Proceedings

of the

Radio Club of America

Incorporated

May - 1929

Volume 6, No. 5

RADIO CLUB OF AMERICA, Inc.
55 West 42nd Street :: New York City

The Radio Club of America, Inc.

55 West 42nd Street :: New York City

TELEPHONE — LONGACRE 8579

OFFICERS FOR 1929

President
Lewis M. Clement

Vice-President
Carl Dreher

Treasurer
Joseph J. Stantley

Corresponding Secretary
Willis Kingsley Wing

Recording Secretary
Charles E. Maps

DIRECTORS

Ernest V. Amy
Edwin H. Armstrong
Wilson Aull, Jr.
George E. Burghard
George J. Eltz, Jr.
Carl F. Goudy
Louis Gerard Pacent
F. X. Rettenmeyer
W. T. Russell
T. J. Styles
A. H. Grebe
Austin C. Lescarboura
Frank King

Business Manager of Proceedings
Carl Dreher

SUGGESTIONS TO CONTRIBUTORS

CONTRIBUTORS to the Proceedings, by bearing in mind the points below, will avoid delay and needless expense to the Club.

1. Manuscripts should be submitted typewritten, double-spaced, to the Chairman of the Papers Committee.* In case of acceptance, the final draft of the article should be in the hands of the Chairman on or before the date of delivery of the paper before the Club.

2. Illustrations should invariably be in black ink on white paper or tracing cloth. Blueprints are inacceptable.

3. Corrected galley proofs should be returned within 12 hours to the office of publication. Additions or major corrections cannot be made in an article at this time.

4. A brief summary of the paper, embodying the major conclusions, is desirable.

5. The Club reserves the right of decision on the publication of any paper which may be read before the Club.

*For 1929 the Chairman of the Papers Committee is Mr. L. G. Pacent, 91 Seventh Avenue, New York City

Rates: Annual subscription to non-members, $5.00; single copies. $.50, except certain out-of-print copies, specially priced. See list on another page.

PROCEEDINGS
of the
RADIO CLUB OF AMERICA, INC.

VOL. 6 MAY, 1929 NO. 5

AN AUTOMATIC VOLTAGE REGULATOR

By CLAUDE F. CAIRNS
President, Acme Apparatus Corp.

Presented before the Club, February 13, 1929.

THE advent of the so-called a.c. radio set has strongly brought out the fact that ordinary 110-volt household lighting mains are not 110 volts all the time or at every location; in other words, a recording voltmeter in the average home shows voltage variations of from 90 to 130 in extreme cases and 105 to 115 in the best of locations, namely, a fluctuation of from plus or minus 20 per cent. to plus or minus 5 per cent. depending on factors within and without the control of the power house. A variation of the order of plus or minus 20 per cent. has two effects on radio sets, first on the quality and volume of reception, and second on tube life.

Most of the manufacturers have put primary taps on the power pack transformer to take care of such variations but have deliberately made it difficult to chance these taps, realizing that the public are not equipped with a voltmeter, and also that if they were they would soon find out, that using the lowest voltage tap gave larger amplitude to the windows, a consummation devoutly to be wished for by the listener. These taps on the primary are, I believe, for dealer use to be selected by him after determining the relative and usual value of the line voltage at a particular installation.

Fig. 1

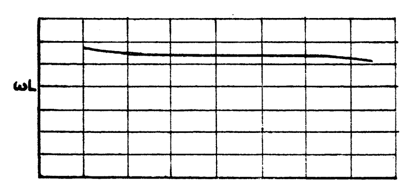


Fig. 2

There are, of course, two types of voltage regulators, namely, manually operated with a measuring instrument and automatic without such instrument. As radio is now enjoyed from an armchair or as an obligato for exercise, the manually operated voltage regulator with instrument is not 100 per cent., due possibly to a perverted sense of humor at the power house.

The automatic voltage regulator can be further subdivided into two classes, namely, those which do or do not require the thing to happen in the radio set which you are trying to prevent, in order to have them work. This sounds ambiguous but there are automatic voltage regulators which require a change of current in the radio set in order to function, and therefore are reducers of voltage variation.

In this class are the regulator tube, the series nickel wire, etc., perfectly understood by every radio and electrical engineer. Naturally this class of automatic voltage regulator must be designed for a particular load.

The automatic voltage regulator which is described here is one which is operated by the line variation itself and which is practically independent of the load up to the capacity of the apparatus itself. In other words, will maintain a given voltage within plus or minus 1 per cent. with a variation of line voltage of plus or minus 20 per cent. on a load which can be varied from zero to maximum. Curiously enough, this one piece of apparatus uses phenomena in electrical engineering such as one would get in the first year of an electrical engineering course including most of the fundamentals of transformer design.

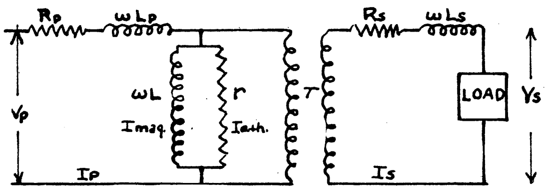


Fig. 3

FUNDAMENTALS OF CIRCUIT DESIGN

IN ORDER to understand fully the action of this voltage regulator, it is necessary to review certain fundamentals of transformer and choke coil design. These fundamentals are briefly as follows:

1. An iron core choke coil with laced core has a variable inductance with varying voltage across its terminals due to the permeability of iron which varies with magnetizing flux. Such inductance can be expressed by the formula:

$$L = \frac{4\pi NA^2\mu}{Zi}$$

Where N No. of turns
A Area of Iron
U permeability
Zi Length of Iron Circuit

The curve of such a choke coil is as shown in Fig. 1. As the permeability of the iron is a variable with voltage the inductance is a variable.

2. The insertion of an air gap in the iron circuit tends to make the inductance of an iron core choke constant especially if the length of the air gap Z_a is large with respect to the length of the iron circuit divided by the permeability μ for the formula then becomes

$$L = \frac{4\pi N^2 A}{Za + \frac{Zi}{\mu}}$$

The curve of such a choke coil is as shown in Fig. 2.

3. The primary winding of a transformer is an iron core choke coil with a value of L henries at a definite voltage. The secondary winding of a transformer has no effect on the primary until an attempt is made to draw current from it. (In the case of high voltage secondaries and high frequencies the distributed capacity of the secondary draws current).

When current is drawn from the secondary, the action produces an equal and opposite action in the primary which then draws more current from the line.

4. A transformer can be represented by an equivalent diagram given in Fig. 3.

Where
R_p resistance of primary winding
ωL_p leakage reactance of primary winding
R_s resistance of secondary winding
ωL_s leakage reactance of secondary winding
r equivalent resistance of iron watts
L inductance of primary winding as a choke coil
T ratio of turns of Sec. to Primary and is a perfect transformer having no resistance inductance or losses
Load on transformer which may be resistance inductance or capacity
V_p Primary Voltage
V_s Secondary Voltage
I_p Prim. Current
I_s Secondary Current
I_{e+h} Current for eddy currents + Hysteresis current
I_{mag}. Magnetizing current of primary

The leakage inductance of the primary and secondary is determined by the dimensions of one with respect to the other allowing flux to link one that does not link the other.

5. This diagram can be further reduced to Fig. 4.

As T is a perfect transformer, the constants of the secondary can be referred to the primary to produce the above circuit. With such a circuit it is easy to determine the effects of making changes in the constant of the transformer or of the load as well as determining the effect of substituting a variable for one of the constants.

The voltage regulator under consideration consists of two transformers and a condenser and the circuit diagram is as given in Fig. 5.

By making the resistance of the windings and the leakage inductance of the windings negligible this circuit can be reduced to the equivalent circuit which is shown in Fig. 6.

Where
V_l line voltage
V_1 voltage across first transformer
V_2 voltage across second transformer
V_3 secondary voltage of T_1
V_4 secondary voltage of T_2
load voltage
L_1 primary inductance of T_1
L_2 primary inductance of T_2
C capacity of condenser across separate secondary of T_2
R_0 resistance of load
r_1 equivalent resistance of iron watts of T_1
r_2 equivalent resistance of iron watts of T_2
I_l line current
I_0 output current

FUNCTION OF THE AIR GAP

BY PUTTING an air gap in the iron circuit of T_1 and operating T_1 at normal flux densities which give high permeability the inductance L_1 of T_1 is kept reasonably constant over a wide voltage range (see Fig. 2).

By operating T_2 at high flux densities above 13000 gauses and with only a small air gap (explained later) the inductance L_2 of T_2 is made variable with voltage (see Fig. 1) and inversely proportional.

For the moment take the no load circuit which becomes neglecting iron watts in T_1 which are small.

In Fig 7 V_l is of course the vector sum of V_1 and V_2 and I_l is the vector sum of I_1 and I_2 and I_3

Vectorially these can be represented as in Fig. 8.

As V_l increases V_1 and V_2 increase. An increase in V_1 has no effect on $\omega L1$ as it remains constant with

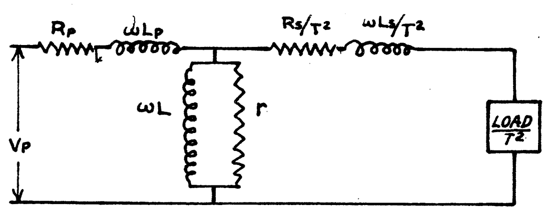


Fig. 4

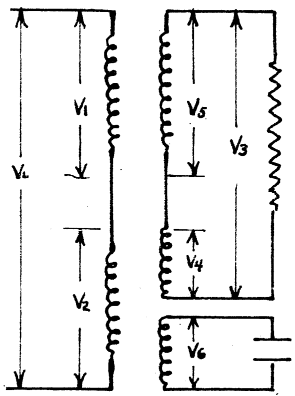


Fig. 5

changes in voltage (Fig. 2) An increase in V_2 however, calls for a decrease in ωL_2 (Fig. 1). All currents I_L, I_1, I_2, I_3, increase but I_1 increases at a greater percentage than all the others. Under these conditions the phase difference between V_1 and V_2 is therefore changed, although their vector sum is of course still equal to V_L. See Fig. 9.

By referring to Fig. 6 it can be seen that the voltage V_5 is in phase with V_1 and the voltage V_4 is in phase with V_2 because we have taken T_1 and T_2 in Fig. 6 as perfect transformers and neglected winding resistance and leakage inductance. Therefore V_5 and V_4 vary proportionately with V_1 and V_2, and have the same phase shift.

If now we connect V_4 and V_5 in series so that V_3 is their vector difference and apply a load R_0 to V_3, Fig. 9 becomes Fig. 10 if V_5 is made the proper value and smaller than V_1 and V_4 the proper value and larger than V_2. See Fig. 10.

As V_L is increased V_5 and V_4 increase and the loci of these voltages are shown by dots. The distance between the locus of V_5 and the locus of V_4 is V_3 and is practically constant over a wide range.

The load current is of course in phase with V_3 if R_0 is a resistance and it will be noted is nearly in phase with V_2 and about 90° out of phase with V_1 which means that the transformer T_1 does not supply much of the energy to the load and the transformer T_2 supplies most all of it. The voltage V_5 is therefore one of the correct magnitude and phase relation that when vectorially subtracted from V_4 leaves a constant voltage V_3.

Since the load is practically all supplied by T_2 the effect of the load in Fig. 7 is practically only a decrease in resistance r and an increase in current I_3. As long therefore as I_1 is large with respect to I_3 the apparatus regulates. That is regulation is obtained from no load to full load as long as ωL^2 is less than r_2.

Very properly the objection may be raised that when operating a transformer above the knee of the saturation curve of the iron, distortion is obtained in the secondary wave form. However, by the addition of a small air gap so that $Za < \frac{Zi}{\mu}$ in the core of a saturated transformer the wave form distortion is practically eliminated. Such an air gap however accounts for the regulation of only $\mp$ 1 per cent. Without the air gap the regulation is practically nothing.

From Fig. 5 and 6 it can be seen that the voltage V_3 can be made any desired value for any given range of V_1 within 20$\pm$ per cent. and furthermore for such a supply as that required, for a radio set, any given number of voltage V_3, V_{31}, V_{32}, can be obtained by the addition of more windings to T_1 and T_2 as long as the ratio of V_4 to V_5 is kept the same for any series pair.

The following figures show the variation of output voltage at full load, ½ load, and zero load:

Volts line	*Volts output*	
90	111	
100	112.5	
110	112.7	full load Max.—Min. 1.7 volts equals 1.5 per cent.
120	112.0	
130	111.8	
90	114.5	
100	114.0	
110	113.5	½ load Max.—Min. 2.9 volts equals 2.6 per cent.
120	112.5	
130	111.6	
90	115	
100	114.5	
110	114	Zero load Max.—Min. 2.5 volts equals 2 2 per cent.
120	112.7	
130	112.5	

Variation of 90 to 130 volts and from 0 load to full load = 4 volts = $\pm$ 2 per cent.

The efficiency of this apparatus is of course lower than that of ordinary transformers but is considerably higher than that of voltage regulators using ballast tubes or nickel wire. The current drawn from the line is about the same but instead of the power factor being about unity, it is less than ½ under the worst conditions.

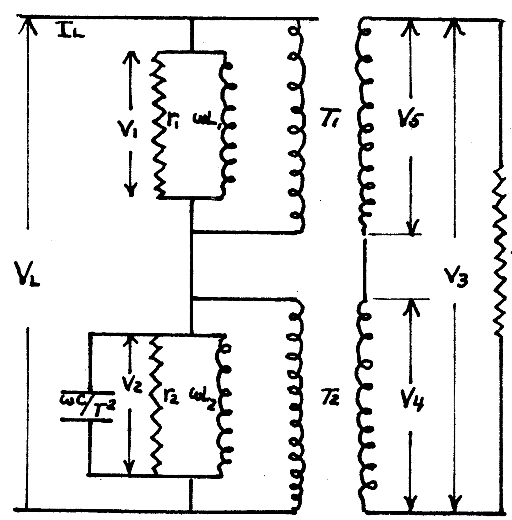


Fig. 6

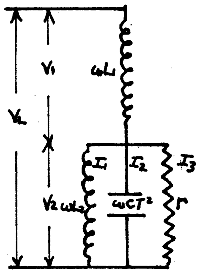


Fig. 7

The percentage efficiency varies from 78 per cent. at 90 volts line to 66 per cent. at 130 volts on the line. Therefore, the maximum watts to be radiated are about 28 in contrast to a regulator tube of 90.

From the above description, it can be seen that this automatic voltage regulator has the following advantages:

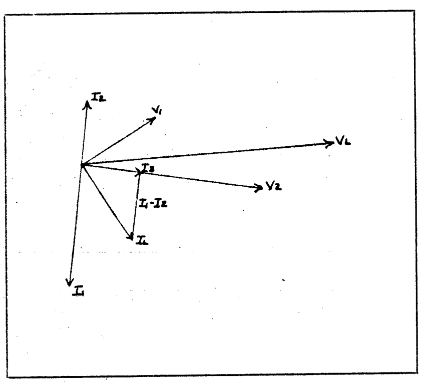


Fig. 8

1. Close regulation plus or minus 1 per cent. in production.
2. Functions on change in line voltages alone and therefore not dependent on a change in load current for operation.
3. Relatively high efficiency, eliminating excessive heat to be radiated.

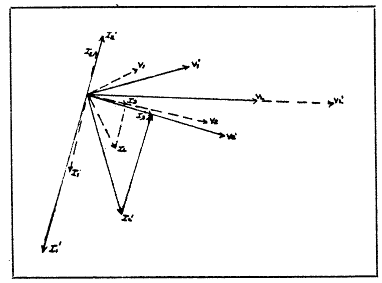


Fig. 9

4. No moving parts.
5. No instruments.
6. Practically independent of load for a given size.
7. Ruggedness.
8. Standard commercial construction.
9. Can be made for any amount of power.

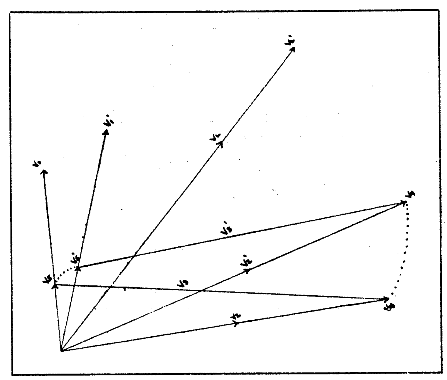


Fig. 10

Disadvantages

1. Cost of 2-mfd. 500-volt condensers for 60 watt circuit.
2. Low power factor.
3. Space required slightly in excess of ordinary transformers.

News of Our Membership

Members are requested to send material on change of occupation, location, or anything of interest to their fellow radio amateurs to

Club Notes Editor
Radio Club of America
55 West 42nd Street
New York, N. Y.

Louis Alexander now lives at 711 West 171st Street, New York, N. Y.

Oliver G. Ayer is Service Manager of Fada Radio at 2619 South Michigan Ave., Chicago, Ill.

A. K. Bohman has resigned from the engineering staff of the Radio Corporation of America to enter the radio communications department of Pan American Airways, Inc. He is located at the West 36th Street Airport, Miami, Florida.

Pierre Boucheron, from his lofty estate of RCA's Southern District Sales Manager, sends greetings to his friends in the Club. (That includes the whole membership)

Santiago Castaneda, after a visit to the United States, where he was located with the Radio Division of the Department of Commerce, has returned to duty with the Telegraph Division, Bureau of Posts, Manila, P. I.

Lewis M. Clement, when not occupied with his duties as President of the Radio Club of America, is Vice-President and Chief Engineer of Brandes Laboratories, Inc.

Lawrence M. Cockaday may be reached in care of the *Herald-Tribune*, 225 West 40th Street, New York, of which he is technical Editor. He is also Instructor in General Science at New York University.

Howard B. Day of the Ohio Power & Light Company is engineer on wholesale power to industries in the Youngstown, Ohio, district. He has been a radio amateur since 1908, and announces as an additional distinction that he is not a "professional" set builder or consulting "radio engineer."

John Di Blasi has changed his business connection from Sales Manager of Stanley and Patterson to General Sales Manager, Pacent Reproducer Corp., Film Center Bldg., 44th Street and 9th Avenue New York.

Carl Dreher is in the talking movies as Chief Engineer of RCA Photophone, Inc.

George F. Droste is Production Engineer of the General Bronze Corp., 480 Hancock Street, Long Island City, N. Y.

B. Dudley has taken over the *Information Service* and Experimenter's Section of *QST*. He may be reached in care of the American Radio Relay League, 1711 Park Street, Hartford, Conn.

John S. Dunham, President of QRV Radio Service, Inc., of New York, N. Y., is writing articles on his specialty for *Radio Broadcast*. His Company has recently purchased the Radio Repair and Service Co. of Brooklyn, N. Y.

Harris Fahnestock, Jr., of 162 Coolidge Hill, Cambridge, Mass., is studying physics in the graduate school of Harvard University.

Leslie B. Fletcher of 69 White Street, Hartford, Conn., is engaged in radio service and sales work, with R. S. Miner, Fada, and Majestic connections. He is also carrying on some experimental developments in radio.

John M. Forshay of 52 Vesey Street, New York, has recently made arrangements to represent the Ohmite Mfg. Co. of Chicago, makers of vitreous enameled resistances. For several years he has been representing the Jewell Electrical Instrument Co., of Chicago. He also maintains a laboratory for testing and servicing instruments.

H. C. Gawler enlisted in the U. S. Navy as a wireless operator on Jan. 1, 1904, and hasn't been out of radio since. He has been an enlisted man in both Army and Navy, as well as a Captain in the Army and a Lieutenant in the Navy. His career as a married man dates back 22 years, or slightly less than his radio experience. He adds: "Have 5 kids."

Harold C. Geise is now assistant to the manager of the Service Dept. of F. A. D. Andrea, Inc., Long Island City, N. Y., having returned from the road as Southwestern Sales Service Engineer.

Herman Heinemann has been interested in radio since pre-broadcast days and joined the A.R.R.L. in 1921. He hopes to have a transmitter when his college studies do not keep him too busy.

John V. L. Hogan of 41 Park Row, New York, is doing consulting engineering work for a number of clients, including the Great Lakes Broadcasting Co., the Radio Corporation of America, the General Electric Co., Atwater Kent Mfg. Co., and the Case Research Laboratories. Mr. Hogan is a Past President of the Institute of Radio Engineers, and qualifies as one of the few engineers who have been active in radio work for over twenty years.

J. L. Hornung combines his duties as Technical Instructor and Radio Supervisor of the Y. M. C. A. Radio Institute at 109 West 64th St., New York, and Chief Engineer of WGBS, with research in short wave communication. With A. R. Nilson, he is author of *A Text on Practical Radio Telegraphy*, and a new question and answer book published by McGraw-Hill.

J. E. Jenkins of J. E. Jenkins & S. E. Adair, Engineers, 1500 N. Dearborn Parkway, Chicago, Ill., is busy making condenser transmitters and complete recording amplifiers for phonograph record and sound picture producers.

Austin C. Lescaboura has his home and business address at Croton-on-Hudson, N. Y., with a branch office in New York at 154 Nassau

Street. With a staff of six he is engaged in sales promotion, advertising, and publicity activities for radio and other technical fields. He has his own shop building where all the mechanical work connected with the business is done.

James E. Linde lives at 3164 Grand Concourse, Bronx, New York, and is connected with Linde and Company. He also serves as assistant to Dr. John Jacobson.

E. H. Loftin is continuing amplifier development in the Loftin-White laboratory in New York City, coöperating with B. F. Meissner in hum elimination in A.C. receiver systems, and working with Electrons, Inc., in development of gas-filled heated cathode rectifiers and new emissive coatings.

R. H. Marriott, Consulting Engineer of the Federal Radio Commission, is at this writing Acting Commissioner for the First Zone.

B. Alan Mayhew, when not installing equipment for a new steam generating plant for the National Sugar Refining Co. at Long Island City, operates Station W 2BYW with very fair success, considering the QRM from a 7-months' old baby—a girl.

Frank W. McDonell is a consulting engineer at 146 Liberty Street, New York, N. Y.

B. F. Meissner reports that during the past year he has licensed twenty radio receiver manufacturers under his AC receiver patents.

F. B. Ostman lives at 353 Spring Ave., Ridgewood, N. J. His business connection remains with A. H. Grebe & Co., where he is Assistant Sales Manager in charge of service engineering. He operates Station W 2OM on phone and ICW.

Greenleaf W. Pickard, Past President of the Institute of Radio Engineers, has been connected with the Wireless Specialty Apparatus Co. since 1907. He is "still peacefully correlating radio reception with all sorts of terrestrial and cosmic fauna and flora."

D. J. Pieri is Sales Manager and Sales Engineer of the U. S. Radio and Television Corp. of Chicago, who manufacture the Radiotrope.

O. C. Roos is at present working on electrostatic loud speaker design for the Du-O-Di Speaker Company, of which he is owner and general manager, at 1575 Townsend Ave., Bronx, N. Y.

A. W. Saunders is Recording Engineer with Electrical Research Products, Inc., at 250 West 57th Street, New York.

McMurdo Silver is President of Silver-Marshall, Inc., 846 W. Jackson Blvd., Chicago, Ill.

E. R. Shute is General Superintendent-Traffic of the Western Union Telegraph Co.

G. Edwin Stewart is Chief Recording Engineer of the Paramount-Famous-Lasky Corporation in New York.

Harry James Styles, of 136-02 Jamaica Ave., Jamaica, N. Y., is in the real estate business and active in politics, but still finds time to devote to radio.

F. C. W. Thiede has moved to 52 Buckingham Road, West Hempstead, L. I., N. Y. His business connection is with the Chas. Freshman Co.

M. S. Tinsley is now located in Dallas, Texas, where he has opened a Southwestern District Office for RCA in the Santa Fe Bldg. He lives at 5618 Vickery Blvd.

John C. Tredwell, of E. A. Tredwell & Co., 41 Park Row, New York, is in the real estate business.

Alfred E. Waller, in answer to the Club's inquiry, replies laconically, See *Who's Who in America.*

Paul G. Watson is Plant Engineer of the Eastern Malleable Iron Works, Wilmington, Del., and lives at 116 West Barnard St., West Chester, Pa. He operates Station W3BU, and is Commander of the Fifth Section Naval Communication Reserve, Fourth Naval District, with the rank of Lieutenant, USNR.

Julius Weinberger, as Division Engineer in charge of Development and Research, Technical and Test Department, Radio Corporation of America, is responsible for RCA research activities in radio and in allied arts.

Donald Whiting's new mailing address is P. O. Box 123, Port Washington, L. I., N. Y. His residence at the corner of Briarcliff Drive and Luquer Road in Port Washington incorporates a novel loud speaker distribution system. Mr. Whiting is engineer in charge of the Fox-Case Movietone Development Laboratory.

Victor N. Wyderman of 5677 Hudson Blvd., N. Bergen, N. J., is still building his own radio sets and reports that his family likes his latest super-heterodyne.

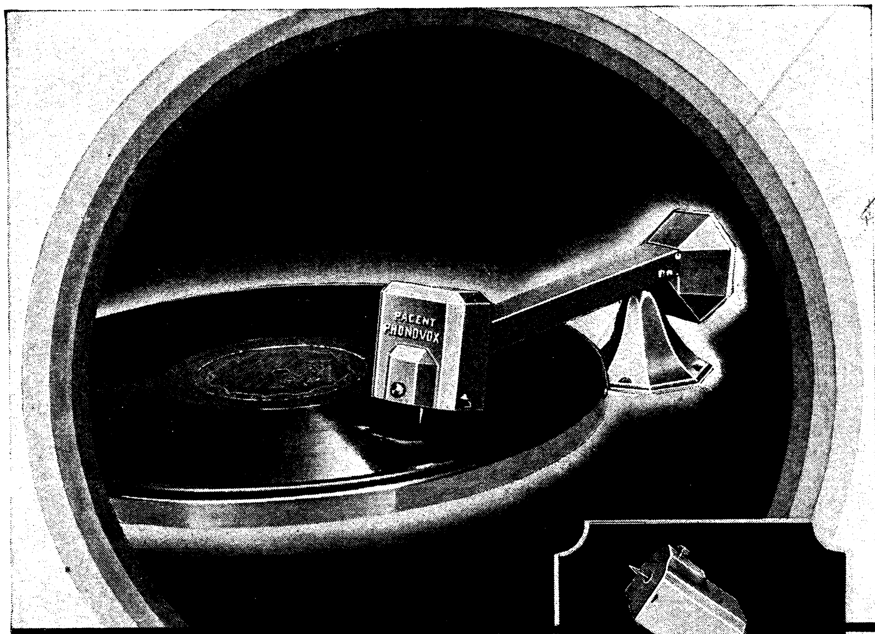
The Club will appreciate information as to the whereabouts of the following members:
W. W. Lindsay, Jr.
Alexander Strelzoff

List of Papers Delivered Before the Club

THE list below represents all papers read before the Club. Extra copies of such paper in stock can be had at fifty cents each. Some papers are out of print and arrangements have been made to supply copies of these in photostat form at a cost which covers this duplication and mailing charges.

PROCEEDINGS AVAILABLE

Year	*Month*	*Vol.*	*No.*	*Title*	*Author*	*Price*
1916	August			"Applications of the Audion"	Paul F. Godley	$2.00
	September			"Applications of the Audion" (Concluded)	Paul F. Godley	1.50
1917	February			"Losses & Capacity of Multilayer Coils"	L. A. Hazeltine	2.00
	June			"Losses & Capacity of Multilayer Coils" (discussion)	L. A. Hazeltine	.50
1920	January	1	1	"A New Method for the Reception of Short Wave Lengths"	E. H. Armstrong	.50
	April		2	"The Vacuum Tube as a Detector and Amplifier"	L. M. Clement	.50
	May		3	"The Vacuum Tube as a Detector and Amplifier" (part II)	L. M. Clement	.50
	June		4	"Recent Development of Radio Telephones"	W. S. Lemmon	.50
	July		5	"Navy Receiving Equipment"	L. C. F. Horle	1.50
	October		6	"Bulb Oscillators for Radio Transmission"	L. A. Hazeltine	.50
	November		7	"Test of Short Wave Radio Signal Fading"	S. Kruse	.50
	December		8	"Test of Short Wave Radio Signal Fading" (part II)	S. Kruse	.50
1921	February		9	"1ZM's Radiophone and C. W. Transmitters"	L. Spangenberg	.50
	May		10	"The Resonant Converter"	W. S. Lemmon	.50
	July		11	"Modulation in Radio Telephony"	R. A. Heising	.50
	August		12	"Design of Loop Antennae"	D. S. Brown	.50
	September	2	1	"Some Operating Notes on the Larger Sizes of Transmitting Tubes"	W. C. White	.50
1922	February		2	"Station 1BCG"	Geo. Burghard	.50
	April		3	"Radio Central"	P. Boucheron	.50
	June		4	"Modulation in Radio Telephony"	L. C. F. Horle	.50
	July		5	"The S-Tube Rectifier"	H. J. Tyzzer	.50
	September		6	"Multi-Stage Amplifiers"	M. C. Batsel	.50
	December		7	"Vacuum Tube Amplification"	S. E. Anderson	.50
1923	March		8	"Tuned Radio-Frequency Amplification with Neutralization of Capacity Coupling."	L. A. Hazeltine	.50
	July		9	"Eighteen Years of Amateur Radio"	G. E. Burghard	2.25
	August		10	"The Thoriated Tungsten Filament"	W. C. White	1.75
	September		11	"How to Build a Super-Heterodyne Receiver"	Geo. Eltz, Jr.	1.00
	October		12	"The Fundamentals of Loud Speaker Construction"	A. Hyman	2.25
	December	3	1	"Why No Receiver Can Eliminate Spark Interference"	L. A. Hazeltine	$1.00
1924	May	3	3	"Solving the Problems of the Neutrodyne"	J. F. Dreyer	1.50
1925	March		2	"The Story of the Super-Heterodyne"	E. H. Armstrong	2.50
	February		4	"A New Method of Radio Frequency Amplification"	C. L. Farrand	.50
	December		5	"An Induction Loud Speaker"	C. W. Hewlett	.50
	November		6	"A Single-Control Receiver"	C. L. Farrand	1.00
1926	July		7	"Tendencies in Modern Receiver Design"	J. G. Aceves	.50
	August		8	"Musical Reproduction Has Improved"	A. F. Van Dyck	.50
	September		9	"Transformer-Coupled Audio Amplifiers"	A. W. Saunders	.50
	October		10	"Cone Loud Speakers"	C. L. Farrand	.50
	November		11	"A Short-Wave Super-Heterodyne Receiver"	Geo. Eltz, Jr.	.50
	December		12	"A. C. as a Filament Supply Source"	B. F. Meissner	.50
1927	January		13	"A. C. as a Filament Supply Source" (part II)	B. F. Meissner	.50
	February	4	1	"A Fundamental Analysis of Loud Speakers."	J. F. Nielsen	.50
	March-April		2-3	"Methods of Measuring Tube Characteristics"	S. Young White	.50
	May		4	"Analyzing the Power Amplifier"	D. E. Harnett	.50
	June		5	"Description of a Short-Wave Station	D. R. Runyon, Jr.	.50
	July		6	"Use of Tubes Having High Amplification"	A. V. Loughren	.50
1928	January	5	1	"Experiences of a Radio Engineer"	G. H. Marriott	.50
	February		2	"Life Test Data on Paper Condensers"	A. A. Leonard	1.25
	April		4	"Application of the Four-Electrode Receiving Tube (UX-222)	A. C. Rockwood B. J. Thompson	.50
	May		5	"Acoustics and Microphone Placing in Broadcast Studios"	Carl Dreher	.50
	June		6	"Acoustics and Microphone Placing in Broadcast Studios." (part II)	Carl Dreher	.50
	September		7	"The A. B. C. of Amplifier Circuits"	Geo. Crom	.50
	October		8	"Overall Measurements on Broadcast Receivers"	L. M. Hull	.50
	November		9	"Notes on Measurement and Design of Audio-Frequency Transformers	J. K. Johnson	.50
	December		10	"A High-Power Output Tube"	K. S. Weaver	.50
1929	January	6	1	"Characteristics of Filament Type Rectifiers	Roger Wise	.50
	February		2	"Production Testing of Vacuum Tubes"	A. B. Dumont	.50
	March		3	"High-Frequency Radio Experiments in Aircraft"	F. H. Schnell	.50
	April		4	"Seasonal Variations in Short-Wave Transmission"	H. E. Hallborg	.50



No. 106 B Type—List Price, $15

The Super Phonovox head hinges backward, allowing easy insertion of the needle—eliminating any external support.

A New Pick-up that offers astonishing Improvement in the Electrical Reproduction of Records!

Again a startling advance in pick-up design and as usual by Pacent—the new Super Phonovox . . . offering a degree of naturalness and tone beauty hitherto unknown . . . new standard improvements, refinements, and finishes.

Among the new features are the elimination of rubber bearings which are the cause of variations between pick-ups, new perfectly balanced tone arm, fold-back hinge for easy insertion of needle, SPECIAL 36% COBALT MAGNETS and many others.

Write today for complete information, discounts, etc.
three models $12, $15, and $25.
Prices slightly higher west of the Rockies

PACENT ELECTRIC CO., Inc.

91 Seventh Avenue **New York**

Pioneers in Radio and Electric Reproduction for Over 20 Years
Manufacturing Licensee for Great Britian and Ireland: Igranic Electric Co., Ltd., Bedford, England
Licensee for Canada: White Radio Limited, Hamilton, Ont.

PACENT *Super Phonovox*


RCA
RADIOTRON
UX 245

THE COUNTRY LIFE PRESS · GARDEN CITY · NEW YORK