, Thomas E. (A)  
Sanmann, Edgar J. (A)  
Willson, Clarence L. (A)

## Mountain View

Winnegar, W. A. (A)

## Oakland

Allen, Preston D. (A)  
Branson, Albert K. (A)  
Brown, James F. (A)  
Cross, Charles H. (A)  
Crippen, Eugene C. (A)  
Engholm, Bernard A. (M)  
Freiermuth, Vincent J. (A)  
Gardiner, Paul C. (A)  
Hazeltine, Louis A. (F)  
Kellogg, Walter D. (A)  
Kerr, Maurice F. (A)  
McCarthy, John N. (A)  
O'Brien, Daniel L., Jr. (A)  
Sherman, Kenneth S. (A)  
Soderberg, Arnold J. (A)

## Olympia

Kaufman, Arthur W. (J)

## Orange

Charbonneau, L. H. (A)  
Waters, John E. (A)

## Oxnard

Newcomb, Carleton Atwood (A)

## Pacific Grove

Anderson, Adrien L. (A)  
Wood, Stanford J. (A)

## Palo Alto

Beal, Ralph R. (A)  
Brower, William M. (M)

## CALIFORNIA (Continued)

## Palo Alto (Continued)

Brown, Archibald S. (A)  
Brown, Elmer L. (A)  
Cattell, Gilbert W. (A)  
Cordes, Henry G. (A)  
Dow, Clifford J. (A)  
Elliott, H. F. (M)  
Fuller, Leonard F. (F)  
Jones, L. F., 3rd (A)  
Kolster, Frederick A. (F)  
Lewelling, Raymond (A)  
Marx, Roland G. (M)  
Overacker, Horace E. (A)  
Ray, John N. (A)  
Scofield, P. F. (A)  
Tinney, Francis B. (A)  
Veirup-Jensen, J. G. (A)  
Wittern, Ray (A)

## Pasadena

Bradshaw, Robert C. (A)  
Brown, Howell C. (A)  
Felch, H. F. (A)  
Hopper, Francis L. (A)  
Howes, Edgar T. (A)  
Macik, Frank (J)  
Oboukhoff, Nicolai (M)  
Smith, Robert L. (A)  
West, L. E. (A)  
Westphal, Richard D. (A)

## Piedmont

Myers, Walter M. (A)

## Pine Knot

Betterley, Jack A. (A)

## Pomona

Parker, Evert L. (A)

## Porterville

Baker, Lewis C. (A)

## Redwood City

Litton, Charles V. (A)

## Riverside

Kennedy, Robert W. (A)  
Norwood, Donald W. (A)

## Sacramento

Barlow, William (A)  
Hayden, J. W. (J)  
Koch, William F. (A)  
Melnicoe, Samuel (A)  
Messner, Roy L. (A)  
Semoni, Anthony J. (A)

## San Bernardino

Beecon, Kenneth H. (A)

## San Diego

Burnett, William L. (A)  
Clement, Jack D. (A)  
Conaughy, Robert B. (A)  
Curtis, Everett N. (A)  
Davidson, Martin (A)  
Doig, John H. (A)  
Highleyman, Richard (M)  
Stone, John Stone (F)  
Walker, Allan N. (A)  
Wisner, Fred L. (A)  
Wright, Robert E. (A)

## San Francisco

Attmore, William B. (A)  
Bear, William P. (A)  
Behr, Francis (F)  
Benson, Francis S. (A)  
Bouson, Herbert H. (M)  
Bradshaw, Lynwood (A)  
Cordell, Harry S. (A)  
Danforth, Richard S. (A)  
Danielson, Ernest G. (A)  
Davey, Cedric (A)  
Delworth, Lee J. (A)  
Farnsworth, Philo T. (A)  
Fass, Sydney J. (A)

Fenner, Paul R. (A)  
Fletcher, Earle S. (M)  
Gary, L. A. (A)  
Glasby, W. Kenneth (M)  
Graham, Lloyd E. (A)  
Halloran, A. H. (M)  
Hanscom, W. W. (M)  
Hart, Arthur H. (A)  
Heintz, Ralph M. (M)  
Henry, Franklin M. (A)  
Hoffman, Samuel (A)  
Kellogg, Richard B. (A)  
King, Howard D. (A)  
Larzelere, William R., Jr. (A)  
Linden, Bernard H. (A)  
Lippincott, Donald K. (M)  
Mathes, R. E. (A)  
Mauran, John (A)  
Maxwell, John F. (A)  
Maynard, Raymond K. (A)  
McDowell, Clyde S. (M)  
McGown, Dudley B. (A)  
Moore, Paul (A)  
Myers, Gilbert B. (A)  
Nikonenko, Paul (A)  
Ogg, Glen R. (A)  
Parker, Ray H. (A)  
Patron, Alfonso E. (A)  
Patten, Stanley F. (A)  
Royden, George T. (M)  
Sachs, Harold S. (A)  
Scott, Leo L. (A)  
Sherman, Warren K. (A)  
Smith, Charles S., Jr. (A)  
Smith, Harold W. (A)  
Sohor, P. H. (M)  
Sphar, Clark H. (J)  
Squires, Harold W. (A)  
Stagnaro, John A. (A)  
Ternow, Helmut G. (A)  
Thiel, Harold A. (A)  
Tustin, John L. (A)  
Umphreys, John L. (A)  
Weber, Glen L. (A)  
Weir, F. Torres (A)  
Wells, W. Bruce (A)  
Wolf, Benjamin (M)

## San Gabriel

Ashbrook, Roy B. (A)  
Zint, Karl E. (A)

## San Jose

Cozzens, Bradley (A)  
Engwicht, Harry (A)  
Quement, Frank J. (A)  
Rathbun, Harry J. (A)  
Reynolds, F. T. (A)  
Tarot, Alfred (A)

## San Marino

Polihman, G. Anton (A)

## San Pedro

Fredericks, John E. (A)  
Johnson, Vendit (A)  
Skov, Jens I. (A)

## San Rafael

Parkin, John, Jr. (A)

## Santa Ana

Sleeper, Lloyd J. (A)

## Santa Barbara

Cooper, Harold G. (A)  
Kempson, Walter D. (A)  
Means, Paul S. (A)  
Partch, Paul C. (A)

## Santa Maria

Gioga, Peter C. (A)

## Santa Monica

Fenton, A. Norwood (A)  
Willis, Edward N. (A)

## CALIFORNIA (Continued)

Sausalito  
Bradley, John T. (A)

Sherman  
Smith, Wade H. (A)

Stanford University  
Miles, Kirk (J)  
Ryan, Harris J. (M)  
Smith, L. E. (A)  
Terman, Frederick E. (A)

Stockton  
Adams, Kenneth A. (A)  
Clarkson, Charles N. (A)  
Harvey, Vernon L. (A)  
Holt, Pliny E. (A)  
Schulz, Paul C. (A)

Tujunga  
Feringer, William (A)

Vallejo  
Robinson, R. J. (A)

Van Nuys  
Black, Robert (A)  
Marsden, George K. (A)

Ventura  
Snow, Louis A. (A)

Walnut Park  
Dalton, Stuart P. (A)

Wasco  
Morrison, L. H. (A)

Whittier  
Leffingwell, E. De K. (A)  
Mendeck, Fred C. (A)  
Thompson, Isaac (A)

## COLORADO

Alamosa  
Dillow, Arthur P. (A)

Arvada  
Kelso, Rupert E. (A)

Colorado Springs  
Blair, Wiley, Jr. (A)

Delta  
Fulghum, Charles K. (A)

Denver  
Grove, William C. (A)  
Love, Nelson R. (A)  
Mather, Cuthbert C. (A)  
Owen, Robert H. (A)  
Painter, Charles E. (A)  
Pyle, William D. (A)  
Reynolds, William D. (A)  
Rowe, F.S. (A)  
Segal, Paul M. (A)  
Vos, Arthur, Jr. (J)  
Williams, Howard W. (A)

Englewood  
Peterson, Frank M. (A)

Greeley  
Sammons, Floyd (A)

Hereford  
Nichols, Frederick (A)

Loveland  
Houge, Charles A. (A)

Pueblo  
Bowen, Clyde L. (A)  
Nelson, A. Leroy (A)

Selbert  
Fingado, Francis H. (A)

CONNECTICUT

Bridgeport  
Campbell, Charles H. (A)  
Chopeky, Peter A. (J)  
Dulbis, Geddie E. (A)

Dunning, S. (A)  
Gould, Lealie A. (A)  
Gravlin, Lee F. (A)  
Ham, Frank M. (A)  
Ivanko, John G. (J)  
LeBoeuf, Wilfred F. (A)  
Lyford, Elmore B. (A)  
Mapes, Harold T. (A)  
Nothnagle, George E. (A)  
Tomlinson, Harry E. (A)

Danbury  
Gillotti, Albert C. (A)

East Hampton  
Carini, Louis (J)

East Hartford  
Randall, J. Clayton (M)

Greenwich  
Thomas, William A. (M)

Groton  
Keily, Delbar P. (A)

Hartford  
Ahrens, Justin H. (A)  
Alcott, George B. (A)  
Beekwith-Ewell, Starr L. (A)  
Cowles, Walter G. (A)  
Handy, Francis E. (A)  
Hebert, Arthur A. (M)  
Hebert, A. Aubin (J)  
Hendricks, Paul S. (A)  
Hull, Ross A. (M)  
Lamb, James J. (A)  
Maxim, Hiram Percy (A)  
Meserve, G. Donald (A)  
Page, Atwood C. (A)  
Pember, Harold N. (A)  
Scell, Russell G. (A)  
Westman, Harold P. (A)  
Wood, Herbert H. (A)

Litchfield  
Vanderpoel, Floyd L. (A)

Meriden  
Donle, Harold P. (A)  
Wilcox, Ernest C. (A)  
Young, Frank A. (A)

Middletown  
Cady, Walter G. (F)  
Harrison, Jamison R. (A)  
Van Dyke, Karl S. (M)

Mount Carmel  
Croteau, Carlton W. (A)

Mystic  
Wheeler, Lester B. (J)

Nangatuck  
Backlund, Louis R. (J)

New Britain  
Johnston, Douglas A. (A)

New Haven  
Doolittle, Franklin M. (A)  
Turner, Hubert M. (M)  
Weed, C. Bronson (A)

New London  
Helgren, Oiva M. (A)  
O'Day, Arthur C. (A)

Norwich  
Hubbard, James L. (A)

Plainville  
Jones, H. Garfield (A)  
Stephenson, Martin A. (A)

Saybrook  
Barnes, Howard N. (A)

Seymour  
Dana, Alan S. (A)

Sound Beach  
Yates, Raymond F. (M)

## CONNECTICUT (Continued)

Southington  
Lewis, Earl B. (A)

Stamford  
Carlson, Einar C. (A)  
Cronkrite, Minton (M)  
Dunning, Orville M. (A)  
Harnett, Daniel E. (A)

Storrs  
Noble, Daniel E. (A)  
Pownall, Roger F. (A)

Stratford  
MacIntyre, James R. (A)

Torrington  
Alvord, Carl G. (A)  
York, Peter J. (A)

Waterbury  
Bennett, Morris H. (A)  
Braverman, Rubin R. (A)  
Cohen, Edward (A)  
Greenblatt, Louis (A)  
Winchell, Alfred M. (A)

West Hartford  
Appleby, Bertie (A)  
Beekley, F. Cheyney (M)  
Gade, William H. F. (A)  
Hatry, Louis W. (A)  
Kruze, Robert S. (M)  
Kutcher, Louis F. (A)  
Montgomery, Philip (A)  
Mueller, Paul M. (A)  
Warner, Kenneth B. (M)

Westport  
Perry, William A. (A)

West Suffield  
Colson, James L. (J)

Wethersfield  
Mitchell, James A. (A)

DELAWARE

Claymont  
Tatnall, Joseph S. (A)

Wilmington  
Boylan, E. Brandt (A)  
Casey, K. K. V. (A)  
Henning, Clarence I. B. (A)  
Merts, John M. (A)  
Wilcox, Robert L. (A)

DISTRICT OF COLUMBIA

Anacostia  
Colvin, Ruel (A)  
Debaun, George H. (A)  
Hanson, Malcolm P. (A)  
Owens, Raymond B. (M)  
Taylor, A. Hoyt (F)  
Wheeler, Lynde P. (F)

Washington  
Austin, Louis W. (F)  
Beckus, Cyrus D. (M)  
Berry, Henry P. (A)  
Blackwell, George C. (A)  
Bliss, Alonso O., Jr. (A)  
Boyer, William P. (A)  
Brady, John B. (A)  
Burgess, Warren B. (A)  
Butman, Carl H. (A)  
Caldwell, O. H. (M)  
Chamberlin, Robert R. (A)  
Chromy, B. J. (A)  
Chubb, William M. (A)  
Cohen, Louis (F)  
Corrigan, James T. (A)  
Crawford, David M. (A)  
Davis, Chester L. (M)  
Davis, Thomas M. (M)  
Dewhirst, Thornton P. (A)  
Diamond, Harry (A)

Dingloy, Edward N., Jr. (A)  
Dorsey, Herbert G. (M)  
Downey, W. E. (M)  
Drury, Paul O. (A)  
Gebhard, Louis A. (A)  
Gilliland, Ted R. (A)  
Glaser, Stanley J. (A)  
Graf, Alois W. (A)  
Greeley, Philip H. (A)  
Gross, Gerald C. (A)  
Guthrie, Frederick P. (M)  
Hafstad, L. R. (A)  
Hall, E. L. (A)  
Hallam, John T. (A)  
Hastings, Harris F. (A)  
Heaton, Vincent E. (A)  
Heinl, Robert D. (A)  
Heron, Louis M. (M)  
Hill, Guy (F)  
Hinemon, J. H., Jr. (A)  
Hooper, S. C. (F)  
Hund, August, (F)  
Jansky, C. M., Jr. (F)  
Jenkins, C. Francis (A)  
Johnson, Albert E. (A)  
Jolliffe, C. B. (M)  
Judson, Elbert B. (A)  
Kear, Frank G. (A)  
Kinley, Clifford B. (A)  
Kirby, Samuel S. (A)  
Kriz, Joseph (A)  
Loomis, Mary Texanna (M)  
Mates, T. Joaquin (A)  
May, Albert (A)  
McCandlish, B. V. (A)  
McClelland, Harold M. (M)  
McKinley, Howard W. (A)  
Mickey, Leroy (A)  
Mims, Clinton F. (A)  
Mirick, Carlos B. (A)  
Page, Robert M. (A)  
Parkinson, Taintor (A)  
Powell, Edwin L. (A)  
Rietake, Eugene H. (A)  
Robinson, Samuel A. (A)  
Rohrich, George J. (A)  
Smith, David H. (A)  
Smith, James E. (M)  
Sprayberry, Frank L. (A)  
Squier, George O. (F)  
Stewart, Ralph B. (M)  
Terrell, Robert L. (A)  
Terrell, W. D. (A)  
Thomson, Paul H. (A)  
Weber, Carl F. (A)  
Worrall, Robert H. (A)  
Wright, J. Warren (A)  
Young, Leo C. (A)  
Zandonini, Elizabeth M. (A)

West Chevy Chase  
Case, Nelson P. (A)

FLORIDA

Coral Gables  
Entrekin, Carl A. (A)

Dade City  
Berg, L. J. (A)

Fort Pierce  
Taylor, James C. (A)

Gainesville  
Loucks, Ivan H. (A)

Jacksonville  
Adams, George G. (A)  
Cooper, John C., Jr. (A)  
Washburn, Cyrus, Jr. (A)

Melbourne  
Christensen, Bernard J. (A)  
Fill, John V. (J)



## FLORIDA (Continued)

- Miami  
Hoselton, Frank B. (A)
- Orlando  
Green, Charles M., Jr. (A)  
Hopkins, John S. (J)
- Pensacola  
Scott, Carl A. (A)  
Taylor, Francis W. (A)
- Sarasota  
Service, Charles A., Jr. (A)
- St. Augustine  
Pope, James C. (A)
- St. Petersburg  
Preece, Richard, Jr. (A)  
Wittstruck, Harold H. (A)
- South Jacksonville  
Grange, Gifford (A)
- Tampa  
Fisher, Carroll S. (A)  
Moore, William P. (A)  
Skelton, Kenneth W. (A)

## GEORGIA

- Atlanta  
Alexander, David C. (A)  
Anderson, Leland E. (A)  
Bayliss, V. B. (A)  
Bellinger, Andrew L. (A)  
Bussey, H. E. (A)  
Cochran, B. W. (A)  
Cook, J. M. (A)  
Daugherty, Carl F. (A)  
Dobbs, Harry F. (A)  
Eubanks, John M. (J)  
Gue, Earl M. (A)  
Hillegas, John W. (A)  
Holbrook, Robert A. (J)  
Jorgensen, Wesley J. (A)  
Llewellyn, George (A)  
MacNaughton, A. K. (A)  
Matthews, Allen A., Jr. (J)  
Morris, James S. (A)  
Murphy, Brower (A)  
Reid, Henry L. (A)  
Thornton, Henry P. (A)  
Van Nostrand, Walter, Jr. (M)  
Walker, Joseph R. (A)  
Wallace, Lawrence T. (A)  
Wills, Harry L. (M)  
Yancey, E. F. (A)
- Columbus  
Coward, Franklin P. (A)  
Stuart, John F. (A)
- Decatur  
Brewin, Robert R. (A)
- Fort Benning  
Allen, Otis T. (A)
- Macon  
Rankin, George P., Jr. (A)
- Millhaven  
Rushing, Wallace E. (A)
- Royston  
Berryman, Forrest G. (A)
- Savannah  
Rollinson, John W. (A)
- Statesboro  
Blitch, James D. (A)
- IDAHO
- Elk River  
MacDermid, L. D. (A)
- Grace  
White, Harold D. (A)
- Lewiston  
Keyes, Edwin F. (A)
- Pocatello  
Davis, Glenwood (A)

## ILLINOIS

- Aurora  
Bliss, Floyd D. (A)
- Batavia  
Leffler, Ralph H. (A)
- Belleville  
Hahn, Richard W. (A)
- Berwyn  
Burns, Elmer E. (A)  
Hromada, Joseph C. (A)  
Komm, Paul M. (A)  
Schnell, William J. (A)  
Wilkinson, L. G. (A)
- Bloomington  
Goodfellow, Elmer D. (A)  
Stillhamer, Arthur G. (A)
- Blue Island  
Damm, George J., Jr. (A)
- Canton  
Ingersoll, William P. (A)
- Chicago  
Adair, Samuel E. (M)  
Albee, Norman E. (A)  
Alexander, Donald W. II. (A)  
Andres, Lloyd J. (A)  
Andres, Paul G. (A)  
Ankersen, G. W. (A)  
Armstrong, Harold W. (J)  
Ayer, Oliver G. (A)  
Barlow, William H. (A)  
Beane, E. A. (M)  
Beindorf, Lucien J. (A)  
Benjamin, Abraham S. (A)  
Blessing, G. W. (A)  
Bloomenthal, Sidney (A)  
Bluzat, Claude R. (A)  
Brack, G. Sterling (A)  
Braun, W. C. (A)  
Brenner, Joseph (A)  
Bridgman, Francis K. (A)  
Brittin, Frank L. (M)  
Bronson, G. E. (A)  
Browne, L. N. (A)  
Burchard, John C. (M)  
Burdett, Sam (A)  
Burkwest, Leonard G. (A)  
Burlington, Fred C. (A)  
Burns, Robert P. (A)  
Butler, Raymond H. (A)  
Butterfield, Roy O., Jr. (A)  
Byrnes, Walter C. (A)  
Callahan, James J. (A)  
Campbell, Donald O. (A)  
Campbell, Robert H. (A)  
Canon, Hartman B. (J)  
Carter, A. J. (M)  
Chun, Herbert H. (A)  
Clausing, Leroy M. E. (A)  
Clough, Kendall (A)  
Cohen, Theodore (J)  
Colwell, Frederick E. (A)  
Corbin, Hal S. (A)  
Crossett Edward C. (A)  
Cumming, George (A)  
Davis, Joseph A. (A)  
Demikis, Anton, Jr. (J)  
Denise, Garet W. (A)  
Douglas, James M. (A)  
Doyel, Lee Conan (A)  
Dubuclet, Sidonia L. (A)  
Dudley, Beverly (A)  
Duskis, Ephraim (A)  
Edelman, Philip E. (A)  
Eells, M. Merwin (A)  
Elam, David L. (A)  
Epslein, Hirsch (A)  
Esmaker, John B. (A)  
Evans, Walter C. (M)

## ILLINOIS (Continued)

## Chicago (Continued)

- Ewald, Fred J., Jr. (A)  
Falknor, Frank B. (M)  
Fast, John E. (A)  
Fernandez, Dan T. (A)  
Ferris, Frank (A)  
Fillmore, Harry P. (A)  
Fischer, Andrew, Jr. (A)  
Flick, A. A., Jr. (A)  
Forbes, Allan C. (M)  
Foringer, Edgar C. (A)  
Forsberg, Otto J. (A)  
Fortington, William H. (M)  
Fox, John E. (A)  
Freeman, Ernest H. (M)  
Freimann, Frank (A)  
Friday, Wilbur L. (A)  
Fritchle, Oliver P. (A)  
Galves, Manuel E. (A)  
Goldman, Stanley (A)  
Golten, J. N. (A)  
Gurrie, Morris (A)  
Hall, Edward G. (A)  
Hall, Harlan R. (A)  
Halligan, William J. (A)  
Hansen, Clarence A. (A)  
Hansen, Leland S. (A)  
Hansen, William H. (J)  
Hanson, Earl C. (A)  
Harper, W. W. (M)  
Hartzell, C. C. (A)  
Hassel, Karl E. (M)  
Hauser, Albert (A)  
Henninger, Andrew F., Jr. (A)  
Henry, Charles C. (A)  
Heywood, John L. (A)  
Hill, Orville (A)  
Hillegas-Baird, L. S. (A)  
Hines, Albert D. (A)  
Hoag, J. Barton (M)  
Holmquist, Carl T. (A)  
Holroyd, Richard J. (A)  
Holst, Wendell L. (M)  
Howard, Austin A. (A)  
Howard, C. M. (M)  
Izenstark, Maurice J. (A)  
Jackowski, I. F. (A)  
Jelen, Matt J. (A)  
Jensen, Karl K. (A)  
John, Kenneth B. (A)  
Jorgenson, Harold (A)  
Kamin, Vernon A. (A)  
Kehm, Clarence H. (A)  
Kelley, Harvey T. (A)  
Knowles, Hugh S. (A)  
Kobberup, Jack R. (A)  
Kobberup, Julius (A)  
Koblitz, August P. (A)  
Koch, Earl L. (A)  
Korbel, George W. (A)  
Kramer, Andrew W. (A)  
Lawton, Harvey B. (A)  
Leidy, Wilmer J. (A)  
Levy, Henry (A)  
Lipey, David H. (A)  
Magos, John P. (A)  
Marco, Frederick J. (M)  
Marshall, Charles E. (A)  
Martin, E. F. (A)  
Matthews, A. C. (A)  
McCullah, Arthur B. (A)  
McGregor, Arthur M. (J)  
McJilton, De Witt (A)  
Meinhard, Herman (A)  
Mercer, John E. (A)  
Michael, Charles (A)  
Miller, John H. (M)  
Million, John W., Jr. (M)
- Mills, Elmer E. (A)  
Minnium, Byron B. (A)  
Mooney, Raymond (A)  
Morey, W. J. (A)  
Morris, John F. (A)  
Morrison, Huber R. (A)  
Morrison, Montford (M)  
Mraz, Edwin (A)  
Mueller, Eugene L. (A)  
Muirhead, John E. (A)  
Nichols, Orlando (A)  
Nieman, Thomas A.  
Nolan, James J. (M)  
Noonan, John J. (A)  
Nordhaus, Charles H. (A)  
Nourse, Philip R. (A)  
Novak, Joe J. (A)  
O'Brien, William J. (A)  
O'Byrne, Leo C. (A)  
Ostrowski, Walter R., Jr. (J)  
Oxner, Edwin K. (A)  
Parisek, Edw. E. (A)  
Parker, Leonard E. (A)  
Pestlin, Le Roy John (A)  
Peterson, Howard E. (A)  
Petzing, E. W. (A)  
Pew, Richard K. (A)  
Pflaff, Ernest R. (A)  
Pfeifer, P. S. (A)  
Piety, Raymond G. (M)  
Polydoroff, W. J. (M)  
Prentiss, John G. (A)  
Preston, Cecil W. (A)  
Procunier, W. R. (J)  
Randall, Harry K. (A)  
Remde, Jack (A)  
Riddel, O. A. (J)  
Rodriguez, Alexander E. (A)  
Rose, Joseph K. (A)  
Ross, Kenneth B. (A)  
Rossiter, Donald R. (J)  
Rothenberger, William L. (A)  
Rowe, Thomas L. (A)  
Royal, Roscoe (A)  
Schaefer, Harold W. (J)  
Schaefer, Kenneth M. (A)  
Schoenwolf, Fred L. (A)  
Schulz, Emil H. (A)  
Shaw, Robert E. (A)  
Silver, McMurdo (A)  
Slauson, W. T. (A)  
Sloan, Francis V. (M)  
Smith, Ernest F. (M)  
Smith, K. R. (M)  
Smythe, Edwin H. (M)  
Somersalo, G. A. (A)  
Sorensen, Carl P. (A)  
Stewart, Arthur C. (A)  
Stone, Carrington H. (M)  
Strandjord, Millard F. (A)  
Stuive, Derk (A)  
Tamburino, Anthony C. (A)  
Ten Cate, Arthur C. (A)  
Trier, Stanley S. (A)  
Trimble, Loren (A)  
Turner, George S. (M)  
Turner, Harry E. (A)  
Turner, Rufus P. (J)  
Victoreen, Charles J. (A)  
Wagner, Elmer H. (A)  
Walgren, C. A. (A)  
Wang, Theodore J. (A)  
Wegner, Charles W. (J)  
Weismantel, C. H. (A)  
Weitzel, Leftoy B. (A)  
White, Arthur C. (A)  
Wilcox, G. M. (M)  
Williamson, Frederick E. (A)  
Witty, W. M. (A)  
Woods, A. A. (A)  
Woods, Michell D. (A)

- ILLINOIS (Continued)**
- Chicago (Continued)**  
Woodward, Clarence H. (A)  
Wright, Oliver (A)
- Chicago Heights**  
Tartak, Paul H. (A)
- Cicero**  
Engst, Norbert K. (A)
- Clinton**  
Arnold, Elmer J. (A)
- Collinsville**  
Gasparotti, Ralph G. (A)
- Crete**  
Anderson, William T. (A)  
Courchene, Homer B. (A)
- Danville**  
Parsons, Charles (A)
- Decatur**  
Barnett, Louis W. (J)  
Cameron, Henry L., Jr. (A)  
Spies, Mark C. (A)
- Dixon**  
Hall, Howard J. (A)
- Downers Grove**  
Allen, Justus (A)  
Hecht, Royal H. (A)  
Johnson, Arthur R. (A)
- Effingham**  
Osgood, Albert S. (A)
- Elmhurst**  
Haag, Merlin W. (A)  
Hercher, Frederick J. (A)  
Ingils, Alexander W. (A)  
Kenney, M. W. (M)  
Kranz, Herman E. (M)
- Evanston**  
Andrews, Edward F. (A)  
Bergman, G. Wiley (A)  
Burt, Andrew G. (A)  
Fisk, Lawrence S. (A)  
Giard, E. A. (A)  
Hill, James H. (A)  
Hughes, Robert E. (A)  
Pennington, Paul (A)  
Wolcott, C. Frederick (A)
- Forest Park**  
Shaffer, Paul E. (A)
- Freeport**  
Meyer, Winston F. (A)  
Nestlerode, Boyd W. (A)  
O'Connell, Gerald (A)
- Geneva**  
Crozier, William D. (A)  
Greaves, V. Ford (F)  
Kranz, Frederick W. (A)
- Glen Ellyn**  
Pieri, Donald (M)
- Glencoe**  
Marsh, Carlton H. (A)
- Harrisburg**  
Tate, Joseph R. (A)
- Highland Park**  
Millard, Everett L., Jr. (J)  
Tucker, G. Lloyd (A)
- Hinsdale**  
Hill, Frederick A. (A)
- Kankakee**  
Wilhelmi, Julian A. (A)
- Kewanee**  
Larson, Clifford L. (A)
- La Grange**  
Farley, G. E. (A)  
Hofert, Fred A. (A)
- Lake Bluff**  
Klock, R. A. (A)  
Olesen, Harold L. (M)
- Lake Forest**  
Haviland, Lyman J. (A)
- Lombard**  
Hollenbeck, A. T. (A)
- Macomb**  
Eller, Walter H. (M)
- Marion**  
Alley, Kenneth G. (A)
- Maywood**  
Peary, Malcolm J. (A)  
Winkel, Herbert C. K. (A)
- Millford**  
Osborn, Paul I. (A)
- Mt. Prospect**  
Gustafson, Gilbert E. (A)
- Niles Center**  
Potter, M. L. (A)
- Northbrook**  
Cole, Jirah D., Jr. (M)
- Oak Park**  
Armstrong, H. M. (A)  
Augustine, R. W. (M)  
Chase, Leslie H. (A)  
Doyle, Horace F. (A)  
Drummond, Ralph S. (A)  
Leland, Edward H. (A)  
Manke, Arthur G. (A)  
Nangle, W. O. (A)  
Penron, Oscar A. (M)  
Pye, Harold C. (A)  
Roe, Douglas J. (A)  
Van Antwerp, Max C. (A)  
Westcott, Philip S. (A)  
Whan, Loren H., Jr. (A)  
Wildner, D. R. (A)  
Woodruff, Albert E. (A)
- Park Ridge**  
Carr, J. O. (A)
- Peoria**  
Brewer, Francis T. (A)  
Kelly, Earl L. (A)  
Shalkhauer, Eric G. (A)  
Tathwell, Archie E. (A)
- Quincy**  
Johnson, Robert J. (A)  
Wilson, A. J. (A)
- Rantoul**  
Arnold, Thomas E. (A)  
Fiechtner, Theodore G. (A)  
Richard, Charles W. (M)
- River Forest**  
Edwards, George W. (J)  
Heald, Merwyn (A)
- Riverside**  
Clemons, Dale R. (M)  
Greaves, Walter M. (A)  
Wills, David C. (A)
- Rockford**  
Ferdinand, Harry P. (A)  
Johnson, Arthur A. (A)  
Ward, Lloyd S. (A)
- Rock Island**  
Foley, Jack (J)
- Savanna**  
Graham, George W. (A)
- South Chicago**  
Kahn, Lamos (A)
- Springfield**  
Borgeason, Carl A. (A)  
Holts, Frederick C. (A)  
Whannel, Raymond L. (A)

- ILLINOIS (Continued)**
- St. Charles**  
Hawkins, John B. (A)  
Shotwell, Harold H. (A)
- Stockton**  
Hanson, Ralph L. (A)
- Streator**  
Licht, Henry M. (A)  
Williams, N. B. (A)
- Sycamore**  
Boynton, Frederick L. (A)
- Tuscola**  
Moulden, Roy B. (A)
- Urbana**  
Brown, Hugh A. (A)  
Hershey, Arthur W. (A)  
Knipp, Charles T. (M)  
Morris, Lloyd P. (A)  
Ross, Ira G. (A)  
Tingley, Freeman T. (A)  
Tykocner, J. T. (M)
- Villa Park**  
Jacker, Edward W. (A)
- Waukegan**  
Rollefson, Karl E. (M)  
Weeks, Robert H. (A)
- Western Springs**  
Scott, Kenneth L. (A)
- West Liberty**  
Waddell, George G. (A)
- Wheaton**  
Taylor, Hawley O. (M)
- Wilmette**  
Martin, Neil H. (A)  
Sholes, S. R. (A)
- Winnetka**  
Gregory, Charlotte C. (A)  
Hinson, Marcus W. (A)  
Johnstone, George A. (A)  
Mathews, Ralph H. (M)
- Zion**  
Mason, C. T. (A)
- INDIANA**
- Albion**  
Evans, Harry R. (A)
- Anderson**  
Perkins, Lawrence M. (A)
- Angola**  
Rickey, Lawrence (A)
- Aurora**  
Achatz, Raymond V. (A)
- Bloomington**  
Hazel, Herbert C. (A)  
Hershman, J. B. (A)  
Ramsey, R. R. (M)
- Connersville**  
Hanes, Fred B. (A)
- Crown Point**  
Hall, Fred F. (J)
- Fort Wayne**  
Baker, Dean R. (A)  
Bohling, C. F. (A)  
Cook, Edward H. (A)  
Rekart, Arthur F. (A)  
Schryver, Henry A. (A)
- Fulton**  
Gray, Floyd E. (A)
- Gary**  
Molony, John D. (A)
- Hammond**  
Orf, Frank B. (J)  
Sherman, Russell H. (A)
- Indianapolis**  
Ashlock, H. D. (A)  
Byers, Russell R. (A)  
Dutton, Charles E. (A)  
Portman, C. (A)
- Lafayette**  
Sabbagh, Elias M. (A)
- Marion**  
Boji, Louis D. (A)  
Foster, Dudley E. (A)
- Notre Dame**  
McCoy, Julius C. (A)
- Princeton**  
Karras, George S. (A)
- Richmond**  
Soule, Harold (A)  
Turner, W. E. (A)
- South Bend**  
Kahn, Albert R. (A)  
Kennedy, James P. (A)
- Syracuse**  
Freeman, Stephen, Jr. (A)
- Terre Haute**  
Brooks, Kenneth E. (A)
- Valparaiso**  
Cummings, Wilbur H. (A)  
Ferrin, Sidney E. (A)  
Leigh, Charles W. (A)  
Marulli, Angelo M. (A)  
Noller, Roy E. (A)  
Packman, M. E. (A)  
Wilson, Leo (J)
- IOWA**
- Ames**  
Huntsinger, Paul R. (J)  
Konkle, Phil (A)  
Osborne, Ralph H. (J)  
Smith, Earl D. (J)
- Burlington**  
Jeffrey, Byron B. (A)
- Cedar Rapids**  
Collins, Arthur A. (J)  
Miller, Clair R. (A)  
Vanek, Lawrence J. (A)
- Clarinda**  
Whitnah, R. B. (J)  
Wilcox, Nathan (A)
- Clinton**  
La Batt, Manor D. (A)
- Council Bluffs**  
Anderson, Gordon A. (A)  
Imler, Glen M. (A)
- Davenport**  
Ehlers, Paul (A)  
Elliott, Frank W. (A)  
Schricker, John R. (A)  
Speers, John C. (A)
- Des Moines**  
Haigh, M. C. (A)
- Dubuque**  
Giellis, Ralph (A)  
Goodspeed, Lynmore S. (A)
- Forest City**  
Jurgensen, Louis (A)
- Fort Dodge**  
Tunwall, Carl S. (A)  
Willits, Andrew A. (A)
- Iowa City**  
Mao Dougal, Drew (J)  
O'Brien, Elwin J. (A)
- Marshalltown**  
Center, Edgar R. (A)  
Pickett, Earl L. (A)

## IOWA (Continued)

Mt. Vernon  
Kafer, Merle D. (A)

Muscatine  
Baker, Norman G. (A)

Sabula  
Kunau, Ralph L. (A)

Shenandoah  
Wildman, Thomas S. (A)  
Yarger, Cecil R. (A)

Sioux City  
Coates, Frank M. (A)  
Hamilton, Joe (J)  
Kerby, Edward J. (A)  
White, Julian M. (A)

Villisca  
Harris, Merion C. (A)

Waterloo  
Hanson, John (A)

Webster City  
Daniels, Paul H. (A)

KANSAS

Abilene  
Brewer, Noble E. (A)

Atchison  
Arthur, Ralph L. (A)  
Crossley, Alfred (M)  
Dimond, Benjamin D. (A)  
Knouf, Ralph J. (A)  
MacCoun, Townsend D. (A)  
Moore, Eugene A. (A)  
Robb, Joseph S. (A)  
Stein, Frederick W. (A)  
Welsh, George E. (A)

Belleville  
Douglas, Ralph S. (J)

Bendena  
Johnson, Milton L. (A)

El Dorado  
Graham, Ira H. (A)

Ellis  
Harrison, Louis A. (A)

Emporia  
Miller, R. F. (A)

Fort Leavenworth  
De Remer, C. W. (M)

Independence  
Elliott, Ralph W. (A)

Lawrence  
Anderson, Harold W. (A)  
Devine, William F. (A)  
Douglas, Norvel (J)  
Jones, George I. (A)

Leavenworth  
Hageman, Oliver C. (A)

Manhattan  
Bueche, Harry S. (A)  
Compton, Robin D. (J)

Pittsburg  
Hall, Harry I. (A)

Pretty Prairie  
Unruh, Franklin T. (A)

Topeka  
Cook, John W. (A)  
Gordon, Herbert C. (A)

Wichita  
Andrews, Elmer (A)  
Byers, Harrison O. (A)  
Lyons, Stewart J. (A)  
Marshall, George E. (A)  
Mitchell, Theodore R. (A)  
Walter, Loren E. (A)

## KENTUCKY

Bypro  
McGeorge, Donald H. (A)

Fort Thomas  
Roes, H. Winston, Jr. (J)

Hardinsburg  
Pyle, R. C. (J)

Hopkinsville  
Harness, Sam A. (A)

Lexington  
Charbonneau, Allan P. (J)  
Hill, Orville Hinton (A)

Louisville  
Berry, Robert C. (A)  
Graft, J. Emmett (A)  
Harlow, Fred G. (A)

Newport  
Pepper, Robert K. (A)

Owensboro  
Field, Robert W. (A)  
Wuertz, John L. (A)

Paducah  
Shelton, Raymond W. (A)

LOUISIANA

Baton Rouge  
Fisher, Theodore (A)  
Webre, Andrew S. (A)

Lake Charles  
Fox, Frank G. (A)  
Lake, Thornton G. (J)

New Orleans  
Aicus, Isaac (A)  
Ammen, Charles E. (A)  
Andres, Charles, Jr. (A)  
Clemmons, Wallace A. (A)  
Deiter, Theodore G. (M)  
Dover, M. H. (J)  
Du Treil, L. J. N. (M)  
Gallo, Louis J. (M)  
Gardberg, Joseph (A)  
Gidiere, Philip S. (A)  
Green, W. H. (A)  
Hart, M. E. (A)  
Jensen, Valdemar (A)  
Jones, Edward T. (M)  
Lehde, Pendleton E. (F)  
Macke, William (A)  
Maier, Otto T. (A)  
Mc Cabe, Louis L. (A)  
Moore, Frank C. (A)  
O'Neil, Maurice B. (A)  
Pasquet, Jean E. (A)  
Pierce, George H. (A)  
Rabito, A. Paul (A)  
Salzer, Herman M. (A)  
Salzer, H. S. (A)  
Schiele, Anton A. (A)  
Stevens, William J. (A)  
Teunisson, John F. (A)  
Whitney, Charles L. (A)

Shreveport  
Claycomb, Hugh (A)  
Kanely, Norman J. (A)

MAINE

Bar Harbor  
Miles, William E. (A)

Belfast  
Ashmore, J. W. (A)  
Morris, Hedley B. (A)

Brunswick  
Little, Noel C. (A)

Houlton  
Dombek, P. John (A)  
Larson, John M. (A)

## MAINE (Continued)

Houlton (Continued)  
Richey, Joseph L. (A)  
Willis, F. H. (A)

Millinocket  
Preston, George D. (A)

Orono  
Cloke, Paul (M)

Portland  
Carles, Reginald C. (A)  
Rice, Harold E. (A)

Yarmouth  
Wright, Louis M. (A)

## MARYLAND

Annapolis  
Brewington, Carl W. (A)  
Carboni, Anthony (A)  
Giet, G. Robert (A)  
Robinson, Gordon D. (A)  
Robison, Samuel S. (F)

Baltimore  
Allen, John E. (A)  
Allner, Frederick A. (A)  
Amick, William M. (A)  
Cooke, Gerald W. (A)  
Cunningham, K. S. (A)  
Del Court, George (A)  
Ellert, Charles A. (A)  
Emmerich, Henry J. S. (A)  
Fallon, Glover P. (A)  
Fetach, Jos. T., Jr. (A)  
Graf, Herman, Jr. (A)  
Hannah, George M. (A)  
Herndon, Landon C. (M)  
Houston, George P. (A)  
Lange, Edward H. (A)  
Leight, Edward R. (A)  
Marshall, Albert E. (A)  
Miller, Purnell J. (A)  
Mullen, Joseph G. (A)  
Banft, William Q. (A)  
Roedell, Leroy W. F. (A)  
Rosso, Thomas (A)  
Seitz, J. Fred (A)  
Sterling, George E. (M)  
Wallgren, Alric E. (A)

Bethesda  
Bush, George P. (M)

Chevy Chase  
Berkner, Lloyd V. (A)  
Dellinger, J. H. (F)

Cumberland  
Sweetzer, Guy H. (A)

Fort Howard  
Wilson, Luther E. (A)

Hyattsville  
Lyon, Harry H. (A)  
Rogers, J. Harris (M)

Silver Spring  
Kuhn, George (A)  
Newell, Lyman T. (A)  
Quaintance, Leland C. (A)

Westminster  
Uts, William C. (A)

MASSACHUSETTS

Allston  
Cook, Wilbert H. (A)  
Pearlstein, Charles D. (A)

Arlington Heights  
Lamson, Horatio W. (M)

Ashmont  
Mullen, Joseph A. (A)

Atlantic  
Heap, Sheldon S. (A)

## Auburndale

Clapp, James K. (M)

Belmont  
Campbell, Winifred H. (A)  
Dolbear, Benjamin L. (M)  
Hughes, A. Morris (A)  
Lane, Henry M. (A)

Beverly  
Appleton, Samuel (A)  
Colby, Edward B. (A)  
Porter, Roland G. (A)  
Woodbury, Stephen E. (A)

Boston  
Abbott, Robert F. (A)  
Beakes, William E. (M)  
Boyden, Davis S. (A)  
Cabot, George E. (A)  
Cumming, L. Gordon (A)  
Edgar, J. Clifton (A)  
Emery, R. C. (A)  
Fowler, Elisha (A)  
Gerber, Nathan (A)  
Jimmy, Norman H. (A)  
Girard, Leon F. (A)  
Goodrich, Robert R. (A)  
Greene, L. C. (A)  
Harris, C. C. (M)  
Hayes, Hammond V. (A)  
Hurd, Volney D. (A)  
Imlach, George (A)  
Jappe, Holger (M)  
Keim, J. D. (A)  
Krikorian, Dickran K. (A)  
Michelman, Edward A. (J)  
Miller, Harold R. (A)  
Murray, Albert F. (M)  
Olmstead, Noel C. (A)  
Parnagian, Aram (A)  
Pitts, Francis D. (A)  
Proctor, John A. (M)  
Putnam, John P. (A)  
Rines, David (A)  
Rosenwald, Edwin D. (A)  
Simpson, Fred H., Jr. (J)  
Smith, Percy De Willard (A)  
Stone, C. W. (A)  
Tanck, Henry (A)  
Whittier, Ellerton W. (A)  
Wigglesworth, Frank (A)  
Winchell, Walter H. (A)

Bradford  
Knowlton, Robert G. (A)

Braintree  
Hanson, Harry (A)  
Robinson, Philip F. (A)

Brighton  
Sylvester, John C. (A)

Brockton  
Wright, William L. (A)

Brookline  
Bowker, Winthrop H. (A)  
Cabot, Sewell (M)  
Campbell, Harold G. (A)  
Corbin, Francis L. (A)  
Nash, Russell K. (A)  
Peckham, J. H. (A)  
Ready, William A. (A)  
Taylor, Theodore (A)  
Weeks, Miles W. (A)

Cambridge  
Baldwin, Preston De Grauw (J)  
Barnes, John L. (A)  
Barrow, W. L. (A)  
Bauer, Paul S. (A)  
Bowles, Edward L. (M)  
Brolly, A. H. (A)  
Burke, Charles T. (M)  
Cavileer, Robert F. (A)

## MASSACHUSETTES (Continued)

## Cambridge (Continued)

Chaffee, E. Leon (F)  
Cormier, Ernest J. (A)  
Chu, Yun (J)  
Cullum, A. Earl (J)  
Eastham, Melville (F)  
Fahnestock, H., Jr. (A)  
Gager, F. Malcolm (A)  
Gleason, Harold H. (A)  
Grant, Lawrence E. (J)  
Horton, J. Warren (A)  
Hsu, C. L. (J)  
Hunt, Frederick V. (A)  
Ide, John M. (J)  
Johnson, Montgomery H., Jr. (J)  
Kennelly, Arthur E. (F)  
Langreth, George L. (A)  
Le Bel, C. J. (A)  
Mc Elroy, Paul K. (M)  
Modrak, Peter (A)  
Phillips, Henry B. (M)  
Pierce, George W. (F)  
Pilkington, Earl J. (A)  
Pratt, P. W. (A)  
Richmond, Harold B. (M)  
Samoiloff, Leon (A)  
Seto, Joe N. (A)  
Shaw, Henry S. (M)  
Shen, Pinlu (A)  
Weare, John (A)  
Weeks, Paul T. (M)  
Wilder, Marshall P. (A)  
Wildes, Karl L. (A)  
Willoughby, John A. (A)  
Woodrow, James A. S. (A)  
Worthen, Charles E. (A)

## Cape Cod

Snow, Albert E. (A)

## Chatham

Chase, Raymond S. (A)  
Erickson, Carl E. (A)  
Robinson, Forrest D. (A)  
Starkweather, Arthur E. (A)  
Weik, Adolf L. (A)  
Woodward, V. M. (A)

## Chathamport

Lee, Walter O. (A)

## Chelsea

Murdock, D. R. W. (A)

## Chestnut Hill

Dellenbaugh, F. S., Jr. (M)

## Chicopee Falls

Andrew, Victor J. (A)  
Kinsman, Warren D. (A)  
Laport, Edmund A. (M)  
Tholstrup, Henry (A)  
Van Niman, Ray T. (A)

## Clifton

Leahy, John E. (A)

## Concord

Hall, Henry D. (A)

## Danvers

Turenne, Wilfred J. (A)

## Dedham

Cowan, Edward J. (A)

## Dennis Port

Skinner, Oscar E. (A)

## Dorchester

Barry, Francis J. (J)  
Chessler, Maxwell A. (A)  
Purseell, Clarence V. (A)

## Dorchester Center

Clarke, Ralph S. (A)

## East Boston

Linmoe, Joseph (A)

## East Pepperell

Hills, Eugene K. (J)

## East Springfield

Batchelder, S. P. (A)  
Coulson, Everett J. (A)  
Henderson, Roy A. (A)  
Hurff, Joseph L. (A)  
Madsen, Carl J. (A)

## East Taunton

Hoard, Norman F. (A)

## Fairhaven

Haydon, Waldo Emerson (J)

## Fall River

Bowen, Harold C. (A)

## Gloucester

Hammond, John Hays, Jr. (M)  
Trenor, Albert D. (A)

## Great Barrington

Barkley, Howard F. (A)

## Greenfield

Bennett, Raymond B. (A)

## Greenwood

Clement, Ivan C. (A)

## Hamilton

Dane, Francis W. (M)

## Haverhill

Taylor, B. H. (A)

## Hingham

Pratt, Fearing (A)

## Hudson

Kaulback, Harold D. (A)

## Jamaica Plain

Mayer, Arthur W. (A)

## Longmeadow

Booth, James D. (A)  
Brackett, Quiney A. (M)  
Coleman, John B. (A)  
Gries, W. Karl (A)  
Phillips, Lloyd B. (A)  
Taylor, Edward C. (A)

## Lowell

Morton, Clarence F. (A)

## Lynn

Abrahams, Samuel L. (A)  
Amato, Peter (A)  
Bailey, W. M. (M)  
Little, Roy S. (A)

## Malden

Millen, James (A)

## Marion

Canfield, N. A. (A)  
Carson, Joseph (J)  
Clifton, B. Stanley Yates (M)

## Mattapan

Hosford, Harold B. (A)  
Weber, Harold C. (A)

## Medford

Cook, Bernard L. (A)  
Greene, C. Francis (A)  
Hartz, Lealie C. (A)  
Wyman, Raymond C. (A)  
Yorks, William R. (A)

## Medford Hillside

Looser, Thomas S. (A)  
Power, Harold J. (M)

## Melrose

Goodwin, Aubrey R. (A)  
Hubbard, Beverly R. (A)  
Jepson, Warren F. (A)  
Philbrick, Lawrence S. (A)

## Mittineague

Sateren, M. G. (A)

## MASSACHUSETTES (Continued)

## New Bedford

Catterall, John (J)  
Hodgdon, Herbert J. (A)  
Pierce, Clyde G. (A)  
Vermilya, Irving (M)

## Newburyport

Hoopes, Thomas T. (A)  
Osgood, George W. (A)  
Scott, Gilbert H. (A)

## Newton

Wilson, Theodore C. (A)

## Newton Center

Miller, William T. (A)  
Pickard, Greenleaf W. (F)

## Newtonville

Stark, Eldon E. (A)

## North Attleboro

Langlois, Gerard L. (A)

## North Cambridge

Grenier, Henry N. (A)

## North Weymouth

Hollis, Hammond H. (A)

## Oak Bluff

Horne, William P. (A)

## Plymouth

McCarty, Laurence (A)

## Revere

Burns, Laurence (A)  
Speirs, George E. (J)

## Rosindale

Van Brocklin, William S. (A)

## Roxbury

Canner, William (J)  
Collins, Lewis R. (A)  
Paley, Albert A. (A)

## Salem

Bolan, Robert S. (A)  
O'Neill, George D. (A)  
Porter, Ralph H. (A)  
Stacey, Frank A. (A)

## Siasconset

Holden, Harry H. (A)

## Silver Lake

Stein, Adam, Jr. (F)

## Somerville

Chatham, Harry R. (M)  
McLaughlin, William P. (A)  
Root, Leland B. (M)  
Trefry, Laurence D. (A)  
Tyzer, Howard J. (A)

## South Boston

Brown, George W. (A)

## Southbridge

Wells, John M. (A)

## South Dartmouth

Chinn, Howard A. (A)  
Goldsmith, Lloyd T. (A)

## Springfield

Bock, Ashley P. (A)  
Burnside, Carroll J. (A)  
Cotter, William F. (A)  
Creaser, Isaiah (A)  
Curtis, Lealie F. (A)  
Der Bedrossyan, Mark (A)  
Dyson, H. R. (A)  
Forbes, Henry C. (A)  
Gilliatt, Leland W. (A)  
Holt, Hillis W. (A)  
Hutcheson, John A. (A)  
Little, Donald G. (M)  
Moauro, Joseph S. (A)  
Neal, Chester T. (A)  
Pettingill, George W., Jr. (A)

Phelps, Roger E. (A)  
Toivonen, Egon O. (A)  
Walker, C. L. (A)  
Wells, Daniel W. (A)

## Swampscott

Humphrey, Stanley M. (A)

## Upham's Corner

Wallace, Gordon S. (A)

## Uzbridge

Kozaczko, Walter H. (J)

## Waban

Church, Vallette S. (A)

## Watertown

Field, Robert F. (A)  
McManus, Cornelius F. (A)

## Wellesley

McDowell, L. S. (M)  
Russell, Robert D. (A)

## Wellesley Farms

Hills, Charles E., Jr. (A)

## Wellesley Hills

Palmer, Harry W. (A)

## West Medford

Stockellburg, A. A. (A)

## West Roxbury

Wolf, Edwin A. (A)

## West Somerville

Ekstrand, Edward B. (J)  
Kolster, Charles C. (M)

## Whitman

Lovell, Webster A. (A)

## Winchester

Allen, Albert (A)  
Browning, Glenn H. (M)  
Burgoyne, Roger M. (A)  
Page, Newell C. (A)

## Winthrop

Colton, Howard C. (J)

## Wollaston

Gray, Alfred R. (A)  
MacAdam, Mark L. (A)  
McGrath, Joseph L. (A)

## Worcester

Adams, Stuart (A)  
Bates, Lee A. (A)  
Gould, Wm. B., 3rd. (A)  
Newell, Hobart H. (A)  
Van Wert, Clayton S. (A)  
Waite, Samuel A. (A)

## MICHIGAN

## Ann Arbor

Beezer, Joseph E. (A)  
Holland Lewis N. (A)  
Katzin, Martin (J)  
Susnich, Eugene W. (A)  
Underwood, O. De Los (A)  
Wullenweber, Milton O. (A)

## Battle Creek

Doty, W. E. (A)  
Roof, Raymond B. (A)

## Bay City

Morse, Louis R. (A)

## Benton Harbor

Miles, K. Walker (A)

## Berrien Springs

Fetzger, John E. (M)

## Birmingham

Stahl, Theodore H. (A)

## Blanchard

Kersey, Russell (A)

## Brighton

Wise, Willard B. (A)

## MICHIGAN (Continued)

## Detroit

Almas, Stan L. (A)  
 Alston, Vernon Charles (A)  
 Annett, Earl (A)  
 Atwood, Warren S. (A)  
 Bailey, Stuart L. (A)  
 Baxter, Chas. E. (A)  
 Berry, Elvin M. (A)  
 Blumenthal, Raymond W. (A)  
 Bobertz, W. E. (A)  
 Brown, Jesse E. (M)  
 Buchanan, Arthur B. (A)  
 Byerlay, H. Le Roy (A)  
 Clark, James E. (A)  
 Clark, Thomas E. (M)  
 Clarke, George R. (A)  
 Collins, Frederick V. (A)  
 Cornwall, James E. (A)  
 Cox, Charles H. (A)  
 Davis, Irving C. (A)  
 Du Bois, Edward P. (J)  
 Earnhart, Glen W. (A)  
 Edwards, Samuel W. (M)  
 Evison, Samuel J. (A)  
 Firestone, Samuel (A)  
 Fisher, J. C. (A)  
 Friedenthal, Andrew (A)  
 Gasparovitch, Stephen (A)  
 Goebel, Eugene S. (A)  
 Griva, John (A)  
 Grove, George A. (A)  
 Grunow, Oscar H. (A)  
 Hoffmann, Walter R. (A)  
 Joy, Henry B. (A)  
 Joyce, Herbert A. (A)  
 Kirby, Corley W. (A)  
 Lathrop, F. A. (A)  
 Lucier, A. J. (A)  
 Mahl, Albert W. (A)  
 Malo, Charles D. (A)  
 Manning, Stanely R. (A)  
 McCaffry, James A. (A)  
 McNary, James C. (M)  
 McWood, Wm. L. (A)  
 Moore, J. Burton (A)  
 Outzen, Andrew N. (A)  
 Owen, Charles W. (J)  
 Putnam, Eric T. (A)  
 Robinson, P. S. (A)  
 Scanlan, Richard J. (A)  
 Schmalzriedt, T. (A)  
 Seielstad, Harold (A)  
 Seymour, Fred M. (A)  
 Simons, Orlin B. (A)  
 Smith, Walter C. (A)  
 Stansfield, Selwyn (J)  
 Swain, Robert R. (A)  
 Taylor, Harold E. (A)  
 Thomas, Walter J. (A)  
 Trittenbach, John M. P. (A)  
 Trowbridge, O. H. (A)  
 Wilber, Delbert J. (A)  
 Worel, Frank (A)

## East Lansing

Ball, I. Dale (A)  
 Graham, Herbert T. (A)  
 Osborn, Burr K. (A)

## Farmington

Kreuzer, A. R. (A)

## Fenton

Dobbs, F. W. (A)

## Ferndale

Harlin, M. F. (A)

## Flint

Blanford, Edwin C. (J)  
 Fallain, Frank D. (A)  
 Forbey, William D. (A)  
 Morgan, Ernest W. (A)  
 Reed, Stanley C. (A)

## Grand Haven

Porter, G. Oliver (A)

## Grand Rapids

Esveld, Clarence D. (A)

## Highland Park

Glatzel, Earle D. (A)  
 Gould, Howard S. (A)

## Jackson

Pacholke, Fred (A)  
 Pickles, Arthur W. (A)  
 Ward, Donald H. (A)  
 Whitlock, Fred (A)

## Lansing

Willis, Ellsworth D. (A)

## Lapcer

Margraf, Frank J. (A)

## Ludington

Lighty, Russell D. (A)

## Menominee

Westervelt, H. P. (A)

## Muskegon

Hewitt, C. Tefft (A)  
 Richardson, A. G. (A)  
 Yoder, Raymond S. (A)

## Muskegon Heights

Wolff, Louis (A)

## Osseo

Lapham, Olin J. (J)

## Pontiac

Courtis, Reginald P. (A)

## Port Huron

Brown, Kenneth L. (A)

## Royal Oak

Miller, Robert L. (A)

## Saginaw

Boyse, Robert E. (A)  
 Elias, Louis W. (A)  
 Hild, George E. (A)  
 Piaszek, Frank (A)  
 Troup, Everett O. (A)

## St. Clair Shores

Osborne, Robert L. (A)

## Trenton

Williamson, Charles G. (A)

## Wyandotte

Morris, Carleton D. (M)  
 Steffin, V. J. (A)

## Ypsilanti

Goodwin, Ernest F. (A)

## MINNESOTA

## Baudette

Gjelhaug, J. A. (A)

## Carver

Olson, Marvin S. (A)

## Chisholm

Ambrozich, John L. (A)

## Duluth

Cosandey, Charles J. (A)  
 Ross, Russell H. (A)

## Edgerton

Rust, Leslie W. (A)

## Elysian

Jarstad, E. O. (A)

## Faribault

Carney, Philip G. (A)

## Hopkins

Fuxa, Albert E. (A)

## Kent

Olson, Martin N. (A)

## Lakefield

Tkach, George (A)

## MINNESOTA (Continued)

## Mapleton

Norgrant, Lawrence A. (J)

## Minneapolis

Anderson, Chester H. (A)  
 Arthur, Guy B., Jr. (A)  
 Comb, David M. (A)  
 Cottam, Dean F. (A)  
 Edwards, Henry W. (A)  
 Gould, Payson R. (J)  
 Hawley, Douglass (A)  
 Hawn, Robert C. (A)  
 Hume, Andrew A. (A)  
 Schnell, Louis J. (A)  
 Smeby, Lynne C. (A)  
 Stevens, Carl T. (A)  
 Sweeney, Claude D. (A)  
 Volkenant, Gordon W. (J)  
 Young, Sumner B. (A)

## Northfield

Culver, Charles A. (M)

## St. Paul

Braaten, Arthur M. (A)  
 Cotton, Richard J. (A)  
 Hance, Kenneth M. (A)  
 Harstad, Harold A. (A)  
 Heiser, Edwin S. (A)  
 Jones, Clinton W. (A)  
 Rankine, James C. (A)

## Virginia

Hauta, Theodore (A)

## Waseca

Johnson, Edgar F. (A)

## Winnebago

Klein, Glen A. (A)

## MISSISSIPPI

## Aberdeen

Moss, W. Hall (A)

## Greenville

Scully, J. Pat (A)

## Hattiesburg

Crews, J. H. (A)

## Meridian

Woodruff, Ben H. (A)

## Utica

Hiar, L. E. (J)

## MISSOURI

## Cape Girardeau

Hirsch, Oscar C. (A)

## Columbia

Lewis, Earl W. (A)

## Hughesville

Riesler, Harold D. (A)

## Independence

Barron, Roy C. (A)  
 Church, Arthur B. (A)  
 Moler, A. R. (A)

## Jefferson

Rawson, Harold R. (A)

## Kansas City

Bielenberg, J. F. G. (A)  
 Boat, John (A)  
 Bradbury, G. V. (A)  
 Cook, Ellis C. (A)  
 Cramer, Wilbur R. (A)  
 Davis, Dudley J. (A)  
 Goldenberg, H. E. (A)  
 Groendycke, Richard W. (A)  
 Kent, James M. (A)  
 Kent, Paul N. (A)  
 Mac Dowell, Earl B. (A)  
 Monfort, Ray A. (J)  
 Pitt, William (A)  
 Schilling, John T. (A)

Schulze, Heri T. (A)  
 Suez, Robert K. W. (J)  
 Williams, Palmer H. (A)  
 Yates, Clarence C. (A)  
 Young, W. M. K. (A)

## Lutesville

Clark, H. A., Jr. (A)

## Moberly

Harl, G. P. (A)

## Rolla

Frame, Floyd H. (A)

## Springfield

Hicks, Kenneth F. (A)  
 Ward, G. Pearson (A)

## St. Joseph

Abercrombie, Julius B. (A)  
 Bauer, Fritz (A)  
 Watts, Harold F. (A)

## St. Louis

Berest, Anton (A)  
 Browning, Roy H. (A)  
 Corwin, Willis P. (A)  
 Croxton, Galen B. (A)  
 Fenton, William C. (A)  
 Fillmore, Francis A. (J)  
 Fowler, D. W. (A)  
 Fritz, Harry R. (A)  
 Garvey, Arthur (A)  
 Glasgow, Roy S. (M)  
 Henric, Edward F. (A)  
 Hoek, Kurt J. (A)  
 McDaniel, Otto S. (A)  
 Montgomery, Martell (A)  
 Nugent, Thomas (A)  
 Pingree, Samuel J. (A)  
 Quinby, Porter H. (A)  
 Settle, Herbert B. (A)  
 Van Sickle, George W. (A)  
 West, William H. (A)  
 Zehr, Nicholas J. (A)

## MONTANA

## Anaconda

Horsfall, James R. (A)

## Bozeman

Crouter, Leslie E. (A)  
 Murray, William A. (A)

## Havre

Peters, Vern (A)  
 Shum, J. Merrill (A)

## Moorhead

Moore, Charles A. (A)

## NEBRASKA

## Alliance

Cox, Ralph V. (A)

## Aurora

Spencer, Albert H. (A)

## Clay Center

Hertel, Roger H. (J)  
 Kotera, William J. (A)  
 Rohwer, Paul C. (A)

## Howells

Fruch, Ernest F. (A)

## Lincoln

Dunning, John R. (A)  
 Jensen, John C. (M)  
 Weldon, James O. (A)

## Norfolk

Leeman, Wilson (A)

## Omaha

Badgerow, Bert E. (J)  
 Chansky, Lou W. (A)  
 Crawford, J. B. (A)  
 Diehl, Charles B. (A)  
 Eaton, Waldo W. (A)

## NEBRASKA (Continued)

## Omaha (Continued)

Fetterman, D. M. (J)  
 Franke, Chas. A. (A)  
 Henry, Gordon I. (J)  
 Hughes, S. B. (A)  
 McIntosh, Frank H. (A)  
 Phillips, Elmo W. (A)  
 Rimmerman, Clyde O. (A)  
 Shirk, Kenneth C. (A)  
 Stultz, Earl D. (J)  
 Thompson, Harry E. (A)

## NEW HAMPSHIRE

## Gorham

Dodge, Joseph B. (A)

## Manchester

Ryan, M. John (A)

## Portsmouth

Martin, Julius (M)

## Sunapee

Graves, William S. (A)

## NEW JERSEY

## Allenhurst

Lewis, Harold M. (M)

## Ampere

Corbett, Walter E. (A)  
 Powers, Walter P. (M)

## Asbury Park

Mallon, William H. (A)  
 Strausman, Arnold D. (J)

## Atlantic City

Flett, William J. (A)  
 Riser, Morris (A)

## Audubon

Fisher, Norman (A)

## Bayonne

Dillenbeck, Preston V. D. (A)  
 Rogers, George White (A)

## Belleville

Clegg, Edward B. (A)

## Bergenfield

O'Connor, Mort F. (A)

## Bloomfield

Born, W. Theodore (A)  
 Colby, Charles C., Jr. (A)  
 Donovan, Daniel R. (A)  
 Hanson, Ernest R. (A)  
 Hoffman, Henry J. (A)  
 Kannenstine, Fabian M. (A)  
 Koechel, W. P. (A)  
 Mitchell, Clair D. (M)  
 Newell, Guy (A)  
 Peck, Gordon V. (A)  
 Schoene, Russell L. (A)  
 Taber, William T. (A)  
 Widell, E. Gideon (M)

## Boonton

Albert, Wm. H. (A)  
 Ballantine, Stuart (F)  
 Drake, Frederick H. (M)  
 Ferris, Malcolm (A)  
 Haas, John G. (A)  
 Hughes, Everett, J. (A)  
 Hull, L. M. (F)  
 Pittenger, Arthur W. (A)  
 Seabury, Richard W. (M)  
 Snow, Harold A. (A)

## Bound Brook

Hagmann, Niklaus (A)  
 Lindstrom, Arthur J. (A)  
 Stair, Daniel N. (A)

## Bradley Beach

Schafer, J. Peter (A)

## Caldwell

Cole, Arthur B. (M)

Eberhard, Lawrence E. (A)  
 Jacobs, Louis (A)  
 Wheeler, C. M. (A)

## Camden

Cooley, Elihu H. (A)  
 Darlington, Edgar T. (A)  
 Gray, J. Calvin (A)  
 Mkitarian, Luther M. (A)  
 Reesor, Delbert A. (A)  
 Spencer, George (A)

## Chatham

De Coutouly, Gustave C. (A)

## Clifton

Pearl, Eugene S. (M)  
 Watts, Ivor B. (J)

## Cliffwood

Feldman, Carl B. (A)  
 Jansky, Karl G. (A)  
 Lowry, Lewis R. (A)  
 Mutch, W. W. (A)  
 Sharpless, William M. (A)

## Clinton

Wagner, Harry S. (A)

## Coytesville

Vecchio, Ferdinand (A)

## Deal

Eberhardt, George M. (A)  
 Ferrell, Enoch B. (A)  
 Roe, Chas. F. P. (A)  
 Schlaack, Norman F. (A)  
 Sterba, E. J. (A)

## Denville

Harlan, Edwin W. (A)

## East Orange

Ackerman, Rudolph W. (M)  
 Akers, Dallas C. (A)  
 Biedleman, Howard B. (A)  
 Brach, Leon S. (A)  
 Brigham, Cecil E. (A)  
 Brigham, Cyril A. (A)  
 Clarry, Harold E. (A)  
 Corwin, Alfred H. (A)  
 Crom, George C., Jr. (M)  
 Curtis, Austen M. (M)  
 Davis, Nathan A. (A)  
 Derrick, William M. (A)  
 Duncan, R. D., Jr. (M)  
 Edison, Theodore M. (A)  
 Fay, Clifford E. (A)  
 Gawler, Henry C. (M)  
 Harris, Sylvan (M)  
 Hiller, Harry E. (A)  
 Holborn, Frederick (M)  
 Israel, John O. (A)  
 Jackson, Donald S. (J)  
 Kober, Paul A. (A)  
 Lederer, Ernest A. (M)  
 McClary, James P. (A)  
 Miller, H. P. (M)  
 O'Donohue, James P. (A)  
 Perry, Irving D. (A)  
 Rowe, Charles R. (M)  
 Rudebeck, Everett L. (A)  
 Shackelford, Benjamin E. (M)  
 Spencer, Millard C. (A)  
 Stanwick, Charles A. (A)  
 Townier, Orrin W. (A)  
 Trogner, Arthur M. (M)

## Elberon

Wisner, Victor (A)

## Elizabeth

Brick, Frank R., Jr. (M)  
 Crowley, David A. (A)  
 Horning, Louis P., Jr. (A)  
 Jatlow, J. L. (A)  
 Kellam, Clark J. (A)  
 Mazik, John, Jr. (A)  
 Morris, Robert M. (A)

## NEW JERSEY (Continued)

## Elizabeth (Continued)

Morrow, Granville P. (A)  
 Pulley, Lester A. (A)  
 Schiffl, Frank (A)  
 Sery, Lester (A)  
 Tucker, John, Jr. (A)  
 Walsh, Lincoln (A)  
 White, Charles P. (A)

## Englewood

Ashton, John E. (J)  
 Emanuel, John H. (A)  
 Gillett, Glenn D. (M)  
 Prosser, Roger D. (A)

## Essex Fells

Bernhard, Frederick S. (A)

## Fanwood

Hall, Clifford A. (A)  
 Todd, Harold C. (A)

## Fort Monmouth

Black, Garland C. (A)  
 Conrad, Victor A. (A)

## Franklin

Tillson, Benjamin F. (M)

## Freehold

Englund, Carl R. (F)

## Glen Ridge

Cunliffe, Paul R. (A)  
 Dart, Harry F. (M)  
 Scherer, Wilfred M. (A)  
 Umbach, Walter R. (A)

## Glen Rock

Bailey, Ralph G. (A)  
 Clark, Louis E. (A)

## Grantwood

Dana, David W. (A)  
 Williams, John C. (A)

## Great Notch

Warner, Herbert M. (A)

## Hackettstown

Mitchell, George G., Jr. (A)

## Haddonfield

Fithian, William S. (A)  
 Thomas, Harry E. (A)

## Hasbrouck Heights

Baker, Neil D. (A)  
 Beach, Chester L. (A)

## Hillside

McCauley, John H. (A)

## Hoboken

Gorton, Roland E. (A)  
 Izzo, Anthony (A)  
 McDonald, William A. (M)  
 Paulding, Herbert L. (A)  
 Pressley, Jackson H. (A)  
 Roters, Herbert C. (A)  
 Seid, Fred C. (A)  
 Stempel, Waldemar M. (A)

## Irvington

Fread, Harold (A)  
 Metzger, Henry G. (A)  
 Momino, Ernest J. (A)  
 Mortimer, Harry H. (A)  
 Wein, Hans A. (A)

## Jersey City

Bremer, Frank V. (A)  
 Bremer, Harry A. (A)  
 Carlewitz, Emil Walter (J)  
 Drews, Ernest (J)  
 Edelbach, Ralph L. (A)  
 Goodwin, Robert F. (A)  
 Gouatin, Joseph (A)  
 Hanks, Alfred J. (A)  
 Holmes, George R. (A)  
 Johnson, Kenneth S. (M)  
 Odenbach, Joseph F. (A)

Oliver, George E. (M)  
 Palmer C. Walter (A)  
 Scarr, Henry F. (A)  
 Shanton, Harry A. (A)  
 Sullivan, S. Edward (A)  
 Walker, C. Robert (A)

## Leonia

Erickson, Herman E. (A)  
 Mustermann, H. G. A. (A)

## Linden

Newall, Benjamin E. (A)

## Little Silver

Ohl, Russell S. (M)

## Long Branch

Reinhart, Sidney M. (A)  
 Watson, Paul E. (A)

## Lyndhurst

Kannenber, Walter F. (A)  
 MacDowell, Theron W. (A)

## Madison

Manning, Charles T. (M)  
 Phelps, Walter A. (A)

## Maplewood

Bohn, William C. (A)  
 Courter, Giles H. (A)  
 Cunningham, Frederick W. (M)  
 Darrow, Leo H. (A)  
 Osmun, John H. (A)  
 Strassner, Frank J. (A)  
 Trube, Carl E. (A)

## Maywood

Stantley, J. J. (M)

## McKee City

Read, George T. (A)

## Merchantville

Patterson, Edward B. (A)

## Metuchen

Bohlke, W. Hollander (A)

## Milburn

Cassedy, William F., Jr. (A)  
 Schauler, Vincent A. (A)

## Montclair

Bogardus, Henry L. (M)  
 De Long, Oscar A., Jr. (A)  
 Hervey, John P. (A)  
 Krahl, Walter L. (M)

## Morristown

Poole, Robert J. (A)

## Mountain Lakes

Asserson, Raymond (M)  
 Flannagan, Coke (M)

## Netcong

Mack, Paul (A)

## Newark

Barnes, T. Dana (A)  
 Bennett, Robert W., Jr. (A)  
 Bliziotis, George E. (M)  
 Carle, Nathaniel A. (A)  
 Collins, John (A)  
 Dannals, Earl W. (M)  
 Doleah, Frank J. (A)  
 Fink, William D. (A)  
 Frost, Herbert H. (A)  
 Gardner, Francis S. (A)  
 Glauber, John J. (A)  
 Goodwin, W. Nelson, Jr. (A)  
 Gundrum, Edward (A)  
 Hall, Norman C. (A)  
 Hooven, Morris D. (A)  
 Kahn, Frederick J. (M)  
 Lewis, George H. (M)  
 Lubinsky, Herman (A)  
 McCrea, M. Walter (A)  
 Meacham, J. F. B. (A)  
 O'Dowd, Thomas E. (A)



## NEW JERSEY (Continued)

## Newark (Continued)

Schermerhorn, J. L. (A)  
Schiffenhaus, Daniel H. (A)  
Schmidt, Joseph H. (A)  
Scholz, Carl E. (M)  
Scott, Walter F. (A)  
Seis, Hollis K. (A)  
Sternberg, F. B. (A)  
Valentine, Russell D. (A)

## New Brunswick

Cumming, Kenneth N. (M)  
Freedman, William H. (A)  
Ruckle, Ernest G. (A)  
Ward, Donald G. (A)

## North Bergen

Pristas, John E. (A)  
Wichern, Leonard (A)

## Oceanport

Corderman, William P. (A)  
Murphy, William H. (M)

## Oradell

Brackett, Harold H. (A)  
De Lime, Thomas L., Jr. (A)

## Orange

Hardwick, Ambrose H. (A)  
Miller, Walter H. (A)  
Powell, Ralph C., Jr. (A)  
Rypinski, Maurice C. (M)  
Seifried, Aiden E. (A)

## Passaic

Berger, Henry C. (A)  
Weinberg, Isaac (A)

## Paterson

Coddington, Raymond L. (A)  
Gold, Herman (A)  
Hogencamp, Harold C. (A)  
Kennedy, Arthur (A)

## Plainfield

Neilsen, H. V. (A)  
Oscanyan, Paul C., Jr. (A)

## Princeton

Roberts, W. Van B. (A)  
Ware, Paul (A)

## Rahway

Gibson, Robert D. (A)

## Red Bank

Applegate, William M. (A)  
Bruce, Edmond (A)

## Ridgefield Park

Pearce, Arthur (A)

## Ridgewood

Affel, Herman A. (A)  
Engel, G. C. (A)  
Felix, Edgar (M)  
Obrig, James H. (A)  
Smith, Theodore A. (A)

## Riverdale

Underhill, Charles R., Jr. (A)

## River Edge

Higson, Albert J. (A)

## Riverton

Ehle, Francis R. (A)

## Rockaway

Wilby, Howard M. (M)

## Roselle

Guber, Fred H. (A)

## Roselle Park

Edwards, Joseph B. (A)  
McNicol, Donald (F)  
Steiner, Melvin C. (A)

## Rumson

Friis, H. T. (M)

## Rutherford

Carrougher, V. Attwood (A)

Gage, David H. (M)  
Jackson, Benjamin B. (A)  
Moorhead, George H. (A)  
Sargeant, Charles E. (A)

## South Orange

Field, W. Thayer (A)  
Hartley, Ralph V. L. (F)  
Leeb, Henry L. (M)  
Snook, H. Clyde (M)  
Walsh, Arthur L. (A)

## Summit

Biele, Charles E. (A)  
Fairchild, F. Earl (A)

## Tenafly

Mallory, Edward B. (M)

## Trenton

Burroughs, Irving D. (A)  
Frost, H. B. (A)  
Kale, Samuel S. (A)  
Knowles, Edward P. (A)  
Raser, Edward G. (A)  
Wentzel, Amandus, Jr. (A)

## Union

Sommer, Emmitt H. (A)

## Union City

Erhard, John Allen (A)  
Lilienthal, F. C. (A)

## Upper Merion

Glenn, Earl R. (A)  
Godley, Paul F. (A)  
Hallborg, H. E. (F)  
Versfelt, Emery L. (A)

## Weehawken

Girard, E. J. (A)  
Gruenberg, Edwin L. (A)  
Smith, Arthur E. (A)

## West Caldwell

Willis, Frederick C. (A)

## West Collingswood

Wunderlich, Norman E. (M)

## Westfield

Coxhead, Harry B. (M)  
Dolan, George C. (A)  
Phillips, Leo E. (A)

## West Long Branch

Burrows, Charles R. (A)

## West New York

Herbst, John A. (A)  
Machiorietti, Louis (A)  
Schoenfeld, K. (A)

## West Orange

Gordon, George (A)  
Tucker, Murray E. (A)

## Woodcliff-on-Hudson

King, William L. (A)  
Walsh, A. L. (A)

## NEW MEXICO

## Albuquerque

Stone, C. D. (A)

## Fort Bayard

Coumbe, Joel B. H. (A)

## Raton

Abshere, Lilburn O. (A)

## State College

Goddard, Ralph W. (M)

## NEW YORK

## Albany

Compton, Ogden B. (A)  
Corey, James H. (A)  
Kaiser, Fred J. (A)  
Mezger, George (A)  
Peck, Emerson P. (A)  
Pozefsky, Leonard (A)  
Skinkle, Myron H., Jr. (A)  
Thomas, Joseph D. (A)

## NEW YORK (Continued)

## Albion

Yahnke, William J. (A)

## Angola

Clark, Charles W. (A)

## Ardsley

Boise, Everett B. (A)

## Astoria, L. I.

Anderson, J. E. (A)  
Bostad, John (A)  
Busch, Hugo W. (A)  
Greene, George J. (A)  
Greene, Harry A. (A)  
Gritaner, Fred A. (A)  
Gunther, Frank A. (A)  
Leslie, Frank (A)  
Mandell, Benjamin F. (J)  
Martin, Louis (A)  
Nagy, A. Wheeler (A)  
Reynolds, John L. (A)  
Schramm, William (A)  
Shen, P. L. (A)  
Toepel, Walter A. (A)

## Babylon, L. I.

Smith, J. O. (M)

## Baldwin, L. I.

Fox, Florian J. (A)  
Stewart, G. Edwin (A)

## Bath

Loveless, Lawrence M. (A)

## Bayside, L. I.

Babcock, Wallace C. (A)  
Troxler, Lucien J., Jr. (A)

## Bellair, L. I.

Brennan, John B., Jr. (A)

## Bellerose, L. I.

Speicher, John D. (A)

## Bellmore, L. I.

Brown, William A. R. (A)  
Himoe, Clifford E. (A)  
Wright, Marshall C. (A)

## Binghamton

Adams, William E. (A)  
Hall, Victor E. (A)

## Brightwaters, L. I.

Camp, V. F. (A)

## Bronxville

Kelly, C. Merrill, Jr. (A)  
Weeden, William N. (A)

## Brooklyn

Abraham, Irving (A)  
Adachi, William Y. (A)  
Aymar, Erwin (A)  
Bartal, Otto (A)  
Bartofsky, Harry (A)  
Baum, Sydney H. (A)  
Baunach, Edward L. (J)  
Bazley, Paul B. (A)  
Bernard, Herman (A)  
Betts, Frederick H. (A)  
Borislavsky, Michael A. (A)  
Brandt, Kristian (A)  
Brimberg, Isaac (A)  
Bristow, Frederick R. (A)  
Browne, Walram S. (A)  
Byran, Herman W. (A)  
Bullock, Walter H. (A)  
Burdick, Adelbert B. (A)  
Burns, George D. (A)  
Callahan, John L. (A)  
Calligheris, John S. (A)  
Canavaciol, Frank E. (A)  
Carroll, James H. (A)  
Castor, Amasa H. (A)  
Clark, Paul L. (A)  
Coe, Alfred (A)  
Cohen, Samuel (M)  
Cole, Fred S. (A)  
Coles, Arthur, Jr. (A)  
Consoli, Vincent (A)  
Cook, Arthur L. (A)  
Crowell, Claude S. (A)  
De Man William (J)  
De Martino, Michael W. (A)  
Densham, Robert S. (A)  
Disser, William G. (J)  
Dobler, William (A)  
Dolid, Abraham (A)  
Domes, Morris M. (A)  
Dummett, H. W. (A)  
Dunn, Lawrence J. (M)  
Duryea, Earle K. (A)  
Ellingham, Irving (A)  
Evans, Porter H. (M)  
Ferrotta, Joseph L. (A)  
Fiala, Anthony, Jr. (A)  
Fishberg, Sidney (A)  
Fogel, Mortimer H. (J)  
Fultz, Miles E. (A)  
Gabel, Morris (J)  
Garity, William E. (M)  
Geloso, John (A)  
Gereh, Alexander (A)  
Gillule, William J. (A)  
Glaser, Edward M. (A)  
Glaser, Marcus (A)  
Glasscock, Glen R. (A)  
Goddard, Frederick M. (A)  
Goldberg, Emanuel (A)  
Gruetzke, Charles P. E. (A)  
Hadden, Weston (A)  
Hajim, Jack (A)  
Hakam, Samuel (A)  
Halligan, Clair W. (A)  
Harris, Leonard F. (A)  
Hausmann, Erich (M)  
Herman, Joseph M. (A)  
Hewlett, Oscar H., Jr. (A)  
Heymann, Joseph (A)  
Hillebrand, Henry G. (A)  
Hines, Joseph (A)  
Hoefler, R. L. (A)  
Holland, Jesse W. (A)  
Hughes, William P., Jr. (A)  
Husted, Donald R. (A)  
Inskip, Leonard S. (A)  
Isaacson, Herbert M. (A)  
Jepson, Milton W. (J)  
Jipp, John (A)  
Joffe, Moe (A)  
Kaplan, Hyman H. (A)  
Kasner, Henry P. (A)  
Kayser, Herbert (A)  
Kennedy, Harold E. (A)  
Kieran, P. J. (A)  
Kirchner, Henry (J)  
Knight, Harold E. H. (A)  
Kolo, R. E. (A)  
Krivan, Fred A. (A)  
Lefferts, B. (A)  
Le Queane, Chas. A. (A)  
Leuteritz, Hugo C. (A)  
Le Viness, J. E. (A)  
Lieberman, Henry C. (A)  
Liebner, Barney (J)  
Luasier, Elphego Achille (A)  
Maher, James F. J. (M)  
Mahoney, Joseph N. (M)  
Marriott, Robert H. (F)  
Marsten, Jesse (M)  
Melvin, George E. (A)  
Meyer, Herman (A)  
Mickelson, C. D. (A)  
Milanico, Clarence (A)  
Miller, Le Roy J. (A)  
Moore, Henry H. (A)

## NEW YORK (Continued)

## Brooklyn (Continued)

Morehouse, Raymond L. (A)  
 Morro, Jack J. (A)  
 Nassy, Josef (A)  
 Osgood, Victor L. (A)  
 Ostrove, William (A)  
 Painting, John A. (A)  
 Parker, Oliver B. (A)  
 Pearson, Herbert B. (A)  
 Pease, Reginald M. (M)  
 Perry, Harold D. (A)  
 Pillsbury, Edward B. (A)  
 Redfern, Forest F. (A)  
 Reimer, August Charles (A)  
 Riccobono, Sebastian (A)  
 Ringel, Abraham (M)  
 Ripper, R. Oliver (J)  
 Rodgers, E. J. (A)  
 Rosenbaum, Jacob (J)  
 Ross, Uda B. (M)  
 Roth, Jesse E. (A)  
 Rubin, Herbert E. (A)  
 Salzman, David (A)  
 Scanlon, Dale L. (A)  
 Schenke, Kurtiss P. (A)  
 Schick, William H. (A)  
 Schlossberg, Morris (A)  
 Schwarzhaupt, Paul J. (M)  
 Secan, Harry (A)  
 Shaffer, Irving R. (A)  
 Shestacovsky, John (A)  
 Shortland, James W. (A)  
 Siegel, Ralph (A)  
 Siegel, Samuel (M)  
 Silver, Benjamin L. (A)  
 Sinreich, Nathan (A)  
 Sinabeimer, Arthur (A)  
 Slater, Saul I. (A)  
 Smith, Franklin S. (A)  
 Starr, Alfred R. (A)  
 Starrett, John S. (A)  
 Steinberger, Louis (M)  
 Stobbe, John A. (A)  
 Talley, David (A)  
 Thomas, Howard H. (A)  
 Trott, Barnett (A)  
 Tucker, Robert A. (A)  
 Tuckerman, Lucien P. (A)  
 Usmann, George J. (M)  
 Vogel, Erwin M. (A)  
 Wardwell, Arthur S. (A)  
 Weber, Paul (A)  
 Webster, Frank E. (A)  
 Welker, Paul L. (A)  
 White, Milton (A)  
 White, Phillip S. (A)  
 Wing, Arthur K., Jr. (J)  
 Wormald, Robert, Jr. (A)  
 Wynne, Walter M. (A)  
 Young, Harold H. (A)

## Buffalo

Barker, H. T. (A)  
 Bentler, Sherwood J. (A)  
 Beyer, Glen R. (A)  
 Deane, Harold A. (A)  
 Dickinson, Alfred H. (A)  
 Donlon, Beinhart J. (A)  
 Eichman, John, Jr. (A)  
 Flutka, Ralph M. (A)  
 Fox, Leon J. (A)  
 Fox, Reginald A. (A)  
 Gail, Preston C. (A)  
 Gallagher, Edward M. (A)  
 Gensler, Edward J., Jr. (A)  
 Hector, L. Grant (A)  
 Hedtke, Edward (A)  
 Hemedinger, Willard (A)  
 Hobbs, Frank B. (A)  
 Hoffman, Joseph (J)  
 Horle, Lawrence C. F. (F)

Huntsinger, F. J. (A)  
 Johnson, James A. (A)  
 Jones, Walter R. (A)  
 Kisker, Lawrence J. (A)  
 Knowlton, Eugene W. (A)  
 Lanmon, Maurice C. (A)  
 Lewis, John C. P. (A)  
 Lounsbury, Isaac R., Jr. (M)  
 MacNish, R. B. (A)  
 March, Philip S. (A)  
 Maxwell, George G. (A)  
 Mengle, Harold B. (A)  
 Miller, Carl (A)  
 Miller, George H. (A)  
 Miller, John G. C. (A)  
 Moore, Chas. G. (A)  
 Morley, William L. (A)  
 Mullett, Charles B. (A)  
 Nauth, Raymond (A)  
 Nichols, Raymond D. (A)  
 Noel, Lionel S. (A)  
 Nowak, Victor V. (A)  
 Patey, Harold W. (A)  
 Peters, Albert (A)  
 Racke, Clarence (A)  
 Reinhard, Melvin C. (A)  
 Richmond, L. P. (A)  
 Roberts, Alfred E. (A)  
 Root, Harry (A)  
 Schelling, Robert F. (A)  
 Schwedt, Milton C. (A)  
 Simpson, Burton T. (A)  
 Smith, Howard J. (A)  
 Smith, Hugo C. (A)  
 Stanko, Edward (A)  
 Stevens, Harvey A. (A)  
 Stone, G. Edgar (A)  
 Telaar, Theodore J. (A)  
 Vanacore, Thomas (A)  
 Van Benschoten, Walter (A)  
 Voorhaar, Frederick R. (A)  
 Wagener, W. Hall (A)  
 Waud, Eugene C. (A)  
 Welsher, Carl E. (A)

Canandaigua  
 Long, John J., Jr. (A)  
 Thompson, John M. (A)

Canton  
 Priest, Ward C. (A)

Carmel  
 Light, Frank B. (A)

Central Valley  
 Reynolds, Edward F. (A)

C. G. Pier 18, S. I.  
 Hagen, Edward J. (J)

Coney Island  
 Lewis, Robert V. W. (A)

Corning  
 Gage, E. Phelps (A)

Corona, L. I.  
 Minde, Charles L. (J)  
 Solari, Frank (A)

Croton-on-Hudson  
 Lescarboursa, Austin C. (M)

Dongan Hills, S. I.  
 Simons, C. Dewey, 3rd. (A)

Douglas Manor, L. I.  
 Weagant, Roy A. (F)

Dover Plains  
 Pleasanton, Archie W. (A)

East Rochester  
 Lucia, Raymond H. (A)

East Rockaway, L. I.  
 Van Duyne, Eugene D. (A)

Edgemere, L. I.  
 Carduner, William (A)

## NEW YORK (Continued)

Elmhurst, L. I.  
 Banks, Adrian C. (A)  
 Eckweiler, George A. (A)  
 Eckweller, Warren M., Jr. (A)  
 Freeman, Edward E. (M)  
 Wics, Jens A. (A)

Elmira  
 Dow, M. Thornton (A)

Farmingdale, L. I.  
 McGuirk, F. W. (A)

Far Rockaway, L. I.  
 Sharp, Watkin W. (A)

Flushing, L. I.  
 Dreisbach, Robert H. (A)  
 Flory, Carl L. (A)  
 Harvey, Clyde C. (A)  
 Scofield, Robert W. (A)  
 Van Sieten, Andrew H. (A)

Forest Hills, L. I.  
 Betwinek, Jack L. (A)  
 Bonanno, Joseph L. (A)  
 Goodwin, W. Carlyle (A)  
 Underhill, Charles R. (A)  
 Waring, Alfred (A)

Freeport, L. I.  
 Barone, Salvatore A. (A)  
 O'Neill, John J. (A)

Garden City, L. I.  
 Henney, Julian K. (M)  
 Wing, Willis K. (M)

Geneva  
 Biles, Frank V. (A)

Glen Cove, L. I.  
 Coles, Robert E. (J)

Glendale, L. I.  
 Meagher, Thomas F. (A)

Grasmere, S. I.  
 Grimes, David (M)

Great Neck, L. I.  
 Rigney, Douglas (M)

Hamburg  
 Hartloff, Gordon S. (A)

Hamilton  
 Dowd, Alfred (J)

Harrison  
 Loscalzo, Peter A. (A)

Hempstead, L. I.  
 Crane, Edwin S. (A)  
 Kent, Stephen F. (A)

Hempstead Gardens, L. I.  
 Clayton, John M. (M)

Hollis, L. I.  
 Batcher, Ralph R. (M)  
 Caputo, Nicholas J. (A)  
 Ehlert, Fred C. (A)  
 Hotopp, Alfred H., Jr. (M)  
 Ma Dan, Edwin M. (M)  
 Srebroff, Charles M. (M)

Huntington Station, L. I.  
 Flathman, Edward (J)

Hurley  
 Warren, William A. (A)

Ithaca  
 Ballard, William C. (M)  
 Merritt, Ernest (M)  
 Meserve, Wilbur E. (A)  
 Reich, Herbert J. (A)  
 Schuetz, Robert F. (A)  
 Smith, Lloyd P. (A)  
 Schon, Harry (A)  
 Van Heiningen, Willard A. (J)  
 Verman, Lal C. (A)  
 Webb, J. S. (A)

Jackson Heights, L. I.  
 Wheeler, Harold A. (M)

## Jamaica, L. I.

Albert, Michael M. (A)  
 Frey, Robert H. (A)  
 Phelps, Boyd (A)  
 Pleasanton, Douglas W. (J)  
 Schwartz, Nathan (A)  
 Steinberger, Arthur W. (A)  
 Sterns, Morton W. (M)  
 Styles, T. J. (A)  
 Voight, George (J)

## Kenmore

Henderson, Kenneth L. (A)  
 Horton, Clarence J. (A)  
 Miers, Floyd (A)  
 Patterson, Curtis B. (J)

## Kew Gardens, L. I.

Montgomery, A. Peers (A)

## Larchmont

Nilson, Arthur R. (M)  
 Van Blaricom, Millard (A)

## Liberty

Mauer, William V. (A)

## Little Neck, L. I.

Di Basi, John (M)  
 Schultes, Martin F. (A)  
 Uehling, Edwin A. (A)

## Long Island City, L. I.

Briggs, Perry O. (A)  
 Clement, Lewis M. (F)  
 Farrand, C. L. (M)  
 Field, John (A)  
 Geise, Harold (A)  
 Hanson, Oscar B. (M)  
 Harrison, Perry (A)  
 Leutz, Charles R. (A)  
 Rettenmeyer, Francis X. (A)  
 Strook, Reeve O. (A)  
 Tureki, Arthur Z. (A)  
 Tuttle, Clarence W. (A)

## Lybrook, L. I.

Fedotoff, Nicholas V. (A)  
 Shaw, James (J)

## Mamaroneck

Annucci, Louis M. (A)  
 Boucheron, Pierre H. (M)  
 Jarabin, Frank G. (A)

## Maspeth, L. I.

Bennett, Jack (A)

## Middletown

Callender Edwin R. (A)  
 Fish, Edward H. (A)

## Milton-on Hudson

Taber, C. Kenneth (A)

## Monroe

Morse, Arthur H. (M)

## Mt. Vernon

Dickely, Fred C. (A)  
 Houck, Harry W. (M)  
 Muhleman, M. L. (A)  
 Stone, Clarence G., Jr. (A)

## New City

Doellner, Le Roy J. (A)

## New Rochelle

Dubilier, William (M)  
 Herbert, Harold R. (M)

## New York City

Adams, Ira J. (M)  
 Adams, Quinton (M)  
 Adams, Robert M. (A)  
 Aiken, Charles B. P. (A)  
 Aikens, Andrew J. (A)  
 Alderman, Lawrence T. (A)  
 Alexander, Louis (A)

## NEW YORK (Continued)

## New York City (Continued)

Allyn, R. S. (A)  
 Almqvist, Milton L. (A)  
 Alpern, Dwight K. (A)  
 Amy, Ernest V. (M)  
 Anderson, Clifford N. (A)  
 Anderson, Edwin C. (A)  
 Anderson, Pierson A. (M)  
 Anderson, Sidney E. (A)  
 Andrews, Joseph F. (M)  
 Armstrong, Edwin H. (F)  
 Arpa, Mervin W. (M)  
 Ashbaugh, Edwin C. (A)  
 Aster, Alvin K. (A)  
 Aull, Wilson, Jr. (M)  
 Bailey, Arnold B. (A)  
 Bailey, Austin (M)  
 Bair, Ralph S. (A)  
 Baker, Brothwell H. (A)  
 Batcheller, Arthur (M)  
 Baukat, Henry W. (A)  
 Bayles, Joseph (A)  
 Behner, Herbert C. (M)  
 Beltrani, Americo (A)  
 Beltz, Willis H. (A)  
 Bemis, Edwin W. (A)  
 Bender, Martin, Jr. (A)  
 Berger, Maurice (M)  
 Berman, Harold (A)  
 Bernstein, P. (J)  
 Berry, James L. (A)  
 Beshgetoor, Ray V. (A)  
 Betts, Philander H. (A)  
 Beverage, Harold H. (F)  
 Binns, John R. (A)  
 Biehoff, Charles F. (A)  
 Bishop, Nathaniel (A)  
 Black, Oliver M. (A)  
 Blackmar, Abel E., Jr. (A)  
 Blackwell, Otto B. (F)  
 Blenheim, William J. (M)  
 Boehme, H. O. (M)  
 Bonell, Ralph K. (A)  
 Bonett, David J. (A)  
 Bouck, Zeh (M)  
 Boughton, Fred W., Jr. (A)  
 Bown, Ralph (F)  
 Braden, Rene A. (A)  
 Brennecke, Cornelius (A)  
 Bril, Jack (A)  
 Brown, Charles J. (A)  
 Brown, D. S. (A)  
 Bruggeman, John T. (J)  
 Brunet, Meade (M)  
 Bruno, Theodore P. (A)  
 Bucher, E. E. (M)  
 Buckley, Boyton E. (A)  
 Bullard, William R. (A)  
 Bunting, Theodore R. (A)  
 Burghard, G. E. (M)  
 Burnside, James H. (A)  
 Busch, Gus A. (A)  
 Butterfield, Charles E. (A)  
 Buttner, Harold H. (M)  
 Campbell, John A. (A)  
 Carleton, Thomas F. (J)  
 Carson, John R. (M)  
 Chaffee, Joseph G. (A)  
 Chernow, Morris (A)  
 Chu, Quong Y. (J)  
 Clark, Baynard H. (A)  
 Clausen, H. P. (A)  
 Cochran, Eugene C. (A)  
 Cockaday, Laurence M. (A)  
 Coggeshall, Ivan S. (A)  
 Colpitta, Edwin H. (F)  
 Cooper, C. B. (A)  
 Cooper, Orville T. (A)  
 Cornwell, Lionel B. (A)  
 Corwin, Charles I. (A)

Cousins, Van Meter (A)  
 Cox, Lloyd V. (A)  
 Craft, E. B. (F)  
 Crite, Mitchel (A)  
 Crosby, George L. (M)  
 Cunningham, H. C. (A)  
 Currier, Guy, Jr. (A)  
 Curry, Walter A. (A)  
 Cutting, Fulton (F)  
 Danziger, Harold I. (A)  
 Davis, Robert J. (A)  
 Deakin, Gerald (A)  
 Dean, Samuel W. (M)  
 De Forest, M. J. (A)  
 Dehmel, Richard C. (A)  
 Della Corte, Joseph P. (A)  
 Demarest, Charles S. (M)  
 De Mello, William (A)  
 Desnoes, Arnold B. (A)  
 De Sousa, George S. (M)  
 Diekey, Edward T. (M)  
 Dietrich, Frederick (A)  
 Dietze, Eginhard (A)  
 Di Giacomo, Aniello (A)  
 Dreher, Carl (F)  
 Drew, Charles E. (M)  
 Drisko, Benjamin B. (A)  
 Duncan, Rudolph L. (M)  
 Dunham, John S. (A)  
 Dunlap, Orrin E., Jr. (M)  
 Dunn, Gano (F)  
 Eichberg, Robert L. (A)  
 Eldredge, Frank E. (M)  
 Emerson, Charles W., Jr. (A)  
 Ender, Charles E. (A)  
 Engel, Francis H. (M)  
 Espenschied, Lloyd (F)  
 Everett, Lynn C. (M)  
 Facey, John W. (A)  
 Fairburn, A. J. B. (A)  
 Farnsworth, Philip (F)  
 Farrington, John F. (A)  
 Fearing, Justin L. (A)  
 Felthousen, A. (A)  
 Fernald, Paul R. (A)  
 Fernando, K. A. (A)  
 Finch, William G. H. (M)  
 Finlay, Robert C. S. (A)  
 Fischer, Herbert B. (A)  
 Fischer, Leonard O. (A)  
 Fisher, Joseph J. (A)  
 Flomenbaum, Hyman (J)  
 Forbes, E. D. (F)  
 Fox, John P. (A)  
 Frank, K. G. (M)  
 Freed, Joseph D. R. (F)  
 Freeman, Robert H. (A)  
 Freericks, Lambert (A)  
 Frimmerman, Frank (A)  
 Furia, John J. (A)  
 Furness, George C. (M)  
 Gabriellini, William (A)  
 Galen, Vincent (A)  
 Gati, Bela (A)  
 Giese, Raymond C. (A)  
 Gilbert, John J. (A)  
 Glenn, Percy R. (A)  
 Goggins, W. B. (M)  
 Goldberg, Harry (A)  
 Goldman, Arthur Z. (A)  
 Goldsmith, Alfred N. (F)  
 Goulden, Stanley W. (M)  
 Graham, Frank H. (A)  
 Graham, William A. (M)  
 Granata, Anthony (A)  
 Graveson, George L. (A)  
 Green, Ashbel (A)  
 Green, Estill I. (A)  
 Greene, Paul A. (M)  
 Greenstein, Phillip (A)  
 Griffiths, Clarence M. (A)

## NEW YORK (Continued)

## New York City (Continued)

Greig, John (A)  
 Grinan, John F. (M)  
 Guild, Baldwin (M)  
 Gutoff, Boris M. (A)  
 Guy, Raymond F. (A)  
 Hadden, Harold L. (A)  
 Haines, Howard J. (A)  
 Halpin, William A. (A)  
 Hand, Carl A. (A)  
 Hanley, John F. (A)  
 Harley, John B. (A)  
 Hauck, Vernon D. (A)  
 Hauffe, Otto (A)  
 Haynes, A. J. (A)  
 Heberlein, Arthur A. (A)  
 Hedges, Ellsworth J. (A)  
 Heindel, Harold J. (A)  
 Heising, Raymond A. (F)  
 Hemberger, E. F., Jr. (A)  
 Henline, Henry H. (A)  
 Herber, John C. (A)  
 Hertzberg, Robert (A)  
 Heuschkel, Paul J. (A)  
 Hibbett, James Orin (A)  
 Hills, Barclay E. (A)  
 Hinehine, Harris D. (M)  
 Hoernel, Paul C. (A)  
 Hogan, John V. L. (F)  
 Hogg, William S., Jr. (A)  
 Holcombe, Henry W. (M)  
 Holloway, Jack (A)  
 Holm, Henry R. (J)  
 Honaman, R. Karl (A)  
 Hornung, Julius L. (A)  
 Horowitz, Saul (A)  
 Hough, Clinton Wallace (A)  
 Hovgaard, Ole M. (M)  
 Howard, Edward J. (A)  
 Howell, Clifford Alexander (A)  
 Howell, Walter J. (M)  
 Hubbard, Frank A. (A)  
 Hunt, Henry T., Jr. (A)  
 Hurlbut, Ronald (A)  
 Isele, Harold Adolph (A)  
 Jamross, Rudolph (A)  
 Janke, Alfred H. (M)  
 Jensen, A. G. (M)  
 Jewett, F. B. (F)  
 Johnson, John K. (A)  
 Johnson, Reverdy (A)  
 Johnson, William J. (A)  
 Johnston, John P. (M)  
 Jones, Dramin D. (A)  
 Jones, Lester L. (F)  
 Jones, Philip C. (A)  
 Kahant, Charles G. (A)  
 Kaufman, Samuel (A)  
 Keefe, Oscar A. (A)  
 Keim, Llewellyn B. (J)  
 Kelley, Leo A. (A)  
 Kelly, Mervin J. (M)  
 Kendall, John A. (A)  
 Kendall, R. M. (A)  
 Kennedy, T. R., Jr. (A)  
 Kennedy, William A. (J)  
 Kilbourne, Covington G. (A)  
 Kilmer, T. W., Jr. (A)  
 King, Frank (A)  
 Kishpaugh, Arthur Wells (A)  
 Kissel, Alfred L. (A)  
 Kitchin, H. W. (M)  
 Klosner, Morris (A)  
 Knaack, Frank E. (A)  
 Knapp, Joseph F. (A)  
 Knight, Octavius (A)  
 Knopp, Ernest (A)  
 Koerner, Allan M. (A)  
 Kroger, F. H. (F)

Kuhn, Alfred S. (A)  
 Lacault, Robert E. (A)  
 Lack, Frederick R. (A)  
 Lakatos, Emory (A)  
 Lane, Frederic A. (A)  
 Latimer, Chester W. (A)  
 Layng, Grant (A)  
 Lazavovich-Hrebelianovich, D. (A)  
 Leach, Harvey B. (A)  
 Lee, Emery H. I. (M)  
 Lee, Fat Chang (A)  
 Leibe, Frank A. (A)  
 Leins, Ernest P., Jr. (J)  
 Lemmon, Walter S. (A)  
 Lenz, Charles S. (A)  
 Leroy, Frank S. (A)  
 Leslie, Fred D. (A)  
 Levy, Mortimer N. (A)  
 Lewis, Elmer H. (A)  
 Lindmark, Elmer S. (A)  
 Lindsay, Russel R. (A)  
 Llewellyn, Frederick B. (A)  
 Lloyd, T. M. (A)  
 Locke, G. Edgar (A)  
 Loftin, Edward H. (M)  
 Logan, Mason A. (A)  
 Long, Maurice B. (A)  
 Loye, Donald P. (A)  
 Loynes, Owen H. (A)  
 Lundahl, Tore (A)  
 Lynch, Arthur H. (M)  
 Mac Donnell, James M. (M)  
 Mac Dougall, Arthur (A)  
 Mac Ilvain, Karl M. (A)  
 Mackay, William Andrew (A)  
 Maddox, Charles H. (M)  
 Manderfeld, E. C. (A)  
 Marriam, W. A. (M)  
 Marron, George P. (A)  
 Marshall, Cesar B. (A)  
 Martin, De Lora K. (M)  
 Mc Connell, Alexander F. (A)  
 McCullough, Maurice B. (A)  
 McCune, Robert H. (A)  
 McCutchen, Brunson S. (M)  
 McFarlane, Maynard L. D. (A)  
 Mc Lagan, Donald R. (A)  
 Mc Lean, Phillip S. (A)  
 Mc Nally, James O. (A)  
 Melhuish, Harold T. (M)  
 Mellor, William N. (A)  
 Meyer, Henry W. (A)  
 Meyer, Louis F. (A)  
 Miller, Leonard H. (A)  
 Miller, Marvin L. (A)  
 Miller, Samuel C. (M)  
 Millikin, Donald D. (A)  
 Mills, John (M)  
 Milnor, J. Willard (M)  
 Misenheimer, Harvey N. (A)  
 Molson, Charles F. (A)  
 Montanin, S. R. (M)  
 Moore, E. B. (A)  
 Morecroft, J. H. (F)  
 Morehouse, Terry B. (A)  
 Morris, Leon A. (A)  
 Morton, Alfred H. (M)  
 Muller, Herbert W. (A)  
 Nally, Edward J. (A)  
 Nein, Harry R. (A)  
 Nelson, E. L. (M)  
 Nestell, J. E. (A)  
 Neville, T. P. (A)  
 Newman, Alfred C. (A)  
 Newman, David H. (M)  
 Nicely, Ralph N. (A)  
 Nicholides, E. (J)  
 Nichols, Leroy C. (A)  
 Nicolai, Erwin W. (A)  
 Nielsen, John E. (A)  
 Nisley, Paul H. (A)

## NEW YORK (Continued)

## New York City (Continued)

Nivison, Theodore E. (A)  
 Norberg, Clifford M. (A)  
 Nordahl, John G. (A)  
 Norton, Frederick A. (A)  
 Nyman, Alexander (M)  
 Oikle, O. A. (A)  
 Osborne, Harold S. (A)  
 Oswald, Arthur A. (F)  
 Otto, Emil (A)  
 Pacent, Louis G. (F)  
 Palmer, W. H. (A)  
 Pamphilon, Leon E. (J)  
 Parker, R. D. (A)  
 Pate, Carlton O. (A)  
 Payne, Charles C. (A)  
 Pegrum, George B. (A)  
 Peterson, Cornelius (A)  
 Peterson, L. C. (A)  
 Pierce, Franklin W. (A)  
 Pischman, Hans E. (A)  
 Polkinghorn, Frank A. (A)  
 Porter, Carlton J. (A)  
 Porta, Earl G. (A)  
 Potter, Ralph K. (M)  
 Potts, John H. (A)  
 Powley, Allan T. (A)  
 Pratt, Haraden (M)  
 Price, H. Stewart (M)  
 Proffer, John W. (A)  
 Proskauer, Julien J. (A)  
 Pumphrey, Walter H. (M)  
 Pupin, Michael I. (F)  
 Purdy, Fred R. (A)  
 Putnam, R. E. A. (A)  
 Radom, Robert (A)  
 Ranger, Richard H. (F)  
 Reh, Frank F. (A)  
 Reber, Samuel (F)  
 Reeber, Herman E. (A)  
 Reeves, J. Russell (A)  
 Regottaz, Joseph M. (A)  
 Reoch, Alexander E. (F)  
 Rhodes, Thomas B. (A)  
 Ridgway, James L. (A)  
 Rodwin, George (A)  
 Roos, Oscar C. (F)  
 Rose, Arthur F. (M)  
 Rose, John A. (A)  
 Rosenberg, Irving (A)  
 Rossi, Ralph J. T. (A)  
 Rossmassler, Edward C. (A)  
 Ruben, Allyn S. (A)  
 Ryan, Francis M. (M)  
 Sacin, C. Fred (A)  
 Salzberg, Bernard (J)  
 Samuel, Arthur L. (A)  
 Sanborn, John W. (A)  
 Sarnoff, David (F)  
 Scharp, Wesley W. S. (A)  
 Schechter, Jack (A)  
 Schelleng, J. C. (F)  
 Schlitz, Karl W. (A)  
 Schmidt, Erwin (A)  
 Schmied, James W. (A)  
 Schmit, Dominio F. (A)  
 Schneck, Harry L. (A)  
 Schneider, Samuel (A)  
 Schneider, W. A. (M)  
 Schnoll, Nathan (A)  
 Scholle, Frederick (A)  
 Schramm, Fred W. (A)  
 Scott, Herbert J. (A)  
 Searing, Hudson R. (A)  
 Seckel, William (A)  
 Secor, Harry W. (A)  
 Seidler, Abraham (A)  
 Seigal, Joseph A. (A)  
 Senauke, Alexander (M)

Shannon, Joseph H. (M)  
 Sherman, Jesse B. (J)  
 Shine, L. J. (A)  
 Shore, Henry (A)  
 Shumard, Charles C. (M)  
 Shute, Emmett R. (M)  
 Sigety, Louis (J)  
 Simon, Emil J. (F)  
 Singer, Emanuel (A)  
 Sivian, Leon J. (A)  
 Skirrow, John F. (M)  
 Small, Percy L. (A)  
 Smith, John S. (M)  
 Smith, John W. (A)  
 Smith, Samuel S. (A)  
 Snow, William B. (A)  
 Solov, Abraham (A)  
 Sonkin, David (M)  
 Southworth, G. C. (M)  
 Spence, P. W. (A)  
 Spencer, Roy C. (A)  
 Spicer, Floyd O. (A)  
 Spielman, H. Max (A)  
 Sprague, Clarence A. (M)  
 Stansel, Frank R. (A)  
 Stern, Bernard M. (A)  
 Stern, Irving (A)  
 Stevens, A. M. (M)  
 Stone, Ellery W. (F)  
 Swanson, John W. (M)  
 Tauasig, Charles W. (A)  
 Taylor, Charles H. (F)  
 Taylor, Edmund R. (A)  
 Taylor, Jay L. (A)  
 Taylor, S. Gordon (A)  
 Taylor, W. H., Jr. (M)  
 Teeter, Albert A. (A)  
 Terwilliger, Donald J. (A)  
 Tesch, Walter L. (M)  
 Thielen, E. J. (A)  
 Thomas, William M. (A)  
 Thompson, Albert C. (A)  
 Thompson, Roy E. (M)  
 Thurston, George (A)  
 Tierney, Walter L. (M)  
 Toth, Albert F. (A)  
 Truax, John (A)  
 Tucl, A. Y. (A)  
 Turner, Alva (A)  
 Vaill, Edward W. (A)  
 Valerio, Mario J. (A)  
 Van Wyck, William Paterson (A)  
 Vaughan, Carroll B. (A)  
 Velasco, Jose M. (A)  
 Volney, S. C. (A)  
 Voorhees, Leo J. (A)  
 Vreeland, Frederick K. (F)  
 Waas, Albert (A)  
 Wald, David (A)  
 Wallach, Moses U. (A)  
 Walworth, Fred (A)  
 Washington, Bowden (F)  
 Waterman, F. N. (M)  
 Weinberger, Julius (F)  
 Wellman, William R. (A)  
 White, John A. (A)  
 Whitehead, Jesse C. (A)  
 Whittemore, L. E. (F)  
 Wilbur, Edwin C. (A)  
 Willhoff, F. O. (A)  
 Wilson, Leon T. (M)  
 Wilson, William (F)  
 Winner, Lewis (A)  
 Winterbottom, William A. (M)  
 Wintringham, W. T. (A)  
 Wise, Roger M. (A)  
 Wolf, Irving (A)  
 Woodcock, N. A. (A)  
 Woodrow, William (A)  
 Wortman, Frank W. (A)  
 Wright, Carleton Fay (A)

## NEW YORK (Continued)

## New York City (Continued)

Wright, Harry M. (A)  
 Wunderlich, H. A. F., Jr. (J)  
 Young, Owen D. (F)  
 Youngstrom, Nels C. (A)  
 Zatorsky, E. F. (A)  
 Zeamans, Harold R. (A)  
 Zyaman, Harry (A)

## Niagara Falls

Brown, Orlan R. (A)  
 Cox, George C. (A)  
 Guinther, George (A)  
 Lidbury, F. A. (A)

## North Lawrence

Melotte, Cyril W. (A)

## North Tarrytown

Sandalls, George T., Jr. (A)

## North Tonawanda

Freck, R. H. (A)  
 Schurr, Wm. (A)  
 Wesselman, Eugene (A)

## Nyack

Freedman, William H. (A)

## Oakdale Station, L. I.

Whildin, Theodore N. (A)

## Old Forge

Christy, Donald P. T. (A)

## Orient

Vail, Leslie G. (A)

## Ossining

Akin, Robert M., Jr. (A)  
 Gowen, Robert F. (M)

## Ozone Park, L. I.

Weilminster, Charles (A)

## Peekskill

Smith, Harold E. (A)

## Pelham

Kolb, Walter R. (A)

## Pittsford

McLaughlin, James L. (A)

## Poland

Prentise, Howard H. (A)

## Port Jefferson Station, L. I.

Thrush, Paul W. (A)

## Port Jervis

Gibbons, Joseph W. (A)

## Port Washington, L. I.

Hafner, Gilbert M. (A)  
 Whiting, Donald F. (M)

## Rhinebeck

Lang, Walter T. (A)

## Richmond Hill, L. I.

Grebe, Alfred H. (F)  
 Heins, Henry F. (A)  
 Leighley, Harry M. (A)  
 Leyh, William D. (A)  
 Oram, Donald K. (A)  
 Weinwurm, Robert (A)

## Riverdale-on-Hudson

High, John M., Jr. (A)

## Riverhead, L. I.

Colvin, R. S. (A)  
 Crosby, Murry G. (A)  
 Dagg, T. Ralph (A)  
 Hollingsworth, R. L. (A)  
 Keary, Hugh F. (A)  
 Knowles, Jerome H., Jr. (A)  
 Matthews, Walter I. (A)  
 Moore, John B. (A)  
 Peterson, Harold O. (A)  
 Pfautz, Christian E. (A)  
 Runquist, Elliot C. (A)  
 Wickizer, Gilbert S. (A)

## Rochester

Bachofner, C. L. (A)  
 Balling, Alfred W. (A)  
 Bickford, Milton F. (M)  
 Bobrovsky, Igor S. (M)  
 Brackett, Richard T. (A)  
 Brown, Gordon P. (A)  
 Brown, Howard A. (A)  
 Chamberlain, Adolph B. (A)  
 Clarke, Maurice H. (A)  
 Dengler, Clarence E. (A)  
 De Witt, William Homer (J)  
 Dye, Leaman A. (A)  
 Friedler, Dewey P. (A)  
 Gordon, Harry E. (A)  
 Graham, Virgil M. (M)  
 Greenman, Roger B. (A)  
 Inas, Paul (J)  
 Hanover, Edward A. (A)  
 Haugh, A. T. (M)  
 Hayslett, L. E. (A)  
 Hitchcock, Joseph F. (A)  
 Huntington, Maurice B. (A)  
 Karker, Earl C. (A)  
 Klumb, Harvey J. (A)  
 Lewis, Bertram L. (A)  
 Longworth, Arthur W. (A)  
 Manson, Ray H. (M)  
 Martin, V. G. (A)  
 McCanne, Lee (A)  
 McCanne, W. Roy (M)  
 Moore, Eric J. T. (M)  
 Mott, Frederick A. (A)  
 Nelson, Edward J. (J)  
 Reddy, Walter G. (A)  
 Reynolds, Francis W. (A)  
 Roesser, Edward A. (A)  
 Schlenker, Vesper A. (A)  
 Schneider, Mendell (A)  
 Schoen, Arthur L. (A)  
 Seoville, George A. (A)  
 Sigl, A. J. (A)  
 Soderholm, Arthur E. (A)  
 Studier, Walter A. (J)  
 Waldorf, E. T. (A)  
 White, Warren W. (A)  
 Wishart, William R. (A)  
 Wood, Merrill A. (A)  
 Worrell, Richard A. (A)

## Rockaway Beach, L. I.

Greiff, Victor (M)

## Rockville Center, L. I.

Cardwell, Allen D. (A)  
 Harper, A. E. (M)  
 Hart, Lester B. (A)  
 Hinners, Frank A. (F)  
 Weeks, Norman E. (A)

## Rocky Point, L. I.

Boerner, Thomas J. (A)  
 Finch, James L. (M)  
 Ganz, Arthur W. (A)  
 Hunsell, Clarence W. (A)  
 McKesson, Lewis J. (A)  
 Tammaro, Joseph C. (A)  
 Usselman, George L. (A)

## Rome

Bevitt, William D. (A)

## Saranac Lake

Lee, W. Justice (M)  
 Riddle, William E. (A)  
 Williams, Thomas F. (A)

## Sayville

Hart, Frank A. (A)

## Scarsdale

Appel, Joseph H., Jr. (A)  
 Kinsley, Carl (M)

## NEW YORK (Continued)

## Schenectady

Alexanderson, E. F. W. (F)  
 Allen, H. Clifford (A)  
 Andrews, Paul D. (A)  
 Austin, Edward (A)  
 Austin, Kirby B. (A)  
 Ayer, Raymond B. (A)  
 Baker, W. R. G. (F)  
 Ballentine, E. C. (A)  
 Berejkoff, Anatol Petrovich (A)  
 Berg, Ernest J. (A)  
 Billings, James H. (A)  
 Bradbury, Burke (A)  
 Brockman, Francis C. (A)  
 Brokaw, Charles A. (A)  
 Brown, William W. (M)  
 Burrill, Charles M. (A)  
 Byrnes, Irving F. (A)  
 Carlson, Wendell L. (A)  
 Carpenter, Glenn W. (A)  
 Carter, E. Finlay (A)  
 Coombs, Clyde F. (A)  
 Cottrell, McKenzie (A)  
 Cummings, B. Ray (M)  
 Darlington, Eugene S. (A)  
 David, William R. (A)  
 De Haven, Thomas V. (A)  
 Demmer, A. H. (A)  
 Devaud, Albert J. (A)  
 Dodge, Albert O. (A)  
 Dome, Robt. B. (A)  
 Douthit, M. L. (A)  
 East, Lawrence A. W. (A)  
 Edwards, Edmund P. (M)  
 Engstrom, Elmer W. (A)  
 Fitch, William A. (J)  
 Ford, Warren A. (A)  
 Frank, Charles W. (A)  
 French, Henry G. (A)  
 Fritschel, Eugene H. (A)  
 Gallagher, James P. G. (J)  
 Garrett, Charles R. (A)  
 Grover, Frederick W. (M)  
 Gunther, Clarence A. (A)  
 Hargrave, W. A. (A)  
 Hauschild, John P. (A)  
 Henyan, George W. (A)  
 Hitt, A. B. (A)  
 Hoffer, George M. (A)  
 Holmes, Ralph S. (A)  
 Hoxie, Charles A. (A)  
 Jackson, Henry W. (M)  
 Johnson, Theophilus, Jr. (M)  
 Jones, Newell R. (A)  
 Junken, L. H. (A)  
 Karr, Ira J. (A)  
 Kinney, Ely M. (A)  
 Lamb, G. F. (A)  
 Langdon, G. G. (A)  
 Langmuir, Irving (F)  
 Lanterman, Walter F. (A)  
 Leibing, Joseph K. (A)  
 Loughren, Arthur V. (A)  
 Love, Joseph E., Jr. (A)  
 Lyndon, Wm. L. (A)  
 McCarrroll, Marshall G. (A)  
 Mead, Milton S., Jr. (A)  
 Meahl, Harry R. (A)  
 Metcalf, George F. (A)  
 Mosher, J. H. (A)  
 Mullaney, Dudley A. (A)  
 Newbold, W. H. (A)  
 Nickle, Emil G. (A)  
 Nolte, Henry J. (A)  
 Patterson, Franklin G. (A)  
 Payne, John H. (A)  
 Pike, Otis W. (A)  
 Priest, Conan A. (A)  
 Prescott, Maurice L. (M)  
 Priebe, Frank (A)

## Scotia

Allen, Hugh E. (A)  
 Artzt, Maurice (A)  
 Baker, Judd O. (A)  
 Butler, Henry R. (A)  
 Chittick, K. A. (A)  
 Cook, Ellsworth D. (A)  
 Fick, Clifford G. (A)  
 Juchter, Pieter (A)  
 Palmer, Harry L. (A)  
 Poch, Waldemar J. (A)  
 Richardson, L. Walton (A)  
 Thomas, George G. (A)

## Sea Cliff, L. I.

Tangen, Reider (J)

## Sheepshead Bay, L. I.

Asch, Moe (A)

## Southampton, L. I.

Homer, Edward C. (A)  
 Pollard, Leon G. (A)

## Springfield, L. I.

Benjamin, Wesley E. (A)

## Springfield Gardens

Bicak, Edward T. (A)

## Spuyten Duyvil

De Forest, Lee (F)

## Stafford

Sheffer, Olan N. (A)

## Stapleton, S. I.

Eklund, Gus (A)  
 Mc Ardell, Wesley E. (A)  
 West, Clarence H. (A)

## Staten Island

Younger, Charles (A)

## St. Johnsville

Ackerman, Milton J. (A)

## Suffern

Ennis, Fred E. (A)

Pulley, Albert A. (A)  
 Rice, Chester W. (F)  
 Ring, Andrew D. (A)  
 Rochford, John (A)  
 Rockwood, Alan C. (A)  
 Roya, H. E. (A)  
 Sadenwater, Harry (M)  
 Scheldorf, Marvel W. (A)  
 Schwarz, Harvey F. (A)  
 Selby, Eugene O. (A)  
 Serrell, Robert (A)  
 Simonds, Dewey T. (A)  
 Simpson, Leroy C. (J)  
 Singleton, Harold C. (A)  
 Sloan, David H. (A)  
 Snyder, Norman (A)  
 Spitzer, Edwin E. (A)  
 Stanton, Clair F. (A)  
 Stocker, Arthur C. (A)  
 Stone, F. Byron (A)  
 Taylor, Laurens A. (A)  
 Taylor, R. B. (A)  
 Terrell, John A. (A)  
 Tittle, Hulbert C. (A)  
 Tolson, W. A. (M)  
 Tyler, Kenneth G. (A)  
 Vose, Charles H. (A)  
 Wallace, Martin J. (A)  
 Warner, John C. (M)  
 Watts, D. E. (A)  
 Weir, I. R. (A)  
 Weston, John L. (A)  
 Whelan, Dow O. (A)  
 White, William C. (M)  
 Wilson, Donald (A)  
 Woodworth, John L. (A)  
 Young, Charles J. (A)

## NEW YORK (Continued)

## Sunnyside, L. I.

Carter, Frank L. (A)  
 Shannon, James E. (A)

## Syracuse

Blaich, J. Ray (A)  
 Nicholson, E. J. (A)  
 Porter, R. A. (A)  
 Potter, Melville R. (A)  
 Randall, Domus P. (A)  
 Wolverson, Byron C. (A)

## Tarrytown

Dinga, Emil (A)  
 Lazarus, Benjamin N. (A)  
 Pineau, Norman T. (A)

## Tonawanda

King, Francis N. (A)

## Tuxedo Park

Loomis, Alfred L. (M)

## Utica

Darjany, S. H. W. (J)  
 Pickett, Glenn H. (A)  
 Terrill, W. Nessler (A)

## Walter Mill, L. I.

Corwith, Howard P. (M)

## Watervliet

Montross, James G. (A)

## Watkins Glen

Pomeroy, Rupert C. (A)

## Wayland

Erhart, Victor J. (A)

## West Brighton, S. I.

Garland, J. Arnold (A)  
 Wombacher, Joseph A. (A)

## West Hempstead, L. I.

Magness, Scott A. (A)

## West New Brighton, S. I.

Bedford, George W. (A)

## West Point

Wenstrom, W. H. (A)

## White Plains

Griggs, Elmer V. (A)  
 Halstead, William S. (A)  
 Lamarque, James W. (A)  
 Lant, E. B. (A)  
 Maloff, Ioury G. (M)  
 Minton, John P. (F)

## Whitestone, L. I.

Adler, Benjamin (A)

## Williamsville

Hopkins, Nelson S. (A)  
 Trago, Robert A. (A)

## Woodmere, L. I.

Birkhahn, Robert C. (A)  
 Ziegler, Frederick J. (A)

## Woodside, L. I.

Brown, Gilbert G. (A)  
 Corcoran, Leo F. (A)  
 Lundie, Ernest S. (J)  
 Reuman, William H. (A)  
 Tucker, George B. (A)

## Yonkers

Craig, Albert G. (A)  
 Grand, Jacob (A)  
 Runyon, Carman R., Jr. (A)  
 Saunders, Alfred W. (A)  
 Van Dyck, Arthur F. (F)  
 Whitaker, James N. (A)

## NORTH CAROLINA

## Biltmore

Moore, George H. (A)

## Charlotte

Callahan, Thomas G. (A)

Gluck, E. J. (A)  
 Reid, Ralph J. (A)  
 Saylor, James G. (A)

## Durham

Seeley, Walter J. (A)

## Gastonia

Jenkins, Russell A. (A)  
 Morris, Robert S. (A)

## Mt. Airy

Worrall, W. W. (A)

## NORTH DAKOTA

## Bismarck

Lucas, Stanley M. (A)

## Fargo

Swisher, Charles L. (A)

## Grand Forks

Garard, Earl A. (A)  
 Jenkins, David R. (A)

## OHIO

## Akron

Aitkenhead, John, Jr. (A)  
 Curtis, James O. (A)  
 Hoffman, Donald A. (A)  
 Mintz, John W. (A)  
 Palmer, Edward D. (A)  
 Palmer, Roland F. (A)  
 Starr, Troy S. (A)  
 Townsend, Samuel W. (A)  
 Weaver Raymon E. (A)  
 Werhan, Alfred B. (A)

## Alliance

Dinger, Harold E. (A)  
 Morgan, O. K. (A)

## Ashtabula

Collins, James A. (A)

## Avon Lake

Harris, John (A)

## Brrzberton

Hillebrand, W. A. (M)

## Berea

Anderson, Raymond T. (A)

## Canton

Boger, Clair E. (A)  
 Cattrall, John B. (A)  
 Herbruck, William M. (A)  
 Pennock, P. L., Jr. (A)  
 Weckel, Wilson E. (A)

## Chardon

Canfield, Ira A. (A)

## Cincinnati

Roes, W. W. (A)  
 Russard, F. J. H. (A)  
 Chambers, Joseph A. (A)  
 Craig, Palmer H. (A)  
 Crosley, Powel, Jr. (M)  
 Dixon, C. C. (A)  
 Estey, F. Clifford (A)  
 Fogg, W. C. (J)  
 Glover, Ralph P. (A)  
 Gray, George J. (A)  
 Israel, Dorman D. (A)  
 Jarvis, Kenneth W. (M)  
 Kellogg, Leonard A. (A)  
 Lampkin, Guy F. (A)  
 Langley, Ralph H. (M)  
 Lehnhoff, Raymond G. (A)  
 Loof-Bourow, J. R. (A)  
 Meyrose, Hubert S. (A)  
 O'Callaghan, Jerome J. (A)  
 Osterbrook, W. C. (A)  
 Peterson, Charles W. (A)  
 Walker, Frank (A)  
 Wanstrath, W. Theodore (A)  
 Youngs, Howard E. (A)

## OHIO (Continued)

## Cleveland

Ackerman, E. K. (A)  
 Baldwin, Leonard G. (A)  
 Benkelman, Glen F. (A)  
 Black, Albert J. (A)  
 Bowditch, Fred T. (A)  
 Browne, Theodore C. (M)  
 Butler, Roy (A)  
 Calkins, William G. (A)  
 Canady, Donald R. (A)  
 Carlton, Raymond A. (A)  
 Covey, Gerald G. (A)  
 David, Bruce W. (M)  
 Disbrow, John D. (A)  
 Dodds, Lee L. (A)  
 Domizi, Dante (A)  
 Donaldson, Robert O. (A)  
 Dorazil, A. F. (A)  
 Dorn, Harry P. (A)  
 Durante, Jean Andre (A)  
 Eberle, Wilbert H. (A)  
 Ermatinger, Alex E. (A)  
 Erwin, Raymond W. (A)  
 Fouse, Harold (A)  
 Gardner, Howard S. (A)  
 Glatz, Henry (A)  
 Gove, Edward L. (A)  
 Gray, Harold E. (A)  
 Hannum, J. C. (A)  
 Henry, Allen W. (A)  
 Herke, Oliver L. (A)  
 Hills, Humphrey J. (A)  
 Hunt, Louis W. (A)  
 Jenkins, Myron Z. (A)  
 Kaehni, Frank J. (A)  
 Kintner, Deane S. (A)  
 Klein, Israel (A)  
 Martin, John R. (M)  
 McColliester, Donald (A)  
 McIlvaine, H. A. (M)  
 McIlvaine, Oran T. (M)  
 McMahon, Alvin (A)  
 Melrose, James W. (A)  
 Newman, Joseph S. (A)  
 O'Connor, Albert J. (A)  
 Pruitt, Wilbur C. (A)  
 Ransom, G. B. (A)  
 Robertson, Frank E. (A)  
 Schlesinger, Burton R. (A)  
 Schneeberger, G. B. (A)  
 Schregardus, Dirk (A)  
 Scott, Ernest P. (A)  
 Scott, Hoyt S. (M)  
 Seitz, Valentine (A)  
 Shaw, John J. (A)  
 Simpson, Paul A. (A)  
 Smith, F. J. (A)  
 Smith, Soreno E. (A)  
 Snyder, Robert B. (A)  
 Sturtevant, Mark (A)  
 Talka, Louis N. (A)  
 Tuminonda, Harry A. (A)  
 Victoreen, E. (A)  
 Victoreen, John A. (M)  
 Waite, Howard G. (A)  
 Ward, Donald O. (A)  
 Watts, E. Gerald (A)  
 Wells, Leland E. (M)  
 Yurgionas, John A. (J)

## Cleveland Heights

Baier, Arthur H. (A)  
 Baier, Henry J. (A)  
 Farnham, Ralph E. (A)  
 Williams, Hollie (A)

## Clyde

Ellsworth, William C. (A)

## Columbus

Bidlack, Cecil S. (A)  
 Cole, Alfred D. (A)

Everitt, William L. (A)  
 Higgy, Robert C. (A)  
 Leeka, Warren C. (A)  
 Mercer, Alva (A)  
 Newby, R. W. (A)

## Dayton

Barbulesco, Constantin D. (M)  
 Bickels, Howard I. (A)  
 Bourne, George E. (A)  
 Copp, Roy S. (A)  
 Finter, Clyde V. (A)  
 Flewelling, Edmund T. (A)  
 Gerstle, John (A)  
 Glendenning, D. B. (A)  
 Hendricks, Lester A. (A)  
 Hopkins, A. R. (A)  
 Knott, William M. (A)  
 Loftis, Homer J. (A)  
 Lohmann, Robert S. (A)  
 Petry, C. A. (A)  
 Roberts, Haydn P. (M)  
 Zimmerman, Robert F. (A)

## East Cleveland

Beasley, Ira E. (A)  
 Leonard, S. Edwin, Jr. (A)  
 Maclaren, Wallace E. (A)  
 Oetting, O. W. A. (M)  
 Rich, Russell H. (A)  
 Shipman, Charles H. (A)  
 Siddall, Richard (A)

## Fostoria

Elsa, Farrel F. (A)

## Green Camp

Barber, D. G. (A)

## Greentown

Myers, Willard D. (A)

## Hamilton

Probat, John E. (A)

## Kent

Kline, Robert L. (A)

## Lakewood

Hamman, G. B. (A)  
 King, Maurice V., Jr. (A)  
 Little, D. S. (A)  
 Maral, Paul A. (A)  
 McMullen, F. C. (A)  
 Nelson, James R. (A)  
 Pichon, Richard S. (J)  
 Satterthwaite, William F. (A)  
 Sturtevant, James W. (A)  
 Thorburn, Jas. M. (M)  
 Van Voorhis, Merrill G. (A)  
 Worden, Ralph P. (A)

## Lorain

Fox, Robert A. (A)

## Mansfield

Kissel, M. Milo (A)

## Marietta

Johnson, J. L. (A)  
 Manley, Edward (A)  
 Muscari, Pietro J. C. (A)

## Marion

Howser, Donald E. (J)  
 Irvin, Raymond D. (A)

## Massillon

Schwab, Charles B. (A)  
 Trubey, Lester E. (J)

## Mason

Whitehouse, Joseph E. (A)

## Minford

Allen, Alva J. (A)

## Mt. Healthy

Kilgour, Charles E. (A)

## New Concord

Martin Paul E. (A)

## OHIO (Continued)

## New Philadelphia

Murray, Charles J. (A)

## Niles

Coleman, Robert M. (A)  
 Parlas, Joseph L. (A)

## Norwalk

Leonhardt, Charles C. (A)

## Norwood

Blair, Russell M. (A)  
 Dwyer, Robert J. (A)

## Port Clinton

Anderson, Gilbert J. C. (A)

## Portsmouth

Jackson, Sylvan E. (A)

## Ravenna

Rettig, Floyd A. (A)

## Sandusky

Voight, Richard J. (A)

## Shiloh

White, Kenneth E. (A)

## Springfield

Reid, Thomas A. (A)  
 Schaefer, Carl A., Jr. (A)

## Toledo

Bitter, A. Romeyn (A)  
 Browne, Merton S. (A)  
 Dietach, Carl G. (A)  
 Dokas, Konstantinos B. (A)  
 Foley, J. W. B. (A)  
 Franklin, Townsend U. (A)  
 Pilzecker, Arthur (A)  
 Pilzecker, Harold (A)

## Wapakoneta

Copeland, Herman A. (A)

## Warren

Fleming, Edward E. (A)

## Youngstown

Phillips, R. G. (A)  
 Remedio, Dominic (A)  
 Wilkens, B. T. (A)

## OKLAHOMA

## Barnsdall

McNally, Eugene C. (J)

## Bartlesville

Adams, Paul Roy (A)  
 Fisher, Frank E. (A)  
 Miller, Erdene K. (A)

## Chelsea

Jones, Varnakale L. (A)

## Chickasha

Cole, Roy H. (A)  
 Shultz, E. Patterson (J)

## Enid

Edwards, Lyman M. (A)

## Fort Sill

Poteet, Daniel P. (A)

## Oklahoma City

Allen, Roy (A)  
 Challenner Ansel (A)  
 Gordon, Earl P. (A)  
 Hirdler, F. C. (A)  
 Lovell, Herman J. (A)  
 Mier, C. W. (A)  
 Sams, Eddleman E. (A)  
 Wallace, David R. (A)

## Okmulgee

White, R. Jordan (A)

## Peckham

Brown, Edwin C. (A)

## Shawnee

Montgomery, Leo E. (A)

## Stillwater

Isbell, G. Terrill (A)

## Tulsa

Breeding, S. H. (A)  
 Drake, Norman B. (A)  
 Holland, Francis L. (A)  
 Lowe, Meredith B. (A)  
 Miller, Claude E. (A)  
 Phillips, H. W. (A)  
 Probert, Edward (A)  
 Thompson, W. H. (A)  
 Willson, P. L. (A)  
 Wilson, O. G. (A)

## OREGON

## Astoria

Lasalle-Dilley, L. L. (A)

## Corvallis

Jordan, Jacob (A)  
 Morris, James M., Jr. (A)

## Eugene

Hoppe, Paul R. (A)

## Falls City

Paul, Byron R. (J)

## Hillsboro

Julien, Ira F. (M)

## Portland

Clark, George W. (A)  
 Dady, Arthur O. (A)  
 Dixon, Ashley C. (A)  
 Johnson, I. W. (A)  
 Laast, George O. (A)  
 O'Day, Marcus (A)

## PENNSYLVANIA

## Adelia

Woodward, Bruce J. (A)

## Aldan

Earle, Ralph P. (A)  
 Trainer, George T. (A)

## Allentown

Claus, Fred W. (A)  
 Eckert, Bryon H. (A)  
 Hardner, Francis J. (A)  
 Thomas, Charles V. (A)

## Altoona

Aughenbaugh, William K. (A)  
 Douglas, Earl C. (A)  
 Youngkin, Ernest E. (J)

## Ambridge

Svegel, Peter J., Jr. (J)

## Ardmore

Hayes, R. S. (A)  
 Wilkinson, Gordon O. (A)  
 Worrell, Howard S. (A)

## Avalon

Allen, James G. (A)  
 Todd, William O. (A)

## Bala-Cynwyd

Croft, Samuel H. (A)

## Bellevue

Donbar, C. Floyd (A)

## Bethlehem

Friend, Halton H. (A)  
 Lessig, Linwood G. (A)  
 Maylott, Carleton F. (A)  
 Seyfert, Stanley S. (M)

## Boyetown

Venske, Herbert F. (A)

## Bradford

Francis, Thomas C. (A)

## Brownstown

Harnish, Ray M. (A)

## Bryn Mawr

Tuttle, William N. (A)



## PENNSYLVANIA (Continued)

Cambridge Springs  
Lord, Harry R. (A)

Charleroi  
Keiso, Herbert F. (A)

Chester  
Nadig, Stanton E. (A)  
Rapagnani, Peter A. (A)

Churchville  
Hinkel, Walter A. (A)

Connellsville  
Cooper, Robert S. (A)  
Craig, Jack (J)  
Silcox, Albert S., Jr. (A)

Coraopolis  
Stewart, Donald P. (A)

Cresson  
Meckley, Raymond C. (A)

Darby  
Knight, Winfield W. (A)

Darlington  
O'Shea, Joseph G. (J)

Drexel Hill  
Brandt, William A. (A)  
Shafer, Albert G. (A)  
Willard, Joseph M. (A)

East Pittsburgh  
Beers, G. Lisle (A)  
Chubb, Louis W. (M)  
Conrad, Frank (F)  
Hanna, Clinton R. (M)  
Hitecock, R. C. (A)  
Kintner, Samuel M. (F)  
Landon, Vernon D. (A)  
Wolf, Lester J. (A)

Edgewood  
Lewis, L. V. (A)  
McCullough, F. S. (M)

Emporium  
Goode, Kenneth H. (A)  
Rishell, George L. (A)  
Schweikart, William F. (A)

Erie  
Jordan, Ralph E. (A)

Etna  
Johnstone, R. S. (A)

Fullerton  
Bachman, Edwin J. (A)

Germanstown  
Bromley, John E., Jr. (A)  
Burnside, Don G. (A)

Gettysburg  
Baker, Harry W. (A)  
Duttera, William S. (A)

Glassport  
Hertz, Stanton (A)

Glenside  
Griffith, Charles H. (A)  
Whitaker, John C. (A)

Greensburg  
Hawk, William K. (A)

Harrisburg  
Beachley, Vance E. (A)  
Campbell, Ralph B. (A)  
Chambers, William B. (J)  
Detweiler, Jay E. (J)  
Gardner, William L., Jr. (A)  
Grim, Clair R. (A)  
Hardy, George E. (A)  
Hoover, Reuben R. (A)  
Lee, William J. (A)  
McCachren, W. S. (A)  
Mummert, Russell E. (J)  
Novinger, Earl M. (A)

Peffer, Ralph M. (A)  
Schwanger, Robert M. (A)  
Sours, M. D. (A)  
Steiger, Charles H. (A)  
Stormfeltz, S. H. (A)  
Walanka, M. R. (A)

Highland Park  
Greenwald, Arthur A. (A)

Honesdale  
Stephens, William H. (J)

Johnstown  
Hanson, Herbert (A)  
Reid, A. J. (A)

Kingston  
Brown, Ralph M. (A)

Lancaster  
Gaitner, Joseph R. (A)  
Geise, Julius C., Jr. (A)  
Mathiot, Jacob E. (A)  
Mumma, Earle L. (A)  
Stauffer, J. Luke (A)

Lansdowne  
Kimball, Gardner W. (A)  
Thompson, Roland F. (A)  
Wilson, A. T. (A)

Lehighton  
Butler, Harry F. (A)

Lester  
Causse, Roger D. (J)

Lewisburg  
Schooley, Harold (A)

Matamoras  
Willers, Theodore H., Sr. (A)

Media  
Delbert, Simon, Jr. (A)

Melrose Park  
Drueding, Albert J. (A)

Middletown  
Bowers, Karl F. (A)

Millon  
Butler, Wilson M. (J)

Mt. Carmel  
Groes, Benjamin F. (A)

Nanticoke  
Brader, Norwood H. (A)

Narberth  
Ford, John R. (J)  
Kaeber, Clarence R. (A)

New Castle  
Martin, Norman A. (A)

New Cumberland  
Rogers, Clifford H. (A)

Norristown  
Hausmann, Ernest O. (A)  
Place, Samuel W. (A)  
Rue, William F. (A)  
Sands, William F. (A)

Northampton  
Lewis, Chester, Jr. (A)

Northumberland  
Smith, Harry Evans (A)

North Wales  
Hendricks, Clarence B. (A)

Oil City  
Hahn, Samuel L. (A)

Overbrook  
Cloesson, H. B. (J)

Palmyra  
Balsbaugh, Clair L. (A)  
Krieder, J. Landis (A)

Parnassus  
Clowes, Robert T. (J)  
McKinley, J. G. (A)

## PENNSYLVANIA (Continued)

Penbrook  
Gelsinger, C. S. (A)

Philadelphia  
Apker, Chas. L. (A)  
Arnold, John P. (A)  
Bartlet, Millard C. (A)  
Bechler, W. C., Jr. (A)  
Benson, Thomas W. (A)  
Bonn, Norman E. (A)  
Borland, Albert S. (A)  
Brown, Henry J. (A)  
Brown, H. Wilbur (A)  
Brown, William L. (A)  
Bruck, Samuel (J)  
Burgess, Edward R. (A)  
Butler, Richard A. (A)  
Cain, Robert E. (A)  
Caporale, Peter (A)  
Clark, Charles F. (A)  
Deal, Harmon B. (A)  
Diehl, William F. (A)  
Doherty, George H. M. (J)  
Doyle, E. D. (A)  
Dunn, James C. (A)  
Earnshaw, David P. (A)  
Eaton, George W., Jr. (A)  
Ebert, Burton E. (A)  
Eby, Hugh H. (A)  
Eby, John B. (A)  
Eckert, Edw. J. (A)  
Ehret, Cornelius D. (F)  
Elias, Morris I. (A)  
Ellis, Wm. G. (M)  
Etkin, Harry (A)  
Fischer, Roy S. (A)  
Fossett, Fred E. (A)  
Friedrick, Calvin M. (A)  
Freedman, Harry J. (A)  
Frigar, John 3rd. (A)  
Gengenbach, Albert W. (A)  
Gilsen, Walter E. (J)  
Godsho, Albert P. (A)  
Griffith, M. H. (A)  
Gruenstein, Philip (A)  
Gryning, John F. (A)  
Helfenstein, Edwin (A)  
Holland, Walter E. (M)  
Holtzner, Ralph (A)  
Jones, H. Rossiter (A)  
Karcher, Donald (J)  
Kearney, L. E. (A)  
Kearney, Wm. A. (J)  
Keast, Philip M. (A)  
Keller, Paul A. (A)  
Kenrick, Gleason W. (A)  
Klenk, Julius G. (A)  
Kloss, F. W. (A)  
Larsen, Olrick S. (A)  
Leonard, John M. (A)  
McFadden, Wilford C. (A)  
Mao Hugh, Wm. L. (A)  
Mao Nabu, Vernon C. (A)  
Mayers, Harvey F. (J)  
McDowell, Albert P., Jr. (A)  
Molver, William R. (A)  
Merkel, Henry F. (A)  
Mevius, John C. (A)  
Miller, Chas. C. (A)  
Miller, John M. (F)  
Mouradian, H. (A)  
Murri, Joseph (A)  
Neutra, Boni. B. (A)  
Nichols, J. J. (A)  
Pearce, Harry G. (A)  
Pitta, C. D. (A)  
Ponsford, Walter W. (A)  
Rabinowitz, Meyer (A)  
Rafferty, Frank A. (M)  
Raycroft, Louis B. F. (A)  
Reeb, Alfred (A)

Reid, Floyd F. (J)  
Roberts, Richard P. (A)  
Robinson, Aloysius V. (A)  
Saunders, William P. (A)  
Schulmerich, G. J. (A)  
Scaman, John C. (A)  
Senior, David B. (A)  
Shannon, Frank J. (A)  
Sirms, Wiswald J. (A)  
Snyder, Richard L. (A)  
Stoudt, John P. (A)  
Tarzian, Sarkes (A)  
Traugott, Paul (A)  
Trinkle, W. S. (A)  
Trump, Wm. H. (A)  
Trumpy, Jay W. (J)  
Tuska, Clarence D. (A)  
Tuttle, Elbert B. (A)  
VanHousen, Charles H. (A)  
VanHorn, J. C. (M)  
Waltz, William W. (A)  
Weyl, Chas. N. (M)  
Wockey, Peter F. (A)  
Wolf, Clarence, Jr. (J)  
Yoet, John C. (A)

## Phoenixville

Shuhart, John H. (A)

## Pittsburgh

Armor, James C. (A)  
Baumgarten, Frank A. (A)  
Bricker, James O. (A)  
Buehl, Louis H. (A)  
Buerger, Charles B. (A)  
Buzsard, A. J. (A)  
Clark, Clarence M. (A)  
Coogrove, Joseph L. (A)  
Cruikshank, Omar T. (A)  
Dauber, Albert E., Sr. (A)  
Davis, Robert L. (A)  
Davis, Sheldon Irwin (A)  
Dill, George C. (A)  
Forstall, Edward L. (A)  
Gorham, Robert C. (A)  
Greenslade, Grover R. (A)  
Griffith, Roy T. (A)  
Hayer, Henry J. (A)  
Irving, Herbert W. (A)  
Joller, Casper R. (A)  
Lassich, Branko (A)  
McElroy, W. R. (A)  
Miller, Paul J. (A)  
Molk, F. T. (A)  
Orlando, Thomas (A)  
Osborn, Perry H. (A)  
Prager, Joseph W. (A)  
Shafer, William L. (A)  
Shuey, Paul F. (A)  
Staege, Stephen A. (A)  
Sunnergren, Arvid P. (A)  
Terven, Lewis A. (M)  
Thomas, William K. (A)  
Wallace, H. Edward (A)  
Wenaley, Roy J. (A)  
Wiesmann, Edw. T. (J)

## Pottstown

Fisher, Charles H. (A)  
Mellon, Ralph E. P. (J)

## Punxsutawney

Bowser, Jacob W. (A)

## Reading

Albert, William V. (A)  
Good, Horace D. (A)  
Kissinger, J. Herbert (A)  
Stoudt, Harold A. (J)

## Ridgway

Anderson, Thure C. (A)

## Royersford

Freed, Russell E. (A)

## PENNSYLVANIA (Continued)

Schwenksville  
Benner, Harold S. (A)

Scranton  
Alexander, F. S. (A)  
Dolph, Stanley E. (A)  
Graf, Joseph J. (M)  
Irving, Ira M. (A)  
Oechmann, Adolph W. (A)  
Stevens, Wilbur C. (A)  
Witkowski, Joseph F. (A)

Shamokin  
Shade, Richard W. (A)

Sharon  
Rankin, Saml. A. (A)

Sharon Hill  
Irelan, A. E. (A)

Shenandoah  
Drescher, G. A. (A)

Smethport  
Biever, Fred H. (A)  
Pierotti, Wm. L. (A)

Springdale  
Armstrong, Reece M. (A)

St. David's  
Stewart, Charles H. (M)

Swarthmore  
Fairbanks, Edmund U. (A)  
Fussell, Lewis (A)  
Higgins, Alfred K. (A)

Swatara  
Cassady, P. H. (A)

Swissvale  
Marshall, James J. (A)  
Roess, Harold (M)

Tarentum  
Jones, Roy L. (A)

Temple  
Stanton, R. E. (A)

Uniontown  
Crow, John B. (J)

Upper Darby  
Chamberlain, Newton M. (A)  
Dudley, D. Clinton (A)  
Frazier, Howard S. (A)  
Mageoch, Yale (A)  
Sharpless, A. Roberts (A)

Warren  
Gruninger, John E. (J)

Washington  
May, Samuel (A)  
Spriggs, Lucian A. (A)

Waverly  
Mack, Dahl W. (A)

West Philadelphia  
Knoll, Lloyd M. (M)  
Logan, William S. (A)  
Muncey, Allan R. (A)  
Stover, Wilmer A. (A)

Wilkes-Barre  
Haines, Joseph, Jr. (A)  
Pacalser, Robert T. (A)  
Shuster, Edmund F. (J)  
Speicher, Ellsworth J. (A)  
Stenger, J. H., Jr. (A)  
Warner, Barney H. (A)

Wilkesburg  
Batsel, M. C. (F)  
Baudino, Joseph (A)  
Boddie, Clarence A. (A)  
Brindley, William E. (M)  
Carothers, W. D. McL. (A)  
Cunningham, David H. (A)

Cunningham, Thomas D. (A)  
Haak, A. H. (A)  
Haller, George L. (A)  
Horn, Charles W. (M)  
Johns, Francis J. (A)  
Koch, W. R. (A)  
Kotsch, Elmer G. (A)  
Mag, Anthony (A)  
McCall, Keith E. (A)  
Shoup, Allen (A)  
Shuler, John H. (A)  
Sutherland, Lee (M)  
Thompson, Max F. (A)  
Trout, Virgil E. (A)  
Ulrey, Dayton (A)

Willow Grove  
Robinson, Harris A. (J)

Wynnewood  
Seeley, S. W. (A)

York  
Gottlieb, Morris (A)  
Heselton, Charles C. (A)  
Lever, Philip R. E. (A)  
Overmiller, Clair M. (A)  
Stewart, James W. (A)  
Weigel, Richard C. (A)

Zelienople  
Bassler, Sherman G. (J)

RHODE ISLAND  
Auburn  
Davis, Charles E. (A)

Edgewood  
Cummerford, Arthur S. (A)  
Massie, Walter W. (M)

Newport  
Kelly, John H., Jr. (A)

Pawtucket  
Le Beau, George B. (J)

Providence  
Cote, Omer E. (A)  
Gerry, Frank L. (A)  
Maker, Albert E. (A)  
Smith, Malcolm H. (A)  
St. Laurent, Herbert (A)

Rumford  
Shaw, Frederick L. (A)

Thornton  
Grain, Everard B. (A)

Woonsocket  
Teachman, Alfred E. (A)

SOUTH CAROLINA  
Aiken  
Terry, Laurence M. (A)

Anderson  
Mitchell, John A. (A)

Charleston  
Smith, Jesse H. (A)  
Zeigler, T. W. (A)

Clemson College  
Garrison, Paul J. (A)

Greenville  
Bangs, Philip C. (A)

SOUTH DAKOTA  
Brookings  
Crothers, H. M. (A)

Rapid City  
Halley, Samuel R. (A)  
Kammerman, J. O. (A)

Yale  
Pauts, Walter O. (A)

Yankton  
Nelson, Ivar (A)  
Seils, Harry A. (A)

## TENNESSEE

Athens  
Knight, Gaylord A. (A)

Chattanooga  
George, E. E. (A)  
Thomas, Norman A. (A)

Cleveland  
Slaughter, Jack D. (A)

Knoxville  
Adcock, Stewart E. (A)

La Grange  
Sims, James W. (A)

Memphis  
Cowles, John W., Jr. (J)  
Dowler, R. B. (A)  
Slavick, Henry W. (A)

Nashville  
Leftwich, E. H. (A)  
Montgomery, L. H., Jr. (A)

## TEXAS

Albany  
Cordington, Jerome H. (J)

Amarillo  
Berg, Arthur A. E. (A)  
Reville, T. A., Jr. (J)  
Todd, William F. (A)  
Wimberly, W. Ben (J)

Austin  
Jones, F. Burton (J)

Bastrop  
Barrow, Lemuel T. (A)

Baytown  
Groves, Wayland M. (A)

Beaumont  
Johnson, Charles A. (A)  
Trevey, C. B. (A)  
Wengel, Raymond W. (A)

Beeville  
Hall, Henry W. (A)

Brownsville  
Do Bardeleben, John F. (A)

College Station  
Sweeny, Carey P. (A)

Dallas  
Corry, Hal F. (A)  
Crabtree, Alfred E. (A)  
Evans, W. J. (A)  
Feickert, Carl A. (A)  
Flynn, Roy M. (A)  
Gaines, James B. (A)  
Glass, Robert Z. (A)  
Green, J. Moore (A)  
Honnell, Pierre M. (J)  
Hull, Blake D. (A)  
Lawther, H. P., Jr. (A)  
Lewis William S. (A)  
McGalin, A. G. (A)  
Owens, Richard M. (A)  
Rich, F. L. (A)  
Sheffield, H. M. (A)  
Smith, Thomas Frank (A)  
Thiele, L. E. (A)  
White, Newell N. (A)

De Leon  
Nance, Maurice L. (A)

Denton  
Fain, Edgar A. (A)

El Paso  
Morris, George W. (A)

Fort Worth  
Abey, Robert E. (A)  
Branch, William E. (M)  
Phillips, James H. (A)  
Sullivan, J. R. (A)

Galveston  
Dickey, J. W. (A)  
Hughes, Kenneth E. (A)

Greenville  
Tull, Milton G. (A)

Harper  
Hopf, Max H. (A)

Houston  
Austin, Francis M. (A)  
Chinski, Gerald R. (A)  
Coe, James C. (A)  
Dupree, Edmund M. (M)  
Gower, S. Gifford (A)  
Hockins, Laban A. (A)  
Kelly, Claude H. (A)  
Knittle, M. B. (A)  
Mc Dermott, Eugene (A)  
McFarland, M. Ralph (A)  
Ricker, Norman H. (A)  
Stalnaker, Burr (A)  
Waters, James S. (A)  
Wheeler, H. (J)  
Zimmerman, G. E. (A)

Kelly Field  
Teague, T. T. (M)

Laredo  
Otal, Carlos, Jr. (J)

Livingston  
McClanahan, Claude (A)

Lockhart  
Shaw, Paul (A)

Lubbock  
Abbitt, William H. (A)

Mercedes  
Schmitter, Ray M. (A)

Pampa  
Thurmond, Vester H. (J)

Plano  
Hayes, Howard D. (A)

Rockland  
Wilson, S. Earle (A)

Rowena  
Machotka, Miroslav (A)  
Machotka, Slavomir (J)

San Antonio  
Bridge, Robert B. (A)  
Cunningham, Edward H. (A)  
Kidd, Thornton L. (A)  
Kush, Fred W. (A)  
McShano, Joe Bailey (A)  
Rayburn, Geoffrey D. (A)  
Wall, Leavell D. (A)

South San Antonio  
Doehne, Eugene C. (J)

Tyler  
Daniel, Roy G. (A)  
Doane, Eldeene M. (A)

Waco  
Jackson, Frank P. (A)

UTAH  
Murray  
Smith, Edwin W. (A)

Salt Lake City  
Baldwin, John M. (A)  
Baldwin, Nathaniel (M)  
Gifford, Delbert K. (A)  
Lasky, Philip G. (A)  
Whidden, Ira P. (A)  
Yeates, Ephraim Leroy (A)

VERMONT  
Northfield  
Howes, Douglas E. (A)

Waitsfield  
Farr, Alton E. (A)

## VIRGINIA

**Alexandria**  
Dowie, James A. (M)  
Evans, Louis M. (A)  
Roesch, Robert E. (A)

**Arlington**  
Mackay, Warren S. (A)

**Cape Henry**  
Remmlin, C. D. (J)

**Danville**  
Clarke, Allen S. (A)  
Ellis, P. H. (A)

**Langley Field**  
Culver, Clarence C. (M)

**Norfolk**  
Kelley, George W., Jr. (A)  
Kenny, Matthew (A)  
Kortcs, George T. (A)  
McConnel, W. G. (A)  
Regan, Smiley I. (A)  
Trigger, Vernon H. (A)

**Petersburg**  
Cooper, David L. (A)

**Portsmouth**  
Baart, John C. (A)

**Quantico**  
Mizell, M. H. (A)

**Richmond**  
Selph, Orris M. (A)  
Wood, W. H. (A)

**Roanoke**  
Maddox, Francis E. (A)

## WASHINGTON

**Auburn**  
Nagata, Charles N. (A)

**Bremerton**  
Peterson, A. W. (M)  
Rowe, Victor G. (A)  
Wilson, George F. (A)

**College Place**  
Kretchmar, G. G. (A)

**Everett**  
Sands, Leo G. (J)

**Fort Lewis**  
Shaw, Robert M. (A)

**Gig Harbor**  
Berkheimer, R. H. (A)

**Port Angeles**  
Kalin, Albert (A)

**Richmond Highlands**  
Melang, Bjorn L. (A)  
Walker, Robert M. (A)

**Seattle**  
Agner, George M. (A)  
Austin, Leslie C. (A)  
Avery, Alfred L. (A)  
Bach, Roy O. (A)  
Brandt, Oscar T. D. (A)  
Brott, F. J. (A)  
Budden, Frank W. (A)  
Burleigh, John A. (A)  
Carver, Orin H. (A)  
Davis, Ranson K. (A)  
Deardorff, Ralph W. (A)  
Demuth, Orin A. (A)  
Douglas, William A. (A)  
Eastman, Austin V. (A)  
Flager, Robert H. (A)  
Foster, Nich H. (A)  
Giovannini, Frank (A)

Hackett, Paul J. (A)  
Hamilton, Edward A. (A)  
Hill, Herbert H. (A)  
Hill, John H. (A)  
Hodges, Arthur T. (A)  
Iversen, I. Vee (A)  
Jenkins, L. A. (A)  
Kleist, Walter A. (A)  
Kraft, Vincent I. (A)  
Kuhn, Frederick S. (A)  
Lovejoy, Edwin W. (M)  
Mason, Howard F. (A)  
Moesman, F. B. (A)  
Reiss, David M. (A)  
Renfro, Herald E. (A)  
Rewak, C. T. (A)  
Richards, John (A)  
Rieger, William (A)  
Ross, J. D. (A)  
Schreiber, Ernst H. (A)  
Sletmos, A. M. (A)  
Sylvester, W. V. (A)  
Tolmie, J. R. (A)  
Williams, Charles E. (M)  
Willson, Abner R. (A)  
Winningham, H. W. (A)  
Zaluskey, Eugene R. (A)

## Smith Island

Riley, Conrad D. (A)

## Spokane

Drobig, Leo (A)  
Eberly, Austin D. (A)  
Jensen, Sven (A)  
Johnson, Carl A. (A)  
Mac Lean, T. Wendell (A)  
Paulson, Clarence I. (A)  
Prince, Frank W. (A)  
Smith, Oliver C. (A)  
Van Dusen, Paul F. (A)  
Wimmer, Joseph (A)

## Tacoma

Evans, Leon R. (A)  
Haymond, Carl E. (A)  
Miller, George C. (A)  
White, Kenneth E. (J)

## Wenatchee

Lanphere, Merle (A)

## Yakima

Hagen, B. W. R. (A)

## WEST VIRGINIA

**Charleston**  
Brandt, Louis H. (A)  
Morgan J. T. (A)

**Chester**  
Faudree, R. F. (A)

**Clarksburg**  
Chorpening, George B. (A)

**Fairmont**  
Beerbower, R. G. (A)

**Huntington**  
Bieber, Clarence G. (A)  
Hines, Oscar T. (A)

**Institute**  
Evans, James C. (A)

**Morgantown**  
Colwell, Robert C. (A)  
Swisher, O. V. (A)

**Wheeling**  
Boundy, Glenn G. (A)  
Pence, Samuel E. (A)  
Risley, F. S. (A)  
Stroebel, John C., Jr. (M)  
Weimer, Earl W. (A)

## WISCONSIN

**Antigo**  
Matthias, Lynn H. (A)

**Beaver Dam**  
Russell, Murray (A)

**Black River Falls**  
Gebhardt, Paul B. (A)

**Coloma**  
Curran, George W. (A)

**Eau Claire**  
Langdell, Henry R. (A)

**Fond du Lac**  
Kessler, P. W. (A)

**La Crosse**  
Leeman, Alvin (A)  
Trumble, L. A. (A)  
Van Loan, Cullen G. (A)

**Lodi**  
Evert, W. E. (A)

**Madison**  
Austin, Otto C. (A)  
Bennett, Edward (F)  
Cheng, L. Y. (A)  
Evans, Herbert P. (A)  
Hoffman, W. Hollis (A)  
Holman, Henry (A)  
Koehler, Glenn (A)  
Miller, Burton F. (A)  
Peters, Leo J. (A)  
Pfeiler, Lawrence F. (A)  
Schnell, Fred H. (A)  
Sveen, Erwing A. (A)  
Terry, Earle M. (M)  
Wetzel, Joseph A. (A)  
Zurian, P. D. (J)

## Manitowoc

Frish, B. F. (J)  
Scholten, Charles H. (J)

## Milwaukee

Almes, William E. (A)  
Bogenberger, John W. (A)  
Braeking, Alvin F. (A)  
Brafford, Charles P. (A)  
Carter, Otis H. (J)  
Cobb, Everett (J)  
Cordes, Edwin L. (A)  
Cummings, George B. (A)  
De Land, Robert E. (A)  
Gainer, William P. (A)  
Halfpap, Bert A. (A)  
Hebal, William H. (A)  
Heim, Carl (A)  
Hiller, Nicolai H., Jr. (A)  
Holst, Ernst W. (A)  
Hostettler, Amos C. (A)  
Kaetel, Herbert C. (J)  
Kazmierowski, John J. (A)  
Kelly, Daniel S. W. (A)  
Kleist, Alfred H. (A)  
Kuenne, K. R. (A)  
Lo Van, James D. (A)  
Luecker, Fred W., Jr. (A)  
Manney, G. C. (A)  
Meyer, John M. (A)  
Moorbeck, Clinton (J)  
Nunn, E. D. (A)  
Pfeifer, Joseph W. (A)  
Richardson, Marston S. (A)  
Ritter, Ralph B. (A)  
Seibel, Donald E. (A)  
Simon, Arthur (A)  
Snead, Sam (A)  
Stoekle, Erwin R. (M)  
Thomas, Morris W. (A)  
Topolinaki, Leo J. (A)  
Vaughn, F. A. (A)  
Wareing, Herbert F. (A)  
Weiss, Tobias (A)

## Neenah

Ponto, Aaron E. (A)

## Oshkosh

Shambeau, W. R. (A)

## Osseo

Nelson, Orrin B. (A)

## Potosi

Roser, Clarence O. (J)

## Racine

Host, Raymond H. (A)

## Rewey

Carpenter, Archie V. (A)

## Stevens Point

Brickson, H. O. (A)

## Watertown

Ebert, Sylvanus J. (A)

## Wauwatosa

Devendorf, H. H. (A)

## Waukesha

Golding, Robert M. (A)

## West Allis

Schunck, Fremont D. (A)

## WYOMING

## Casper

Hood, Norman R. (A)  
MacKenzie, Jack (J)  
Martin, Donald E. (A)

## ALASKA

Hannon, John P. (A)  
Maki, George J. (A)  
Woolverton, Robert B. (F)

## CANAL ZONE

Bullock, Gilbert D. (A)  
Ellingson, H. J. (A)  
Grafe, Hans R. (A)  
Lyman, Reginald P. (M)  
Young, John W. (A)

## HAWAII

Abbott, Walter (A)  
Balch, J. A. (M)  
Borthwick, James H. (A)  
Eller, Willard H. (A)  
Gould, George B. (A)  
Janitschke, E. O. (A)  
Schaeffer, Carl T. (A)  
White, Edwin L. (A)  
Yonemoto, Masato (A)

## PHILIPPINE ISLANDS

Bender, Louis B. (M)  
Dow, J. B. (M)  
Elser, F. Johnson (A)  
Grupe, Emilio (A)  
Hurwitz, Solomon Bernard (A)  
Lara, Albino (A)  
Nance, Curtis H. (M)  
Novotney, H. J. (A)  
Olivares, J. E. (A)  
Rau, David S. (A)  
Slater, F. Robert (A)

## PORTO RICO

Agusty, Joaquin (A)  
Draigh, Canton V. (A)  
Mayer, Everett W. (A)  
Schell, Richard, Jr. (A)

## CANADA

## ALBERTA

Duncan, James E. (A)  
Ryley, Raymond (A)

## BRITISH COLUMBIA

Barclay, Hugh N. (A)  
 Bartholomew, Francis J. (A)  
 Benson, John P. (A)  
 Claringbull, D. (A)  
 Deacon, Alan I. (A)  
 Filtness, Arthur W. (A)  
 Gilbert, George (A)  
 Hawkins, Ernest H. (A)  
 Hawkins, Leslie S. (M)  
 Irvine, Basil (A)  
 Kitchin, J. E. (A)  
 Lapham, James P. (A)  
 Marriott, John S. (A)  
 Mawson, John T., Jr. (A)  
 Rose, F. W. (A)  
 Sawford, Frank, Jr. (A)  
 Stout, Edward A. (A)  
 Thomas, Clarence W. (A)  
 Thompson, J. H. (J)  
 West, Horace E. (J)

## MANITOBA

Bishop, Ernest F. (A)  
 Leitch, Donald J. H. (A)  
 Mills, Gilbert H. (A)  
 Pound, Harris D. (A)  
 Salton, Lynn V. (M)

## NEW BRUNSWICK

Stevens, Ronald C. (J)  
 Vaughan, Frank P. (A)

## NORTHWEST TERRITORY

Hastings, R. Stuart (A)

## NOVA SCOTIA

Cusack, Sidney C. (A)  
 Starr, C. Harry (A)  
 Sutherland, Alexander (A)  
 Way, Harry C. (A)  
 Wood, William (A)

## ONTARIO

Ainsworth, A. L. (A)  
 Anderson, J. F. (A)  
 Bailey, Ambrose L. (J)  
 Baldwin, Arthur V. (A)  
 Baldwin, George (A)  
 Barber, Walter G. (A)  
 Bayley, B. De F. (A)  
 Blakely, Robert J. (A)  
 Bond, Roydon J. (A)  
 Brown, Harry S. (A)  
 Burke, Joseph L. (A)  
 Carment, James M. (A)  
 Caton, William A. (A)  
 Chapman, Edmund V. (A)  
 Choat, William F. (A)  
 Cline, Russell A. (J)  
 Cluff, Harold D. (A)  
 Cooper, Ashton B. (A)  
 Crittle, W. J. (A)  
 Crump, Albert E. (J)  
 Dalton, F. K. (M)  
 De Grave, Claude (A)  
 Dibblee, John (A)  
 Dorte, Philip H. (A)  
 Dresser, Carl C. (A)  
 Edwards, C. P. (F)  
 Emes, Karl C. (A)  
 Evans, George L. (A)  
 Ferguson, Arthur F. (A)  
 Fiegehen, Maurice G. (A)  
 Fletcher, Henry J. (A)  
 Ford, J. S. (A)  
 Fowler, Walter D. (A)  
 Gaby, Frederick A. (A)  
 Gadsby, S. J. (A)  
 Galbraith, R. A. II. (A)  
 Geldert, George M. (A)  
 Gerrie, William H. (A)  
 Gowan, Frank S. (A)

Gowan, Hubert S. (A)  
 Graham, Burwell (A)  
 Grant, Eric A. (J)  
 Gurd, Ronald H. (A)  
 Hackbusch, Ralph A. (A)  
 Hebbel, Charles T. (A)  
 Henderson, J. P. (M)  
 Hepburn, Dugald (M)  
 Hodsoll, Martin (A)  
 Howe, A. E. (A)  
 Hughes, Peter (A)  
 Hutton, George (A)  
 Innes, Ronald G. (J)  
 Jackson, Leslie (A)  
 Jessop, F. R. (A)  
 Kelterborn, W. H. (A)  
 Knapman, Jack (J)  
 Kynnersley, Charles (A)  
 Langford, Clare H. (A)  
 Laurie, W. L. (A)  
 Lee, Stanley A. (A)  
 Leslie, John M. (A)  
 Lowry, Charles A. (A)  
 Jundy, Stanley R. (A)  
 Mackeen, Rupert T. (A)  
 Mann, George F. (A)  
 McAleavey, Henry V. (A)  
 McCullagh, Karl G. (A)  
 McClain, Gordon W. (A)  
 McLachlan, Walter R. (A)  
 McMillan, Donald B. (J)  
 McMurtry, Cyril A. W. (A)  
 Meredith, C. C. (A)  
 Mills, Thomas A. (A)  
 Mitchell, Leonard W. (J)  
 Mock, Elmer E. (A)  
 Mogridge, J. Nairn (A)  
 Montagnes, Henry (A)  
 Mosley, R. F. (A)  
 Mott, Harold E. (A)  
 Nash, James C. (A)  
 Newman, John R. (A)  
 Northover, Harold W. (A)  
 Olding, Norman R. (A)  
 Oxley, Allan B. (A)  
 Paisley, Stewart R. (A)  
 Parsons, J. B. (A)  
 Patience, A. Melbourne (M)  
 Patterson, C. F. (A)  
 Pipe, Gordon E. (A)  
 Pollock, C. A. (A)  
 Pounsett, Frank H. R. (A)  
 Price, Harold W. (A)  
 Price, Roland J. C. (J)  
 Relyea, John D. (M)  
 Richardson, Charles L. (M)  
 Robertson, Joseph J. C. (A)  
 Rogers, Edward S. (M)  
 Roe, Robert J. (A)  
 Roe, Sidney (A)  
 Rosebrugh, Thomas R. (A)  
 Rothera, W. F. (J)  
 Ruse, Arthur (A)  
 Rush, Walter A. (F)  
 Russell, A. H. K. (A)  
 Russell, W. G. (A)  
 Scott, Arthur L. (A)  
 Sherratt, Joseph B. (A)  
 Smith, Arthur (A)  
 Smith, B. J. (A)  
 Smith, C. C. (A)  
 Smith, Victor G. (A)  
 Soucy, Chester I. (A)  
 Spotton, J. G. (A)  
 Steel, W. Arthur (M)  
 Stephany, Harold (J)  
 Taber, Harold E. (A)  
 Thompson, Milton L. (A)  
 Thomson, J. M. (A)  
 Underwood, Clifford C. (A)  
 Van Sickle, Melvin (A)

## ONTARIO (Continued)

Wallace, J. M. (A)  
 Walsh, Harold E. (A)  
 Warwood, W. E. (A)  
 Watling, William J. (A)  
 Weaver, William E. (A)  
 Weber, Rennie I. (A)  
 Weir, Harold G. (A)  
 Welch, Clifford (A)  
 Whitmore, Walter R. (A)  
 Wilkinson, Allan E. (A)  
 Williams, James (A)  
 Wilson, F. Clinton (A)  
 Wood, H. T. W. (A)

## QUEBEC

Action, Edward H. (A)  
 Andrae, Robert T. (A)  
 Barrow, Frederick A. (A)  
 Bellew, Leo T. (J)  
 Blais, Alphy L. (A)  
 Boyd, David (A)  
 Cann, John O. G. (F)  
 Conroy, Joseph M. (A)  
 Cooper, Samuel J. (A)  
 Fenwick, James R. (A)  
 Goldin, Hyman C. (A)  
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**INDEX TO THE PROCEEDINGS**  
of the  
**INSTITUTE OF RADIO ENGINEERS**  
1927-1928

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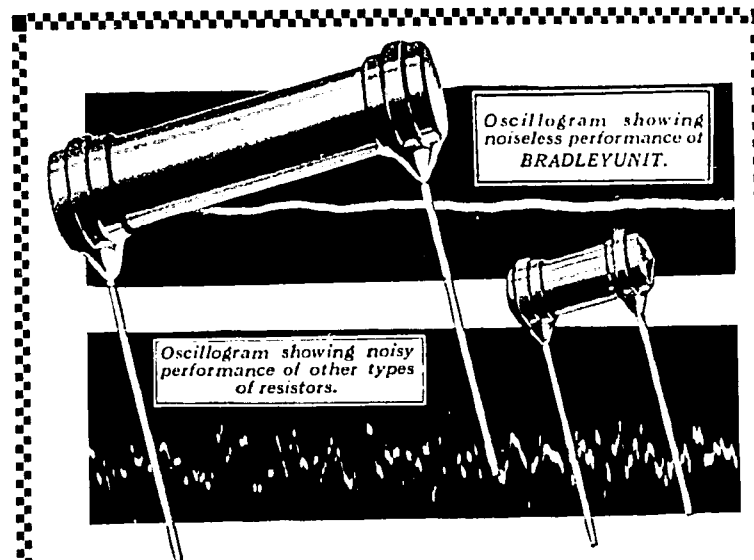


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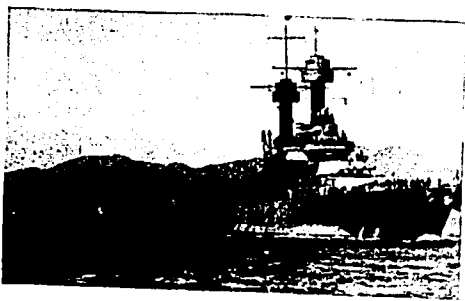
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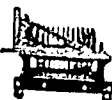
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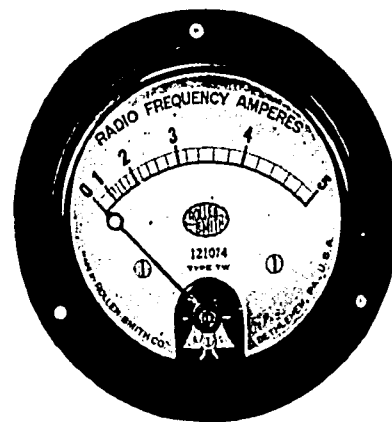
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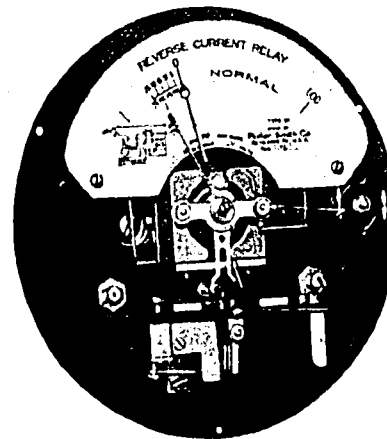
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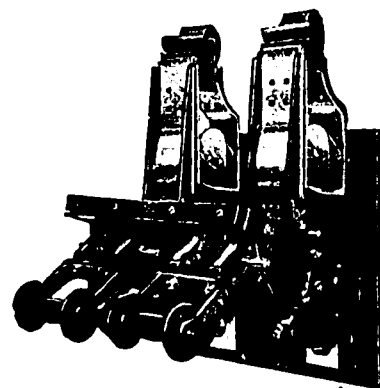
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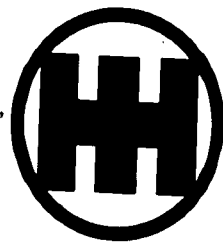
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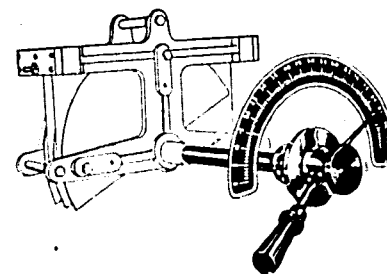
VI

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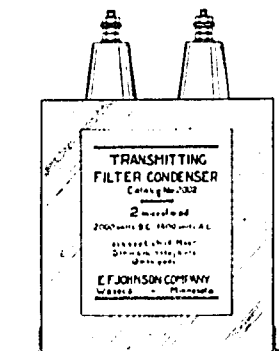
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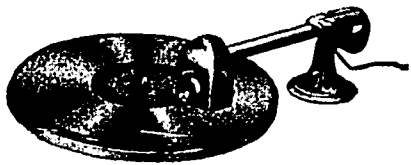


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VII

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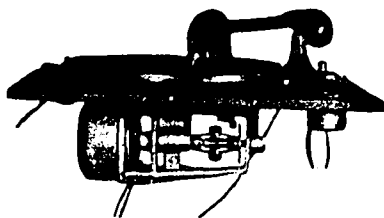
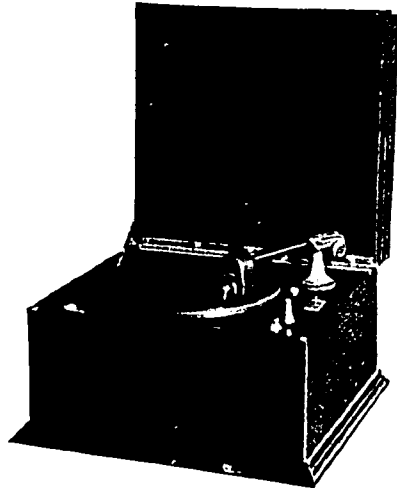
Among the features of the Phonovox responsible for its tremendous success are the balanced tone arm, the patented needle holder which assures perfect contact between needle and record, and the fact that it will use fibre needles without loss of volume. Attractively finished in bronze and black. List price, \$13.50.

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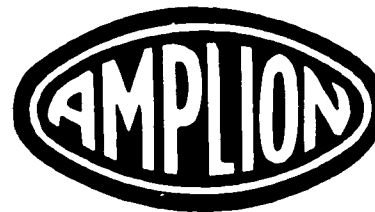
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VIII

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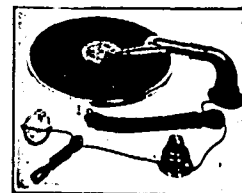
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IX

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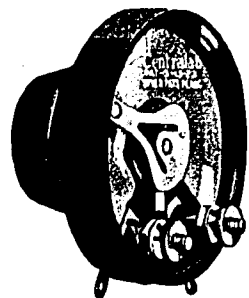
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X

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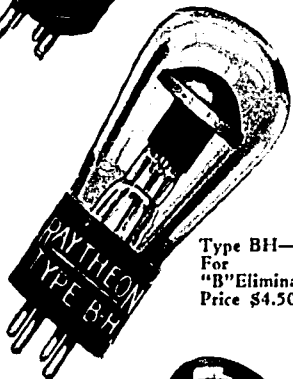
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XI

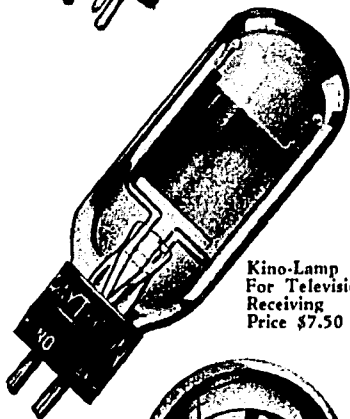




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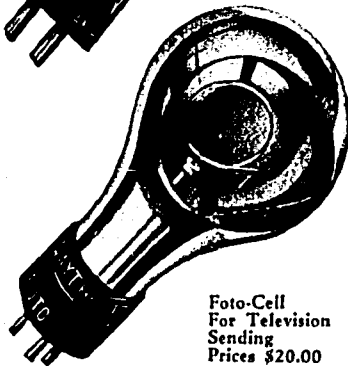


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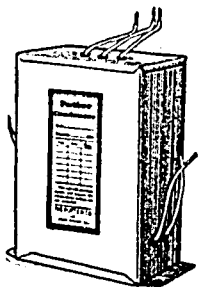
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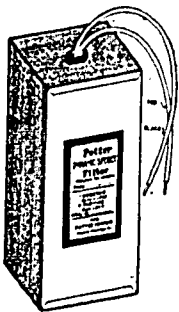


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The construction allows the use in any position as it is of the dry type which is a solid mass in texture, permanently sealed, and in no way should be confused with electrolytic wet condensers using solutions, pastes or jellies, and requires no servicing attention. The dielectric provides the durability and minimum leakage current, which, in a unit of this kind, is of the order of one milliampere at ten volts in the correct sense according to the polarization.

A Potter Dynamic Speaker Filter is the ideal unit to use with a dynamic speaker to correct whatever hum may be present and to give increased operating qualities.

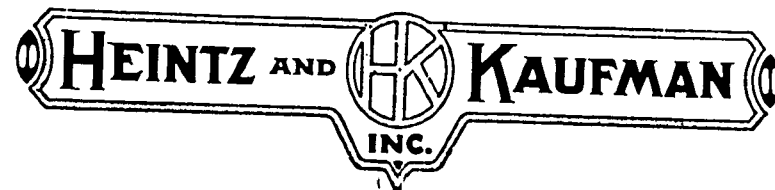


**The Potter Co.**

North Chicago, Illinois

*A National Organization of Your Service*

**CONSULTING & CONSTRUCTING  
RADIO ENGINEERS**



219-237 NATOMA ST.  
SAN FRANCISCO, U.S.A.

CABLE ADDRESS  
HEIKAU

**Choose Your  
WIRE**

Here are shown fourteen popular types of wire and insulations each made in a full range of commercial sizes.

1. Silk Covered Enamelled Wire	8. Bare or Tinned Copper Wire
2. Silk Covered Magnet Wire	9. Square and Rectangular Magnet Wire
3. "Ducotto Wire." A cotton covered wire, enameled	10. Stranded and Braided Cables
4. Cotton Covered Enamelled Wire	11. Enamelled Magnet Wire
5. Cotton Covered Magnet Wire	12. Flexible Coil Leads
6. High Frequency Cables, Latex-insulated wire	13. Antenna Wire—Stranded Enamelled or bare
7. Flat Braided Cables	14. Square and Rectangular Wire

Special wires made to specifications. The world's headquarters for Radio coils.

**DUDLO**

**DUDLO MANUFACTURING CO., FORT WAYNE, INDIANA**

*Division of General Cable Corporation*

420 Lexington Ave.  
NEW YORK CITY

105 West Adams St.  
CHICAGO, ILL.

274 Brannan St.  
SAN FRANCISCO, CALIF.

4143 Bingham Ave.  
ST. LOUIS, MO.

**SM**

**SOUND  
AMPLIFICATION  
of QUALITY  
UNEXCELLED**

S-M sound amplifiers embody the concentrated experience of Silver-Marshall in building amplifiers powerful enough to cover large crowds, with practically perfect tone fidelity. Both of these standard types are available through the trade. All amplifiers here listed operate entirely from the A.C. light socket, and, using the famous S-M Clough-system audio transformers in all stages, insure a straight-line characteristic from 5000 cycles down to 70 cycles or below.

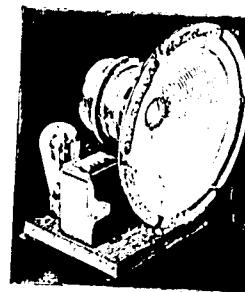
S-M 690, to reach 2000 or more people, has three stages, the last two being push-pull; will supply 6 to 12 or more dynamic speakers. Fading control is provided on the panel, and a three-point switch for record, microphone, and radio input selection. Tubes required: 1—27, 2—26, 2—50, 2—81. List price less tubes, \$265.

S-M 679, (two-stage, supplying 2 to 4 or more dynamic speakers) will cover 1500 people or more. It has binding posts for microphone, record, or radio pickup. Tubes required: 1—26, 1—50, 2—81. List price less tubes, \$135.

#### "PA" Rack-and-Panel Unit Amplifiers

The largest areas can be covered with amp e volume by using S-M Rack-and-Panel Amplifiers—and at a surprisingly low cost. These amplifiers are sold not through the trade, but direct to engineers. The illustration shows two PA-30A 15-watt output panels, each using 2—50 tubes in push-pull with 2—81 rectifiers, together with volume indicator, input control, input amplifier, meter, and input-power-supply panels. These panels are available in any combination as required, and when properly installed will give results comparing favorably with any competitive American equipment at any price.

#### Matched-Impedance Dynamic Speakers



S-M dynamic speaker units embody a speaker head of the very finest construction, equipped with S-M 229 output transformer with taps (brought out to tip-jacks) so that connections can be instantly altered to match impedance of any standard power tubes, singly or in push-pull. S-M 851 (D.C. 110 volts), price \$48.50. S-M 850 (A.C. 110 volts) uses 1—80 rectifier tube, with S-M high-efficiency filter, insuring hum-free operation with no bucking coils to impair bass note reproduction; price, less tube, \$58.50.

*Recommendations for any sound amplifier installation may be had promptly, without obligation. Address Chief Engineer, Power Amplifier Division.*

**SILVER-MARSHALL, INC.** 876 W. JACKSON BLDG.  
CHICAGO, U. S. A.



PAM 16 or 17  
List Price without tubes,  
\$125.00  
Smallest of a complete line

## Standard Equipment Everywhere With Radio Engineers

THE U. S. Government, technical laboratories, universities, broadcast stations and other places where radio values are known and only the best apparatus tolerated use

### Samson Radio Products

from the tropics to the polar regions and in both the most humid and arid regions of the world. In the air, on land and sea, and under water you will find them in service. You are invited to avail yourself of our Research Laboratories where 30 years engineering experience is available.

**Samson Electric Co.**

MANUFACTURERS SINCE 1882

Main office:  
Canton, Mass.



Factories at Canton  
and Watertown, Mass.

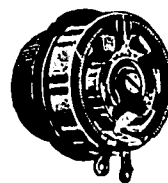
XVIII

## Radio Parts are an Investment They Must Measure Up to Your Circuit

All the engineering skill and knowledge that you put into your receiver design and construction must be safeguarded by the use of the very best parts. Yaxley parts are made to give lasting, efficient service and

**YAXLEY**  
APPROVED RADIO PRODUCTS

to do their work perfectly. That is why they persist in retaining first place in the choice of the leading engineers and set manufacturers of the country who use them as an investment against trouble.



### Junior Rheostat

Small in size, but a master instrument. Exceedingly fine adjustment and velvet smooth action. Diameter, 1 7/16 inches.

Up to 400 ohms.....	\$ .75
1,000, 2,000 and 3,000 ohms.....	1.00
Potentiometers, extra.....	.25
Self-attaching, positive-acting switches for Junior Rheostats.....	.40

### Resistance Units

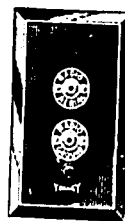
Absolutely dependable. Run true to rating. Have convenient screw eyes and soldering lugs for easy mounting and wiring.



Space wound, 1 to 60 ohms.....	15¢
100 to 400 ohms.....	25¢
Tapped resistances, 6 to 64 ohms.....	30¢
100 to 400 ohms.....	40¢
Grid resistances, 100 to 500 ohms.....	25¢
600 to 3,000 ohms.....	35¢

### Radio Convenience Outlets

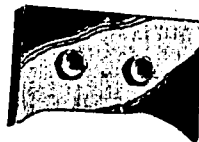
Fit any standard switch box. Full instructions for installing with each outlet.



No. 135—For Loud Speaker.....	\$1.00
No. 136—For Aerial and Ground.....	1.00
No. 134—For Several Loud Speakers.....	2.50
No. 132—12 Conductor—For Power Pack Connections.....	3.00
No. 137—7 Conductor—For Battery Connections.....	2.50
No. 138—For A. C. Connections.....	1.00

Also furnished in two- and three-plate gang combinations.  
WITH BAKELITE PLATES  
Now furnished with a rich satin brown Bakelite plate, with beautiful markings to harmonize, at 25¢ extra.

### Colored Phone Tip Jacks



Have distinctive colored caps, red for positive side of loud speaker and black for negative side. Cap is of Bakelite. Take standard Phone Tips. Phone tips nest all the way

in Jack, making excellent spring contact. Lessens danger of shorts. For Bakelite or metal panels.

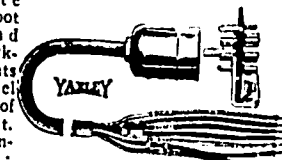
No. 422—Insulated Colored Phone Tip Jacks, Per Pair. 25¢

PHONE PLUGS  
AUTOMATIC POWER RELAYS  
AIR-COOLED RHEOSTATS

New Illustrated Catalog

YAXLEY MFG. CO.

### Cable Connector Plug



Complete with 5-foot cable and cable markers. Mounts on base panel by means of bracket. Bakelite construction; positive spring contacts; no loosening of pins or springs in soldering. Impossible to connect improperly. Terminal and cable ends plainly marked.  
No. 660—Complete .....\$3.00

CABLE MARKERS  
PANEL LIGHTS  
JACK SWITCHES

Mailed FREE on Request

Dept. K, 9 So. Clinton St., Chicago

XIX



## COMPETITION *in* QUALITY Pays

THERE has been a steady increase in the amount of Formica used by the leading electrical manufacturers for many years.

This increase has been due in large part to the fact that cheaper, less reliable materials have been replaced.

By increasing their material costs, manufacturers have reduced costs due to service, replacement and trouble, by a larger amount.

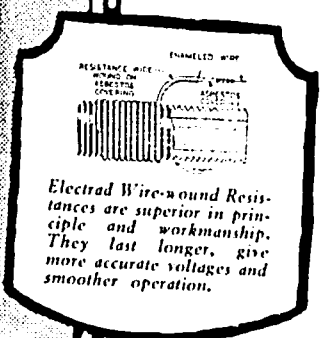
Steadily growing use of this non-absorbant, uniform and dependable insulating material, is proof that it pays to use it.

Quick service from a centrally located plant on a quality material made by an organization of specialists . . . that's what Formica offers.

**FORMICA**  
Made from Anhydrous Bakelite Resins  
SHEETS TUBES RODS

The Formica Insulation Co., 4626 Spring Grove Ave., Cincinnati, Ohio

Not Because They're Different—  
But Because They're BETTER!



**TRUVOLT**  
ALL-WIRE  
RESISTANCES

U. S. Pat. No. 1,676,869  
and Pats. Pending

Electrad Wire-wound Resistances are superior in principle and workmanship. They last longer, give more accurate voltages and smoother operation.

FOR "B" Eliminator and Power-Pack construction Truvolt All-Wire Resistances have definite advantages.

Study the illustration. Nichrome resistance wire wound over asbestos, having a flexible enameled copper core, then this in turn wound around a grooved fire-clay base. Simple—accessible—safe.

Perfect insulation; direct air cooling; larger resistance wire in smaller space, giving finer voltage regulation; positive metal-to-metal contact, with endwise travel assuring smoother variations and less wear; avoids complicated calculations.

Variable with knob control—also fixed types with a sliding clip adjustable to different set values—an exclusive Truvolt feature.

Our Engineering Department will gladly recommend special units with full technical data.

Electrad specializes in a full line of Controls for all Radio Purposes, including Television.

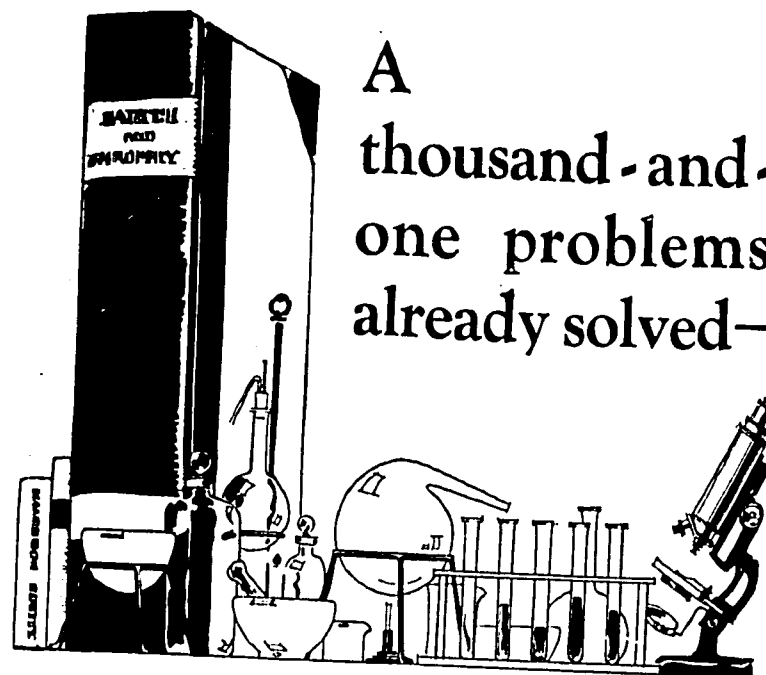
Write for Blueprints and Technical Data.

Dept. IRI, 175 Varick St., NEW YORK

**ELECTRAD**  
Inc

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A  
thousand-and-  
one problems  
already solved—

*yours is undoubtedly among them*

The records of our Service Engineering Department constitute a complete library of information relative to laminated bakelite and vulcanized fibre electrical insulation.

This data is available to you . . . Make use of it to overcome any difficulties encountered in the fabricating or performance of your products. Let us know what you want laminated insulation to accomplish and we will check back over the thousand-and-one problems already solved to determine the exact grade best suited to your needs.

**NATIONAL VULCANIZED FIBRE COMPANY**

Wilmington, Delaware, U.S.A.

**NATIONAL  
VULCANIZED  
FIBRE**

*"the material with a million uses"*  
SHEETS: RODS: TUBES: SPECIAL SHAPES

For every electrical and industrial use. Graded to your requirements. Adequate stock insures prompt delivery at all times.

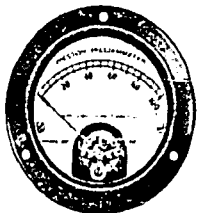
**PHENOLITE**  
Laminated BAKELITE

SHEETS: RODS: TUBES: SPECIAL SHAPES

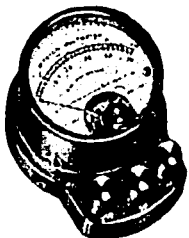
There is a grade of Phenolite of correct mechanical, dielectric and physical properties to meet every electrical or industrial use.



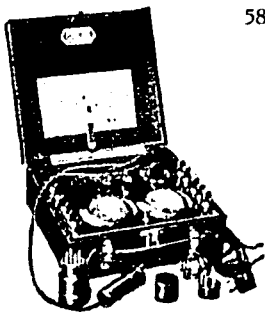
## The WESTON RADIO LINE



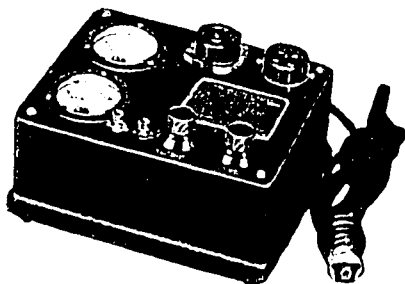
2" and 3 1/4" Diameter  
A. C., D. C., and  
Thermo-Couple Types  
for Flush Panel Mount-  
ing.



Portable Table Models  
—A. C. and D. C.—  
in Single, Double and  
Triple Ranges—1000  
or 125 Ohms per Volt.  
A. C. Model No. 528.  
D. C. Model No. 489.



Model 537 A. C. and D. C. Radio Set  
Tester. Quickly, automatically and  
positively diagnoses all radio troubles.  
Makes every required test on any A. C.  
or D. C. receiver.



Model 533 Counter Tube Checker.  
Operates from any A. C. source. No  
batteries required. Tests A. C. or  
D. C. tubes—all voltages—including  
rectifying types.

# WESTON RADIO INSTRUMENTS

THE selection of instruments should be guided by the universal preference of leading engineers and decided on scientific merit. Pioneering in the field of electrical measurement for more than forty years, Weston instruments are known the world over for their high quality, long-life dependability and incomparable workmanship.

There is this important distinction between the Weston radio instruments and those of other makes. Weston instruments are the original miniature designs—representing years of research and development to produce small models that would in all respects closely resemble their famous prototypes in important electrical characteristics, construction and performance—and yet be extremely moderate in price. This has been accomplished, and the Weston radio line is everywhere recognized to be one of the most important contributions to the art during the whole course of radio's development.

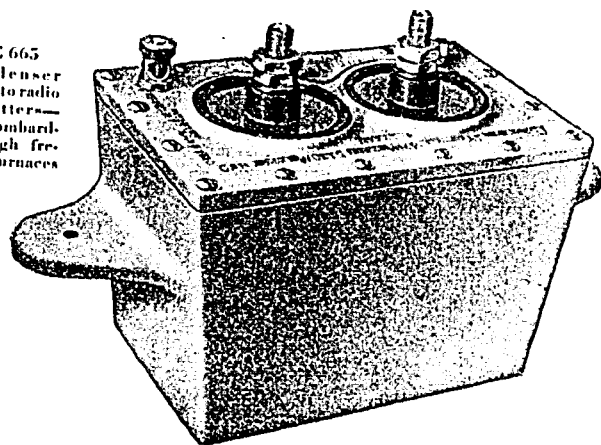
Illustrated herewith are a few of these popular instruments, typical of the line. For full particulars, descriptions, prices, etc., write for the new booklet, "Circular J".

WESTON ELECTRICAL INSTRUMENT  
CORPORATION

589 Frelinghuysen Ave. Newark, N.J.

You Can Forget the Condensers, If They Are DUBILIER'S

TYPE 665  
A condenser  
adapted to radio  
transmitters—  
tube bombard-  
ers—high fre-  
quency furnaces



DUBILIER  
Devices  
—since—  
Reg. U.S. Pat. Off.

## Dubilier—the manufacturers' standard

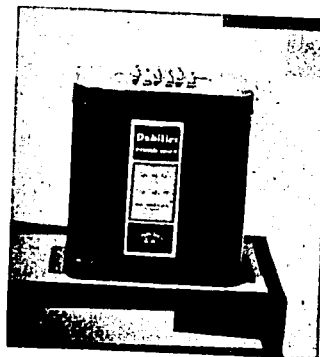
Why do foremost radio engineers specify Dubilier condensers? Because they can't afford to take a chance—and save a few cents!

They must have the assurance that their sets are going to stay sold and they know that the ample factor of safety means *long life*. That's why they specify Dubiliers.

Dubilier has been manufacturing condensers since 1913. Surely this means something.

Consult us in reference  
to your problems

Address Dept. 87

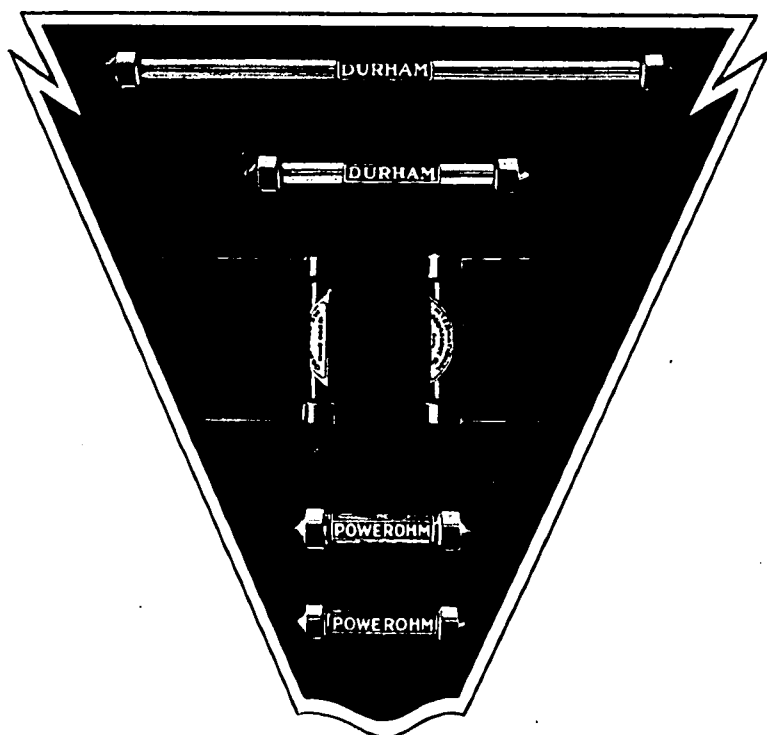


One of the many hundred types of Condensers Dubilier is producing for radio manufacturers. Many thousands of these condensers are being used in well-known and nationally advertised radio sets.

# Dubilier

## CONDENSER CORPORATION

10 East 43rd Street  
New York City



### The New Improved DURHAM POWEROHMS

Each succeeding year, more and more important manufacturers of radio, television and talking movies are standardizing on DURHAMS—the resistances which are dependable, accurate in rating, and can be relied upon for long continued and uninterrupted service.

Supplied in 1 and 2 watt types in standard, pig-tail or special tips; temperature rise at 1 watt is 45°c and at 2 watts 74°c; all types are flash tested at double the rated power load as an extra precaution against electrical or mechanical weaknesses; extremely rugged construction; supplied in all ranges from 500 to 200,000 ohms in power types and from 1 to 100 megohms in resistor types.

Samples for testing gladly sent upon request, together with engineering data sheets. Please state ratings in which you are interested.

# DURHAM

METALLIZED

## RESISTORS & POWEROHMS

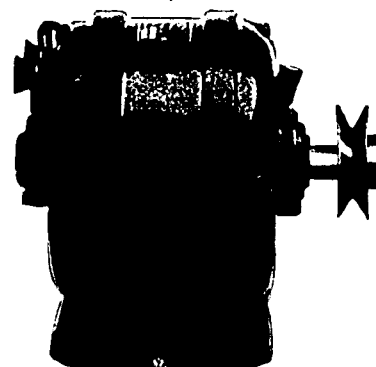
International Resistance Company, 2006 Chestnut Street, Philadelphia, Pa.

XXVI.

## “ESCO”

### Synchronous Motors for Television

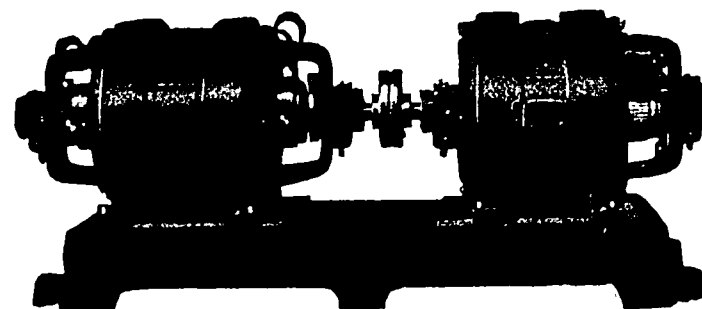
In addition to building reliable and satisfactory motor generators, “Esco” has had many years of experience in building *electric motors* for a great variety of applications.



*Synchronous motors*, small, compact, reliable, self starting are now offered for *Television* equipment. They require no direct current for excitation, are quiet running and fully guaranteed.

Other types of motors suitable for *Television* may also be supplied.

*Write us about your requirements.*



Type BFR, Two Unit Motor Generator Set

“ESCO” two and three unit sets have become the accepted standards for transmission. The “ESCO” line consists of over 200 combinations. These are covered by Bulletin 237D.

*How can “ESCO” Serve You?*



ELECTRIC SPECIALTY COMPANY

TRADE “ESCO” MARK



300 South Street

Stamford, Conn.

XXVII

# AEROVOX

**BUILT BETTER**  
**CONDENSERS AND RESISTORS**

## Without A Doubt The Most Complete Line of Condensers & Resistors

**N**O matter what your requirements may be in the fixed condenser or resistor field, you are sure to find an Aerovox unit exactly suited to your needs.

Filter Blocks	Pyrohm Heavy Duty
Buffer Blocks	Edison Base Pyrohms
Socket Power	Tapped Pyrohms
High Voltage	Wire Wound Units
Transmitting	Grid Suppressors
Bypass	Center-Tapped Units
"A" Power	Non-Inductive Lavite
Bakelite Moulded Mica Condenser	Grid Leaks
Interference Filters	Resistofomer Kits
	Resistor Mountings

In addition to the large number of stock sizes of condensers and resistors, the Aerovox Wireless Corporation is equipped to supply to manufacturers special types and sizes of condensers, filter blocks and resistors in all fixed and tapped combinations on short notice.

### SEND FOR COMPLETE CATALOG

Complete specifications of all Aerovox units, including insulation specifications of condensers, carrying capacities of resistors and all physical dimensions, electrical characteristics and list prices of condensers and resistors are contained in a complete 1928-29 catalog which will be sent gladly on request.



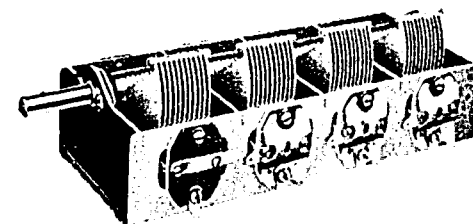
The Aerovox Research Worker is a free monthly publication that will keep you abreast of the latest developments in radio. Your name will be put on the mailing list free of charge on request.

AEROVOX WIRELESS CORP.

80 Washington Street, Brooklyn, N. Y.

PRODUCTS THAT ENDURE

XXVIII



To radio set manufacturers the Scovill Manufacturing Company offers a complete manufacturing service. The Scovill organization, a group of skilled craftsmen, will cooperate with you on your Radio Condenser problems.

Our manufacturing departments have the facilities and capacity to turn out large quantities of condensers built and tested to meet the exact requirements of your set.

Why not let Scovill work with you on your next condenser problems?

#### PRODUCTS

<i>Made to Order</i>	<i>Carried in Stock</i>
Radio Condensers - Variable and Variable Vernier	Brass, Bronze and Nickel Silver
Radio Condenser Plates	Sheet, Rod, Wire and Tubing
Metal Stampings	
Screw Machine Products	Standard Cap and Machine Screws
Special Machine Screws	
Decorated Metal Panels	
Dry Battery Nuts	High Speed Brass Rod for Automatic Screw Machines
Switches	
Special Goods from Brass, Bronze, Steel, Nickel Silver, Aluminum and other metals	Etching Brass

# SCOVILL

#### Scovill Service

Scovill is the name of a broad service to industry. It places acres of factories, forests of machinery, hosts of skilled workmen, metallurgists, modern laboratories and trained representatives at the disposal of those who require parts or finished products of metal. Why not see how Scovill can serve you? Call our nearest office.

**SCOVILL MANUFACTURING COMPANY**  
Waterbury Connecticut

NEW YORK, BOSTON, CHICAGO, PROVIDENCE, PHILADELPHIA, CLEVELAND, SAN FRANCISCO, LOS ANGELES, ATLANTA, CINCINNATI, DETROIT.

European Sales office:  
13 Korte Voorhout, THE HAGUE, HOLLAND

XXIX

Radio Manufacturers Since 1908



## What <sup>PILOT</sup> Offers the Radio Engineer

Scientifically designed, correctly engineered, honestly constructed radio parts built to highest precision standards—

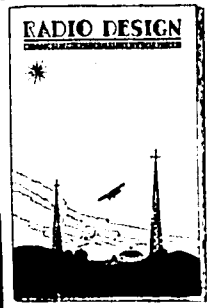
Plus, an engineering service available without cost or obligation—

Plus, intelligent pioneering without commercial consideration, of Television and Airplane Radio apparatus.

Pilot is also the sponsor of "Radio Design," a quarterly devoted to radio developments: television, short wave and broadcast reception. Radio Design is edited from an angle of particular interest to student engineers and professional set builders. Subscription—50¢ a year.

**PILOT ELECTRIC MFG. CO.**

World's Largest  
Radio Parts Plant



323 Berry Street  
Brooklyn, N.Y.

XXX

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## What is Your Measurement Problem?

Fourteen years of experience in the design of precision communication-frequency instruments place us in a position to deal intelligently with your problem. Our engineering staff is at your service for the design and manufacture of special equipment as well as for help on the best methods of using our standard instruments.

If you are not now receiving our monthly bulletin, *The General Radio Experimenter*, a request for it will place your name upon the mailing list.

## GENERAL RADIO COMPANY

*Manufacturers of Electrical and Radio  
Laboratory Instruments*

30 STATE STREET

CAMBRIDGE, MASSACHUSETTS

