EIGHTH YEAR OF SERVICE

RADIO ENGINEERING

Vol. VIII JUNE 1928 Number 6

R. M. A. SHOW NUMBER

THE ENGINEERING RISE IN RADIO
By Donald McNicol

THE POWER SUPPLY OF THE FUTURE
By George B. Crouse

THE SULPHIDE RECTIFIER
By Dr. H. Shoemaker

A. C. TUBES VS. SERIES FILAMENT OPERATION
By William P. Lear

SELECTING A BAND OF RADIO FREQUENCIES
By C. F. Lampkin

HIGH VOLTAGE DIRECT CURRENT GENERATORS
By J. H. Blankenbuehler

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The TECHNICAL MAGAZINE of the RADIO INDUSTRY

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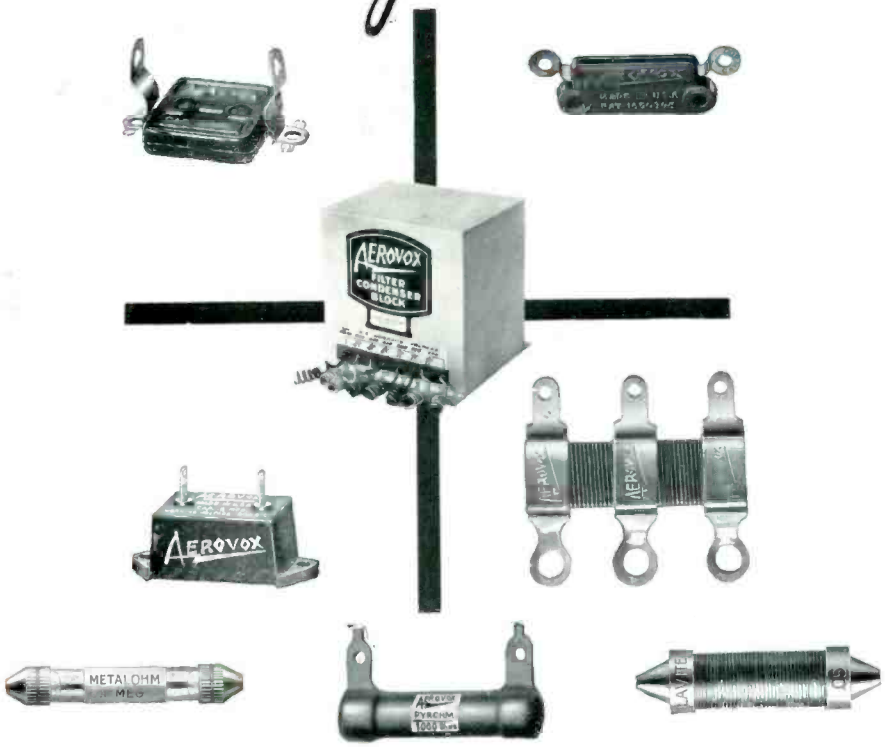

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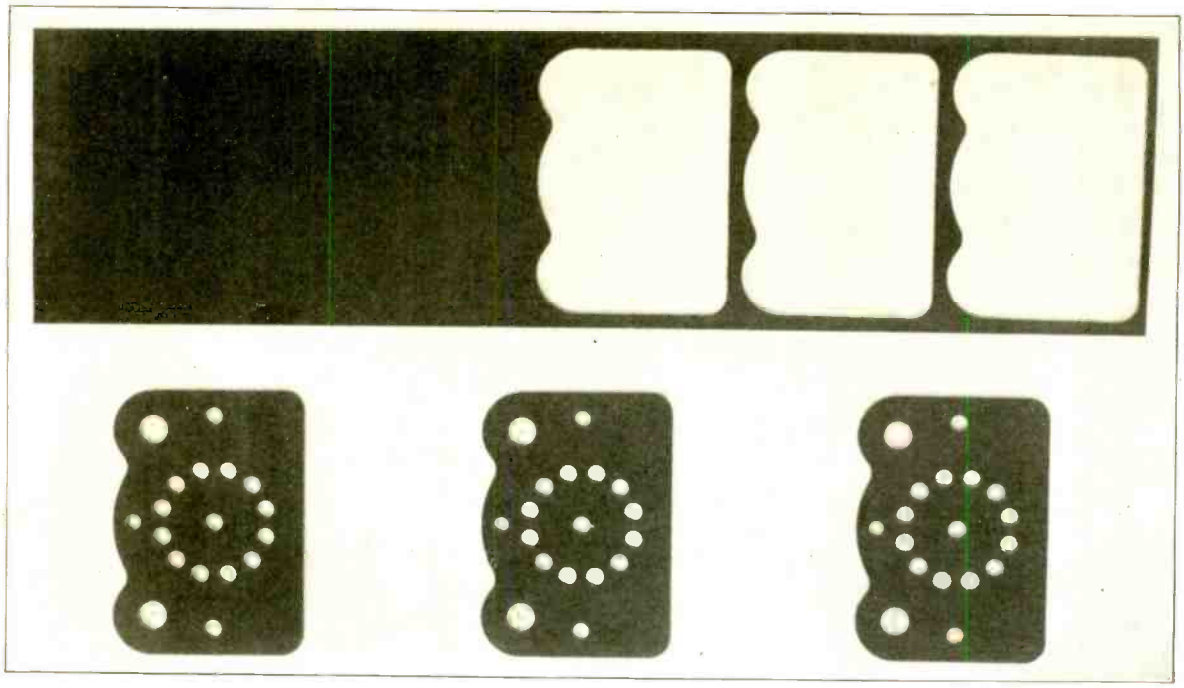

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Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

RADIO ENGINEERING

for JUNE 1928

Edited by M. L. MUHLEMAN

52 Vanderbilt Avenue
New York, N. Y.

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VOLUME VIII NUMBER 6

Editorial

AMONG the myriad of misapplied words, "radio" stands supreme. Any contrivance utilizing one or more of the many devices associated with a complete radio receiver is "radio" in the public mind. Being devoid of the necessary knowledge to formulate a proper distinction the public has employed the word radio to cover all such devices as may appear in some way similar to the "machines" in their homes.

The word radio never would have been misused by the public if it were not for the fact that the engineering minds in the field have, in their extensive researches, struck upon numerous arrangements, producing new effects, or old effects in a new manner, these arrangements becoming applicable to a broad commercial field.

Commercial developments invariably spring up in otherwise restricted industries and quite often assume very prominent positions. Find if you can another industry that does not turn to the radio manufacturer or designer for assistance in solving commercial problems or for means to increase business.

There is not sufficient space here to list all the commercial developments but let us mention a few of the major ones and some of the odd applications. The leading development, from the viewpoint of business possibilities, is the power amplifier and speaker or so called "public address system." The demand for equipment of this nature has grown tremendously within the past year due to the influence on the public of improved audio-frequency amplifiers in radio sets and the consequent realization of the commercial possibilities. The demand is for the complete equipment, including the power speakers, microphones, electrical pick-ups, etc. The day will come when every school, church, theatre, auditorium and roadhouse will have installations.

This in turn has created a demand for automatic electric power phonographs to be used for educational and amusement purposes, as well as talking motion pictures and standard films accompanied by instruction delivered through a public address system.

Television is still behind a veil but may become a sound commercial venture sooner than we expect.

Reviewing the peculiar applications there will be found devices employing radio equipment in conjunction with photo-electric cells, for sorting and grading almost everything from soup to nuts; in the paper industry, a device for automatically measuring the thickness of paper, which device employs an oscillator. In the medical field audio amplifiers and R.F. circuits are utilized for amplifying heart beats, for detecting reflex actions of the nervous system and other biological actions.

The Kenotron tube is employed for reducing corona on high-voltage A.C. lines; glow tubes are used for the remote control of power apparatus and vacuum tube relays have found hundreds of applications.

Radio, as a fundamental, is so flexible that there is no predicting what it may ultimately lead to. The commercial field can be developed to greater proportions and presents interesting opportunities to forward-looking manufacturers.

M. L. MUHLEMAN, *Editor.*

Contents

The Engineering Rise In Radio 27
By Donald McNicol

Radio Industry Presents Broadcasting Proposal 31

R. M. A. Personalities 32

List of R. M. A. Show Exhibitors 33

The Sulphide Rectifier 35
By Dr. H. Shoemaker

Selecting a Band of Radio Frequencies ... 39
By G. F. Lampkin

Book Review 41

The Problem of Radio Set Power Supply, Part VI 42
By George B. Crouse

The Solution of an Interference Problem .. 44
By C. Harold Campbell

A. C. Tubes vs. Series Filament Operation . 45
By William P. Lear

The Mathematics of Radio, Part VII 50
By John F. Rider, Associate Editor

Paper vs. Mica Condensers in R. F. Circuits 53
By J. George Uzmann

Departments

Commercial Developments:

High Voltage Direct Current Generators. 54
By J. H. Blankenbuehler

Through the Looking Glass 56

Constructional Developments 57

News of the Industry 60

New Developments of the Month 63

Buyers' Directory 84

Index to Advertisers 86

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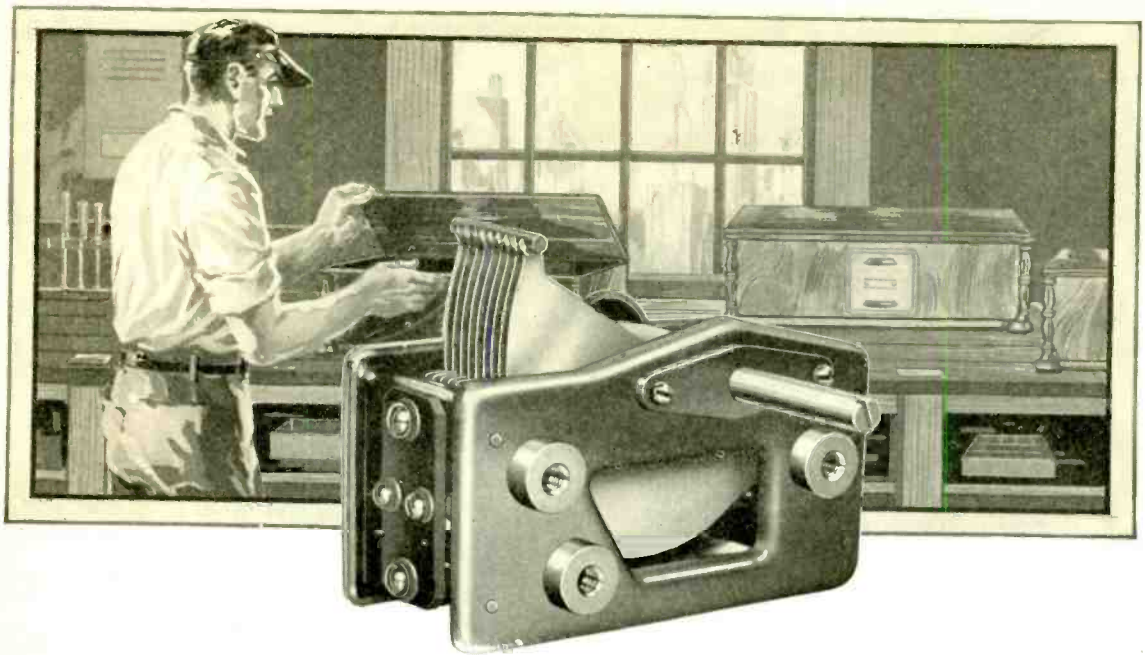
R A D I O - P A R T S



Tone, volume, selectivity — how all radio manufacturers strive for this combination. Success depends in a large measure on the design, construction and quality of every small part. So these manufacturers naturally turn to Scovill for such articles as condensers, condenser parts, metal stampings, screw machine products, switches, etc. Strict laboratory control, modern methods, trained workmen and adequate testings are the means by which Scovill develops production for any quantity of radio parts and turns them out exact in every detail, consistent in quality.

Scovill means SERVICE to all who require parts or finished products of metal. Great factories equipped with the last word in laboratories, and modern machinery manned by skilled workmen, are at your disposal. 'Phone the nearest Scovill office.

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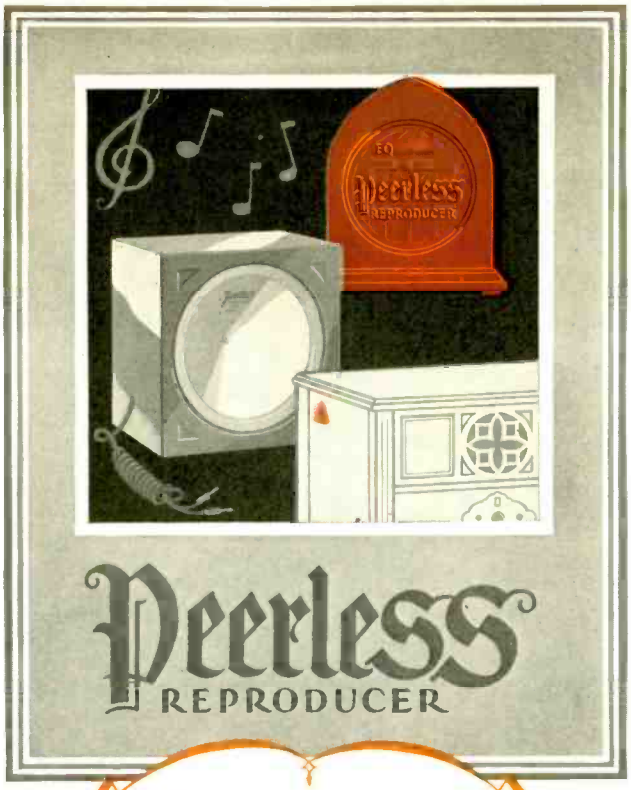


This little bronze emblem in the familiar shape of the famous Gothic Peerless Reproducer is available to all set-makers using the 7-B Peerless Unit. Attached to the cabinet, it is an evidence of Quality Construction that the dealer and jobber can point to with pride.

This Is Probably The HIGHEST PRICED SPEAKER In America

THERE is an idea in this country that as volume goes up, profit per unit goes up along with it.

But the really successful manufacturers have invariably put all extra profits back into a better product. That is the only way any maker can continue to dominate his market.

The staunch and sturdy Peerless Reproducer as built today would cost almost 50% more if we were operating on our original small-volume basis. Only by producing the largest volume of any independent Speaker manufacturer can we give you such a reproducer as the Peerless, at our present unit price.

We frankly admit the Peerless Built-In Reproducer (Model 7-B) is probably the highest-priced speaker unit in America. We just as frankly confess you can buy *alleged* speaker assemblies at considerably less.

But we know one thing that you may not—

No maker can possibly produce a Speaker unit comparable in quality with Peerless at the Peerless price until he attains Peerless volume.

And radio engineers and purchasing agents of radio manufacturers should note this: The price you get on your Built-In Peerless 7-B Reproducers is based on a chassis production of a great many more than 100,000 units per year. You get a "quantity" cost figure based on a volume product that no other independent speaker-maker can even approach.

A FRANK TALK WITH RADIO ENGINEERS

BY A. T. HAUGH
Vice-President, United Radio Corporation
Rochester, New York

Which simply means that even though Peerless is the highest-priced speaker unit in America—you also get in Peerless the biggest *dollar-for-dollar VALUE in America.*

In other words, you would have to pay from 50% to 100% more to get anything approaching Peerless Reproducers in dollar value.

And this leaves out of consideration the sales value of the Peerless name. You know that the name Peerless on a speaker is like "Sterling" on silver—*the country's standard of value!*

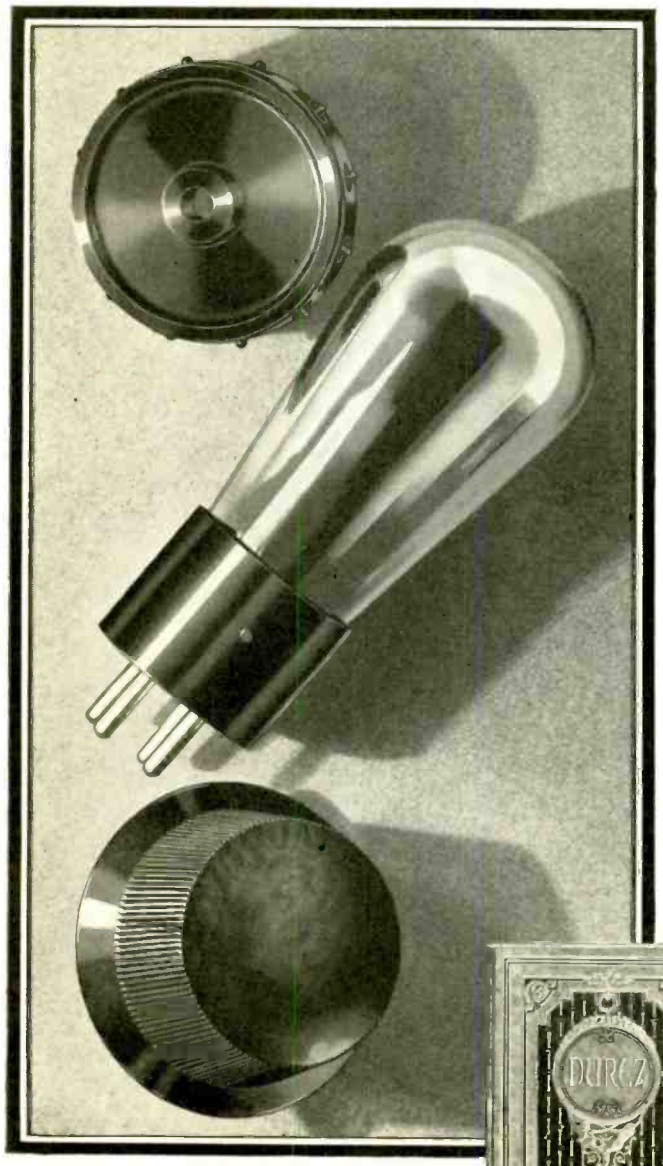
If you have a good radio, look into Peerless now. Small size, high efficiency. Handles output of 210 and other power tubes. Easily installed. No baffle needed. Practically service-free. In use by more than 30 radio set manufacturers.

Send for a Peerless man—or Peerless Engineering data. No obligation.

UNITED RADIO CORPORATION, ROCHESTER, NEW YORK

UR-131

One or a million without variation



THE Sylvania Products Co. of Emporium, Penna., makers of Sylvania radio tubes, now use Durez for their tube bases. They find that this remarkable plastic not only meets their high standards of quality, but—it actually lowers their production costs.

Many other large manufacturers have told us the same thing. Durez eliminates many costly operations. It fuses and hardens with marvelous rapidity. Once molded the part is complete. No tooling or burnishing necessary. And—best of all—the millionth part an exact duplicate of the first

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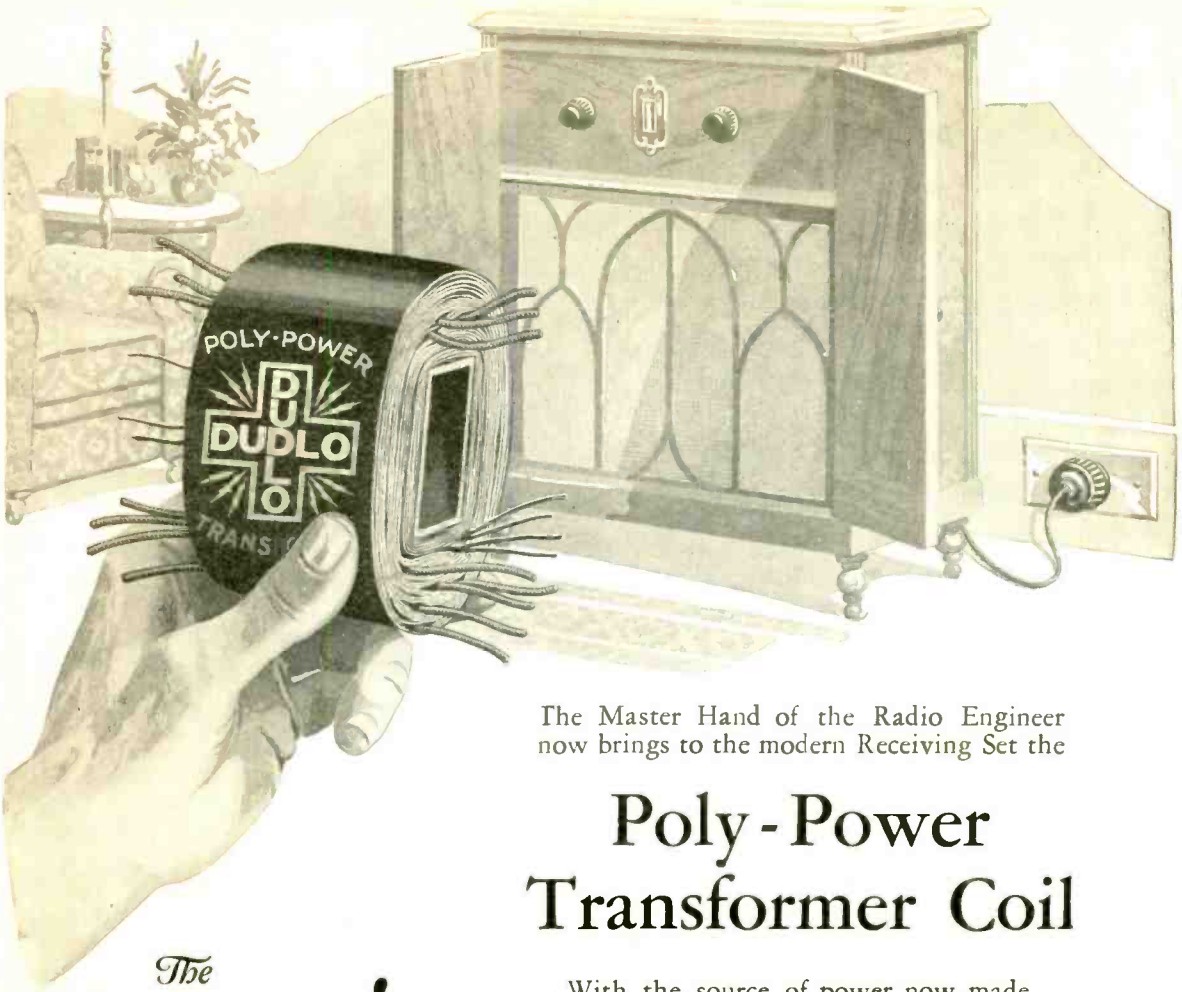
Send for this interesting booklet

Our new booklet, "Do it with Durez," tells the complete story of this wonderful plastic. It shows how Durez is economically adapted to meet the most exacting needs. Profusely illustrated in full colors. Write for a copy today.



The Master Hand of the Radio Engineer now brings to the modern Receiving Set the

Poly-Power Transformer Coil

The
Coil's the thing!

that makes the "Light Socket" set possible.

Dudlo Poly-Power Transformer Coils can be wound and tapped to furnish A, B, and C currents at any specified voltages required by Radio receivers or power units.

Dudlo engineers are at the service of Radio Manufacturers to assist in designing a Poly-Power coil to meet their special needs.

With the source of power now made as convenient and reliable as electric lights, a great new market is opened up.

Thousands of folks who never before thought they could operate a Radio can now enjoy the wonderful programs without worry about the A, B, or C current supplies.

So again Dudlo meets the needs of the Radio manufacturer by preparing far in advance for volume production of these, the most intricate of all Radio coils. Special machinery has been designed and installed in anticipation of the greatest season the industry has ever known.

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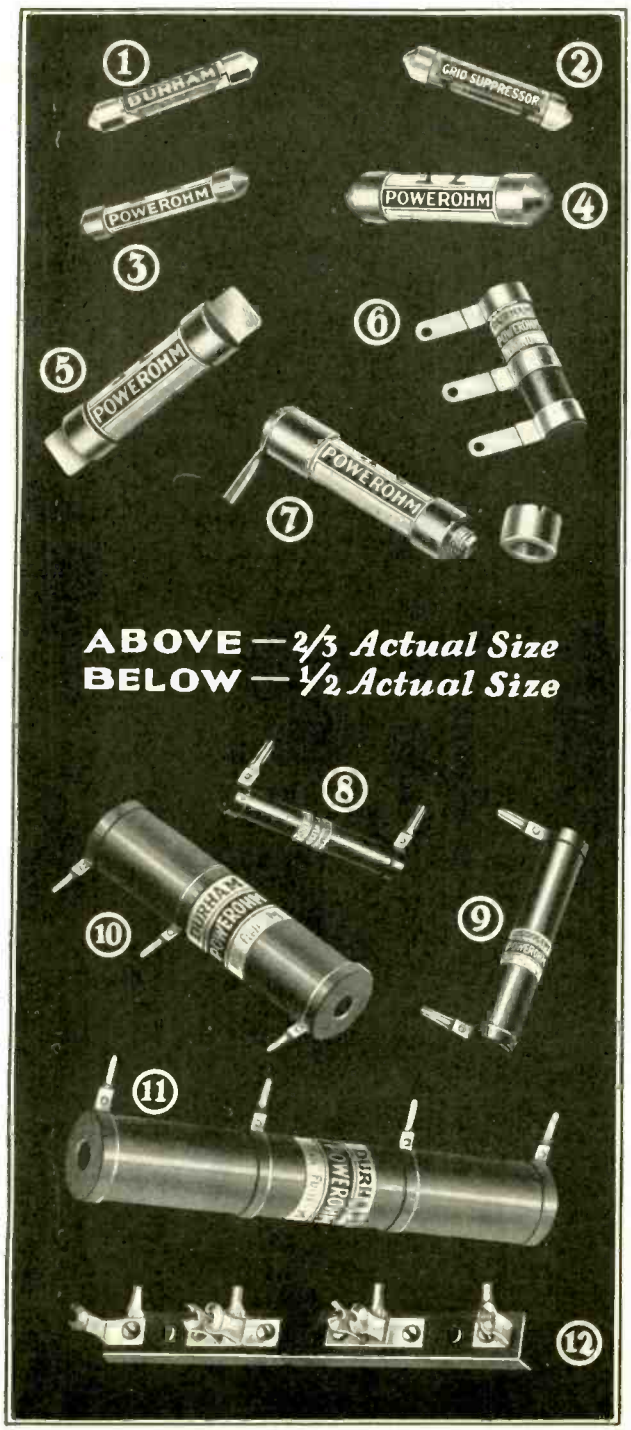
See These New Metallized POWEROHMS at the Chicago Show



Now in All Sizes from 1/8 to 50 Watts!

THE best *guarantee* of the absolute accuracy of this complete line of resistors and powerohms lies in the reputation of the firm that makes them—a firm of specialists, who have devoted years to the single task of perfecting the metallized filament and who have invested their full resources to effect absolute precision in all ranges.

The best *proof* of Durham Leadership is the fact that these units are used in practically every radio laboratory in this country, are standard equipment in leading receivers and power amplifiers and are available through most radio dealers and jobbers.

Samples and full data with accurate operating curves together with prices supplied upon request.

1 *Durham Resistors—500 Ohms to 10 Megohms; standard brass end tip, mould or pigtail type.*
2 *Durham Grid Suppressors—250 Ohms to 3000 Ohms in steps of 100; standard brass end tip.*
3 *Durham Powerohm—1 Watt: 250 to 1,000,000 Ohms; standard brass end tip or pigtail type.*
4 *Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; standard brass end tip type.*
5 *Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; knife-end type.*
6 *Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; soldered end tapped type.*
7 *Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; screw-end type.*
8 *Durham Powerohm—5 Watts; 250 to 250,000 Ohms; soldered end tapped or screw-end type.*
9 *Durham Powerohm—10 Watts; 250 to 250,000 Ohms; soldered end tapped and screw-end type.*
10 *Durham Powerohm—25 Watts; 250 to 250,000 Ohms; soldered and tapped.*
11 *Durham Powerohm—50 Watts; 250 to 250,000 Ohms; soldered and tapped.*
12 *Durham Mounting supplied in various lengths to carry any required number of Powerohms where quick change of resistance is necessary.*

INTERNATIONAL RESISTANCE COMPANY
2½ South 20th Street, Philadelphia, Pa.

DURHAM METALLIZED
RESISTORS & POWEROHMS

WEBSTER Power Units

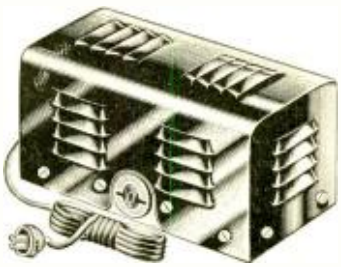
The WEBSTER COMPANY CHICAGO

ANNOUNCING the NEW
Webster Auto-Potentialator

THE Webster Auto-Potentialator is a remarkable new product that instantly and automatically regulates the local A. C. line voltage and produces an even flow of A. C. current of the exact voltage necessary for the most successful operation of A. C. Receivers or A and B Eliminators. It contains no tubes, no liquids, no hand switch or rheostat. It is entirely automatic in operation, and is a voltage regulator that regulates without a particle of attention or adjustment.

The Webster Auto-Potentialator not only provides the exactly correct voltage at all times, on the normally high or low line, but also automatically protects A. C. tubes from sudden line fluctuations that occur in any A. C. line. This assures longer life to the tubes, makes the operation of the A. C. receiver much more enjoyable, and saves the owner money.

The Auto-Potentialator has been subjected to grilling tests that have proved beyond question its ability to deliver invarying voltage under the widest fluctuations of line voltage. It is compact in size, requires no attention, and operates with sensational smoothness that is almost mystical.



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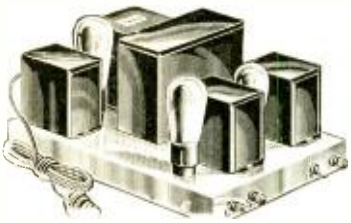

Price: $85.00 less tubes. Prices of other models supplied on request

Price of New Webster Auto-Potentialator

$12.50

For Quick Action Use the Coupon Below

Style B, less tubes, $32.50

The Webster Amplifier

Webster Amplifiers are designed for use in phonograph reproduction where an electric pickup is employed, or to replace the audio system of a radio receiver so as to obtain greater amplification and greatly improved tone quality. The Amplifier illustrated above is a simple two stage power amplifier. We can supply other models up to a three stage double push-pull amplifier incorporating the new 250 Tubes, a unit capable of operating two dynamic speakers. All models operate this type of speaker. Webster Amplifiers are mounted on a steel base, beautifully plated in a dull cadmium satin finish, with individual covers in contrasting black crackle.

Webster A. C. Power Packs

Designed to supply all A. C. and D. C. voltages as well as all grid biases for all makes of receivers utilizing A. C. tubes. Made in two styles as follows:

Style A—6 in. wide, 8 in. high, 11½ in. long, price $35.00. Including cable, less tubes. Style B—2¾ in. wide, 6¼ in. high, 16 in. long, price $32.50, less tubes.

Webster Reliable "B"

Supplies ample voltages for the most powerful receivers, adjustable to meet requirements of any set by means of duplex Carostats with slotted shafts for screw driver adjustment—a new feature that insures against voltages being accidently changed after being set. Superbly designed. Price, less tubes, $18.50.

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THE WEBSTER COMPANY,
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Please ship me — Webster Auto-Potentialators, price $12.50 each. I enclose $ ——.

Also send me complete data on all Webster Power Units.

Name .....

Address .....

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

Mail This Coupon

To enable you to secure the new Webster Potentialator without delay, in case your regular supplier cannot furnish promptly from stock, you can order direct from us by filling out coupon at left.

New EBY Insulated Tip Jack

The new Eby insulated Tip Jack delivers a tight spring contact the full length of the phone tip. Counterbored so that the tip can't move. Nickel plated brass equipped with red and black washers to establish polarity.

Here is a better subpanel socket for A. C. Tubes at a new low price—EBY model 8.

Manufacturers' Items

Top view of new model 8 socket, showing built in guide for tube prong. A simple twist in the groove and the tube is in!

Moulded of genuine Bakelite. Phosphor bronze contacts. Available in UX and UY types. Easy rivet assembly.

A Binding Post for Mounting on Metal

Junior P-4 model especially designed for mounting on metal. Moulded extension insulates post from panel. Extension available in different lengths.

Bottom view of new model 8 socket, showing design of prongs. Spring action *can't* be impaired.

Model No. 12 "Universal" UX Socket

This is the famous Eby "Universal." Its good looks will improve the appearance of any set. Moulded of genuine Bakelite in a new and different design.

The Standard Post

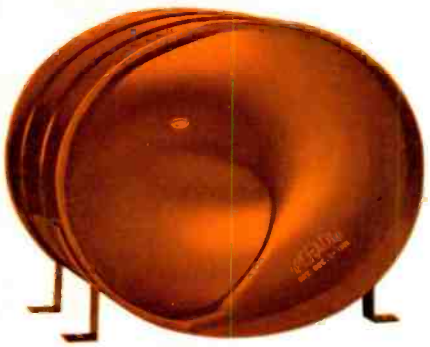
Eby Posts don't lose their heads. The tops are non-removable. Available either with tops plain or engraved in forty of the newest markings. See panel at side.

The H. H. EBY MFG. CO., *Inc.*

4710 Stenton Avenue

PHILADELPHIA

WHY *Operadio Speakers for Your Cabinets*?



MODEL No. 84-A
Length of air column 84"; depth 12"; width 20"; height 16".

MODEL No. 54-A
Length of air column 54"; depth 7"; width 14½"; height 12¼".

MODEL No. 30
Length of air column 30"; depth 7"; width 8"; height 7".

1. Universal—operates with or *without* power tube—A-C or D-C sets.
2. Unsurpassed tone fidelity due to monolithic bloc construction which prohibits absorption and side wall vibration.
3. More than meets present day public demand for full acoustic range.
4. One of the most, if not the most sensitive speakers yet produced.
5. Easy to mount—lugs ready for lag screws or bolts.
6. Always the same under any climatic conditions—free from service and adjustments.

Note: Operadio tone chambers are made in a variety of sizes and varying lengths of air columns to meet almost any condition. They are light, as light as is consistent with correct performance. From actual experience we know they are constructed to withstand the most extreme shipping conditions.

Our Engineering Department is at your service

OPERADIO

BLOC-TYPE SPEAKER

OPERADIO MANUFACTURING COMPANY

St. Charles, Ill. MEMBER RMA St. Charles, Ill.

Aluminum Contributes to Radio

—Lightness, Beauty, Finer Results

MANUFACTURERS of the finest sets are using Aluminum in constantly increasing quantities. Their tests have demonstrated that Aluminum is the *one* metal that most efficiently meets the widely differing conditions encountered in radio design.

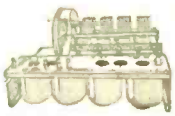
Its lightness; its permanent beauty; the fact that it does not rust or corrode; its high electrical conductivity; its efficient shielding quality; its "workability"—all are advantages that combine to make Aluminum the ideal metal for radio.

IN many of the most advanced receiving sets Aluminum Shields are used to achieve better

tone quality, greater selectivity, closer tuning—in short, finer reception.

Aluminum shielding reduces interference. It eliminates electrostatic and electro-magnetic interaction between various stages of radio-frequency amplification. It eliminates modulation of radio frequency stages by feed-back from audio-frequency amplifier. It makes possible more compact design.

Aluminum performs these functions efficiently and adds



less to the weight of the set than any substitute metal. Moreover, it is easily worked into special shield shapes—cans, boxes or casings. Thus it presents few limitations of size and shape.

It allows the engineer great freedom to design his shielding to meet, ideally, the various requirements of his set.

ALUMINUM is widely used for variable condenser blades. Aluminum Company of America produces special sheet Aluminum for this purpose that is accurate and uniform beyond anything hitherto attained. Gauge tolerance in thickness is

±.001 inch and the *total* variation within one sheet is limited to .0005 inch.

Aluminum Company of America also makes finished condenser blades from this highly accurate and uniform sheet.

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ALUMAC Die Castings of Alcoa Aluminum combine lightness, strength, accuracy and high conductivity. They have equal strength with *less than half the weight* of other casting materials. They are used with complete success for loud speaker frames and bases, condensers and condenser frames, drum dials, chasses—and even for cabinets.

There is a fund of information on the use of Aluminum in radio, and on radio in general, in the new edition of "Aluminum for Radio." Your copy of this interesting book will be mailed on request.

ALUMINUM COMPANY OF AMERICA

ALUMINUM IN EVERY COMMERCIAL FORM

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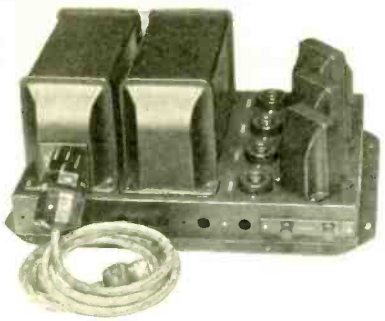
ALUMINUM

The mark of Quality in Radio

Worth while profits for you in this year 'round seller—

When you sell a Samson "Pam" Amplifier you can usually sell tubes, phonograph pick-up and turn-table, microphone, radio set, loud speakers or head sets and wiring for installation.

Type "PAM" 16 is for all ordinary types of loud speakers.



Type "PAM" 17 is for and supplies field current to dynamic type speakers.

A self contained, rugged, all electric two stage audio amplifier, with the famous Symphonic and Symphonic Push Pull Transformers, uses the new AC tubes and operates from 110 volt 50-60 cycle AC current. Compensation is made for line voltage variation. Designed to meet Underwriters' and AIEE Standards, and made for either dynamic or ordinary type loud speakers as specified. List Price $1.25 without tubes.

Wide variety of uses make the Samson "Pam" Amplifier a universal all year ready seller for:

Electrification of Phonographs.
Quality Power Amplifier for Home Entertainment.
Announcement Amplifier, Public and Private Institutions, Incidental Music in Theatres, Lodges, etc.
Distribution of Radio Programs to Apartments, Hotel and Hospital Rooms, etc.
Beauty Parlors, Shops, etc.
Sound Detecting Systems.
Dance Music in Tea Rooms, Dancing Schools, Dance Halls, Restaurants, Cabarets, etc.
Roadside Stands, Filling Stations, etc.
Athletic Contests, Races, Fairs, etc.

If you did not receive our broadside containing a special offer for one sample "Pam" amplifier, write for details.

Samson ABC Eliminator, Type ABC-71

supplies raw AC filament current from 105, 110, 115, 120 volt 50-60-cycle power source to five 226, two 227 and two 171 type tubes. Also supplies 3 voltages as follows: 30 to 75 volts variable and 90, 135, 180 fixed. C voltages supplied are —4½, —9, and —40. This is practically a constant voltage eliminator, and it has a total capacity of 70 mils. Tubes required—one UX280 and one UX874.

Samson Electric Co.

Manufacturers since 1882

General Offices
Canton, Mass.

Factories
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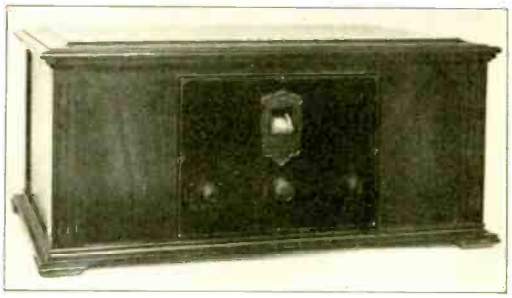
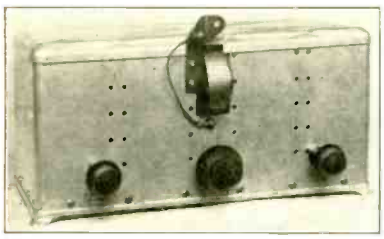
Announcing

LOFTIN-WHITE JEWELL AND MEISSNER A-C 8 TUBE "R.P.L." RECEIVER





Loftin-White Totally Shielded Tuner

Combination Jewell Dual Impedance, Push-Pull Audio Amplifier

Field Representatives WANTED

Radio Products Laboratory,
15 West 18th Street,
New York City

Gentlemen: Kindly send me. without obligation, your Field Representative Plan.

Name.....

Address.....

City, State.....

RADIO PRODUCTS LABORATORY

NEW YORK CITY

Mr. Radio Fan and
Professional Set Builder.

Dear Sir:

Through the collaboration of the most prominent radio engineers in the world today who have pooled their engineering skill and inventions with us, we have developed a radio receiver that is the best that can be built under the present known theories of the science.

The Radio Products Laboratory was organized for the purpose of commercializing and popularizing this receiver, EITHER COMPLETE OR IN UNIT FORM.

Therefore we require the aid and assistance of you, as a radio fan and professional set builder, to help us by demonstrating, selling and installing these sets in your community, either part or full time, for which we will pay you liberally, and at the same time help you build up your own independent business.

With our cooperation, such as liberal discounts, advertising and financing you on radio receivers sold on time payments, you should earn not less than $100.00 per week for your spare time, and considerably more if you devote your entire time to representing us.

The eight tube "R.P.L." Radio Receiver incorporates three stages of Loftin-White constant coupled radio frequency amplification, detector, two stages of Jewell dual impedance audio amplification and one stage of output push pull power amplification, and the Meissner system of A. C. operation is employed.

We are now appointing Field Representatives throughout the United States to represent us on exclusive territory basis from factory to consumer, and we will appreciate it very much if you will fill out and mail to us the coupon below, and we will forward you, without obligation, our exclusive Representative Plan and booklet describing our products.

Yours very truly,

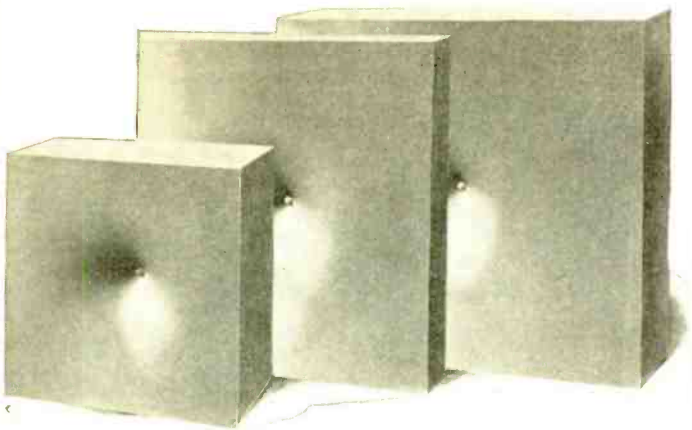
RADIO PRODUCTS LABORATORY

F. A. Jewell

FAJ:WEF GENERAL MANAGER.

Licensed Under the Loftin White, Meissner and Jewell Systems

The Original Air-Chrome Speaker Now Available to Set and Cabinet Manufacturers



WE all know that tone is all important this year. You are vitally interested in the tone performance of your set. The speaker you use in your consoles can make a tremendous difference in your set's tone efficiency.

Matched to Your Output

It would be ridiculous for us to claim that the standard Air-Chrome will operate with the same efficiency on every set.

The standard Air-Chrome speaker favors no band of frequencies. Low, intermediate and high are all reproduced with the same relative intensity—so that the Standard Air-Chrome will reproduce naturally everything the audio amplifier gives it.

Some sets, however favor the lower frequencies, some the higher. We are able to match the output of your set exactly, so build up the high or low frequencies, as the occasion demands.

The Custom-Built Air-Chrome

The Air-Chrome Speakers for set manufacturers are made in 3 standard sizes as shown above, 24″ x 24″, 18″ x 23″, 14″ x 14″, these will fit most of the cabinets.

On account of the construction we can build any special size where the quantities warrant.

Send for Sample for Demonstration and Test in Your Own Laboratory

The only way to tell whether you want to use the Air-Chrome on your set is to try it. Try to make it chatter—demonstrate it against any speaker—if you find that some frequencies are over-emphasized, remember that we can give you exactly what you want. The tone of the Air-Chrome is uneffected by atmospheric changes.

Send the coupon or write us today. A sample speaker will be sent on memorandum to responsible set and cabinet manufacturers.

AIR-CHROME STUDIOS, INC.

W. B. WHITMORE

Licensor of Temple, Inc., and Browning-Drake Corporation

160 Coit Street, Irvington, N. J.

Air-Chrome Studios, Inc., 160 Coit Street, Irvington, N.J.
Please send us a sample speaker on memorandum.
Check size wanted.
24″ x 24″
18″ x 23″
14″ x 14″
Name
Address
R

TEMPLE

Tone is the Biggest Factor in Radio

Pats. Pend. Model 25

Air Column Models

Temple Air Columns are now available in many shapes and sizes—in models that will fit almost every standard cabinet dimension. The models are of the new light weight construction—offering all the advantages of the previous models which have made the name Temple a by-word in quality reproduction—plus the advantage of being very light in weight which is of extreme importance to radio set manufacturers.

Through a new method of manufacture the new Temple Exponential Air Columns combine rigidity and a freedom from internal vibration with a lightness in weight which will set a new standard in air column construction.

Temple Air Columns being fundamentally correct offer maximum response and cover wider frequency bands than any previous offerings—all with a brilliancy that is startling in its realism.

Model 25—The circular type has a center line air column length of 54". This is a correct mathematical exponential design making for maximum response and true brilliancy in the entire audible range. 11½" diameter, 7½" deep and weighs but 6½ lbs. without unit.

Model 14—Rectangular in shape. It is 18" wide, 9¾" high and 6" deep. The same air column length as model 25. Weight without unit 13½ lbs. This model is not made in the new light weight construction.

Model 24—The larger of the standard manufacturer's type of Air Columns. This correct exponential design has a center line air column length of 75", is 24" wide, 18" high and 11" deep. The weight, without unit, is but 12 lbs.

TONE quality — realism of reproduction — is the most important factor today in the sale of radio receivers. It overhadows everything else. Distance and an ability to bring in a great number of out-of-town stations no longer assumes the leading place of importance. Temple solves this most important problem for you. The famous Temple Air Column Speakers need no introduction.

They are recognized and associated with quality wherever radio exists. They are outstanding examples of mathematically correct exponential designs which offer a maximum response to all audible frequencies and in a truly realistic fashion.

This year the Temple Air-Chrome Speakers have been added—the latest development in the open radiator type of construction. A balanced tension diaphragm is made use of which gives not only a true response over the entire range but a response where each tone is individually distinctive in itself.

Many Sizes Light in Weight

Temple Speakers are made in many shapes and sizes. Either the Air Column or the Air Chrome will adapt itself to practically every kind of cabinet installation.

Licensed under Whitmore Inventions Model F

Air Chrome Models

The Temple Air-Chrome represents one of the most startling speaker developments that the industry has ever seen. It couples Temple engineering and experience in speaker manufacturing with one of the most advanced principles ever developed in sound reproduction.

The Temple Air-Chrome is of the open radiator type. Its diaphragm is so arranged that the larger front half is tuned to the lower frequencies and the smaller, or back half, to the higher frequencies. This type of construction makes possible the balanced tension principle whereby the slightest impulse is carried from the driving unit to the diaphragm without any loss. Lightness is combined with rigidity, climatic changes have no influence in that no paper is used, and the mechanical construction and design eliminate the inherent difficulties ordinarily met with in open radiator types.

Model F—The larger oblong model. May be installed either in an upright position or horizontally. Size 18 x 23".—Depth 8½".—Weight 8½" lbs.

Model J—The larger of the Temple Air-Chrome speakers (manufacturer's types). Size 24" x 21".—Weight 16 lbs.—Depth 9".

Model K—The small square model. Size 11" x 14".—Weight 8½ lbs.—Depth 7".

Model R—The small oblong model. Size 9" x 24".—Depth 5".—Weight 4½ lbs.

Model Z—9¾" x 21".—Depth 5".—Weight 4¼ lbs.

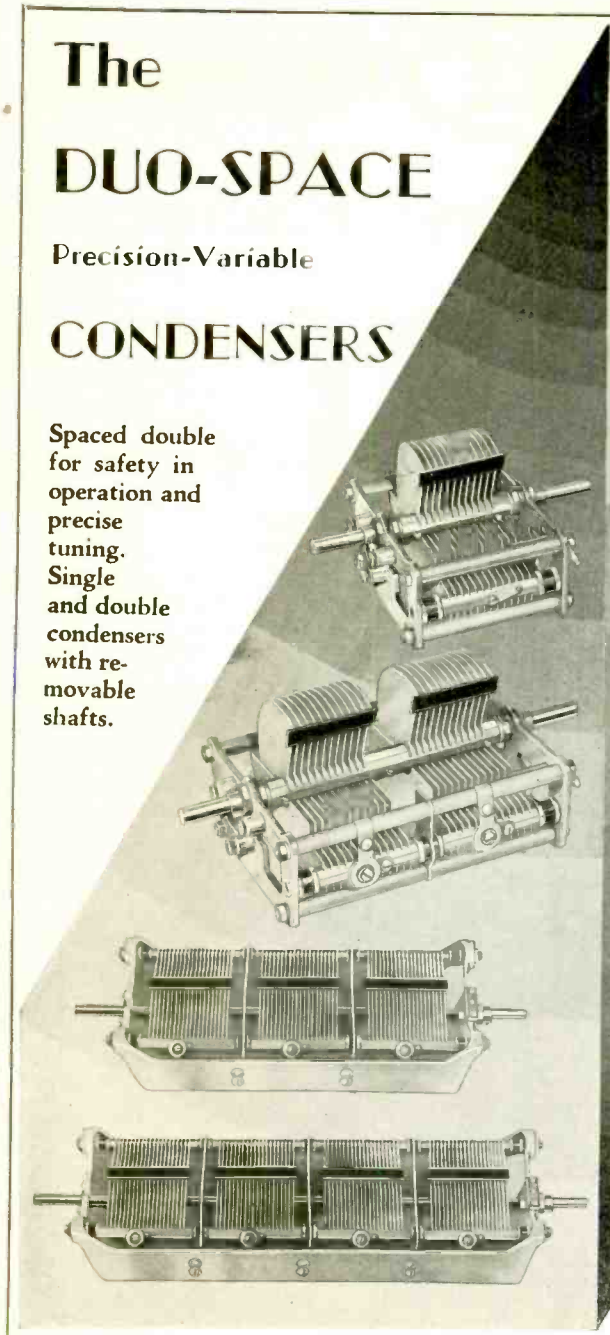
TEMPLE, Inc.

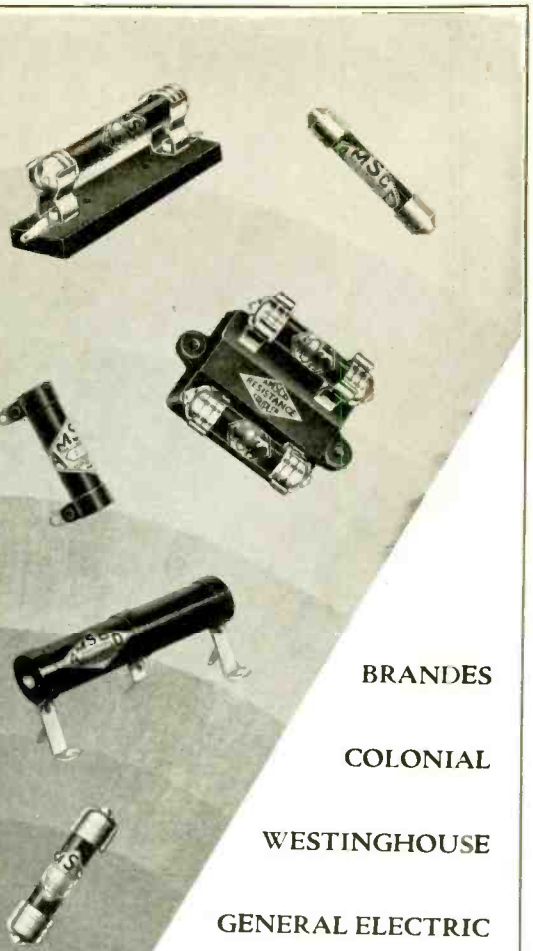
1933 South Western Ave. Chicago, U. S. A.

LEADERS IN SPEAKER DESIGN

The DUO-SPACE Precision-Variable CONDENSERS

Spaced double for safety in operation and precise tuning. Single and double condensers with removable shafts.





BRANDES

COLONIAL

WESTINGHOUSE

GENERAL ELECTRIC

STROMBERG-CARLSON

Are among the prominent manufacturers who use Amsco Heavy Duty Resistors.*

*Resistors made under the following U. S. Patents—Numbers 1,034,103—1,034,104—1,635,184.

Designed to the Requirements of Modern House Current Receivers

AMSCO PRODUCTS, Inc.

Broome and Lafayette Streets, New York, U. S. A.

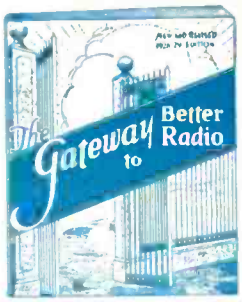
MEMBER RMA

Be sure to see us at Booth 24 at the R. M. A. Show

IDEAS!

Primarily intended to guide the radio enthusiast toward better radio results, "The Gateway to Better Radio" may serve as a book of ideas for the radio engineer, production manager, and manufacturer, not to forget the custom-set builder and service man. It may get you thinking along new lines; it may suggest a solution to a problem; it may confirm your views. At any rate, write us on your business letterhead, and a copy will be mailed to you—without obligation. And incidentally, recommend it to those who ply you for radio information! It will be worth the quarter which it will cost them.

A handy manual—36 pages and cover—88 illustrations—20,000 words of practical, concise text—prepared by Austin C. Lescarboura and our engineering staff.



Usable. Unbiased. Unselfish. Just the plain and workable radio truth for everyone interested in better radio results. Sold at 25 cents per copy for those not commercially engaged in radio.

There's a CLAROSTAT for Every Purpose

VOLUME CONTROL

A handy means of controlling loudspeaker volume, tone, r.f. stabilization, plate voltage, regeneration and other functions of the receiving circuit. Compact. Neat. Inexpensive. Holds any adjustment. Silent. Practically zero to 500,000 ohm range.

TABLE TYPE

A handy form of variable resistance for many uses, such as remote control of volume, "fading" correction, volume control for A-C tube harness, and so on. Neat. Compact. Finished in statuary bronze and nickel. Felt bottom.

STANDARD (Universal)

Long the ideal variable resistor for controlling voltage taps of radio power units and socket-power receivers. Practically 0-5,000,000 ohms in universal range. Other ranges made to order. 20-watt rating.

POWER

A big, husky unit for handling real power in socket-power receiver, A-B-C power unit, or power amplifier. 40-watt rating. Obtainable in low, medium and high resistance ranges. Neat. More compact than wire-wound resistances.

GRID LEAK

A precision grid leak, providing any resistance value from 1/10 to 10 megohms, for use in critical circuits, particularly short-wave reception. Holds adjustment. Silent. Neat. Compact. For panel mounting or with special bracket.

DUPLEX

Two Clarostats in one, each independently adjustable. Screwdriver adjustment instead of usual knobs. Reduces service troubles by eliminating knobs. May be employed in gangs for resistance network of radio power units.

Write for your copy of our manual as well as Clarostat literature. Send along any resistance problems you may have. And don't forget to look us up at Booth 24 when you visit the RMA Trade Show at Chicago.

AMERICAN MECHANICAL LABORATORIES, INC.

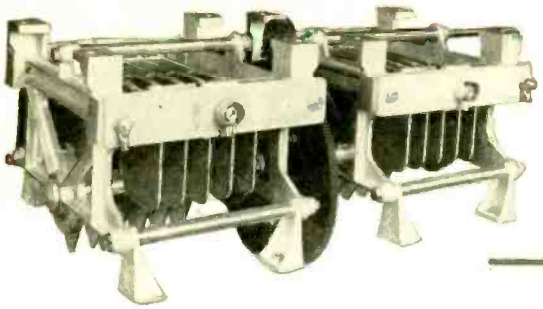
Specialists in Variable Resistors

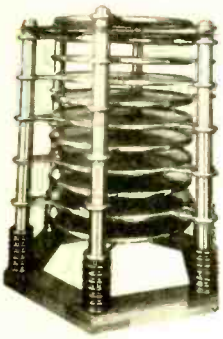
285 North Sixth Street : : Brooklyn, N. Y.

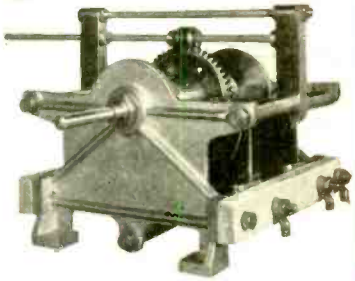
CLAROSTAT

Reg. U. S. Pat. Off.

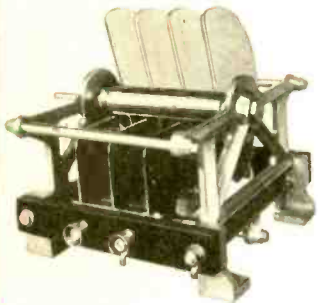
Cardwell Condensers

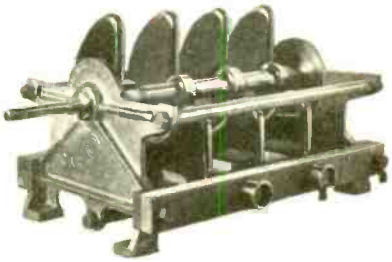






Now ~

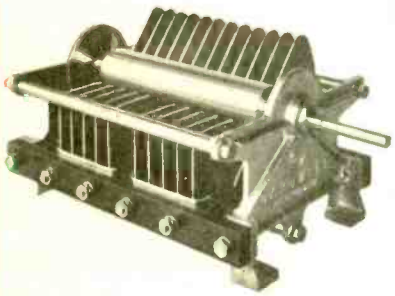




BEHIND the Scenes, so to speak, in scores of broadcasting and commercial stations, in installations sponsored by the real Giants of Radio, *Cardwell High Voltage Condensers* are upholding the reputation established and maintained by their smaller predecessors since the beginning of the present era of broadcasting.

Hundreds of these special condensers for specific uses have been designed and built for Engineers long familiar with their reliability and excellence.

What is your problem? A special folder describing the condensers illustrated will be sent upon request.



There's a

Cardwell

for every

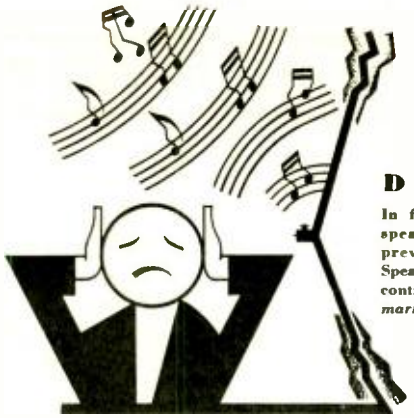
TUBE and PURPOSE

Write for Literature!

The Allen D. Cardwell Mfg. Corp.

83 Prospect Street, Brooklyn, N. Y.

"THE STANDARD OF COMPARISON"



Eliminate DISTORTION

In free-edge or uncontrolled cone speakers, distortion cannot be prevented. Lektophone Licensed Speakers eliminate distortion. They control the edge . . . *and control the market.*

LEKTOPHONE *licensed speakers*

are installed in the *more expensive* instruments sold by the three Leading Phonograph Companies of America.

LEKTOPHONE *licensed speakers*

are built by the following manufacturers of Phonograph and Radio Products, licensed under the Lektophone patents in the United States:

American Bosch Magneto Corporation
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Brandes Products Corporation
Farrand Manufacturing Company
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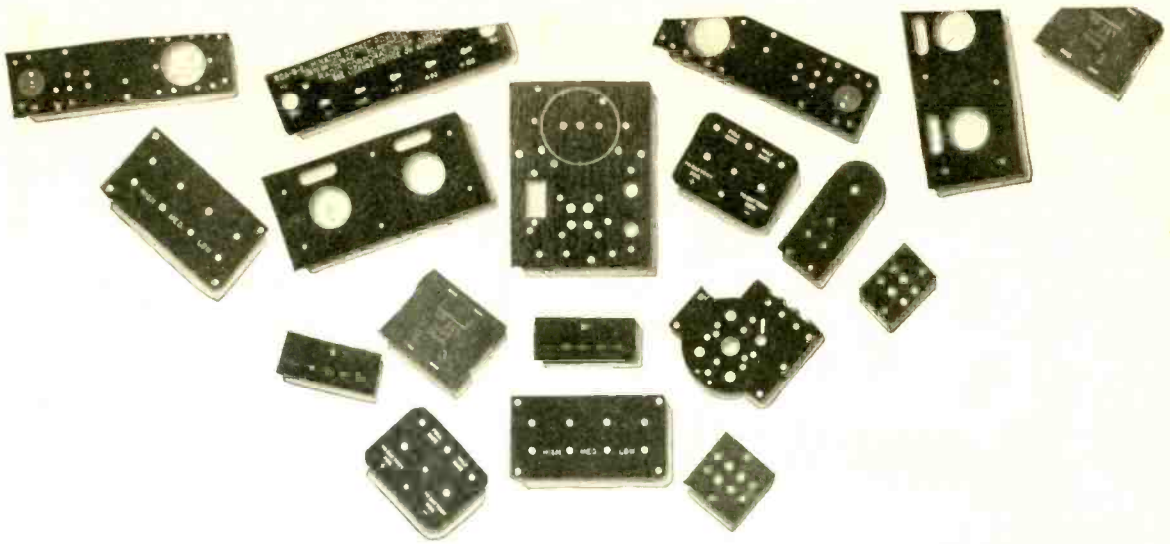
O'Neil Radio Corporation
Pathe Phonograph & Radio Corporation
Radio Corporation of America
Radio Foundation, Incorporated
Stromberg-Carlson Telephone Manufacturing Company
J. S. Timmons, Incorporated
United Radio Corporation
Utah Radio Products Company

The merits of Lektophone construction . . . the controlled edge . . . are understood both here and abroad by responsible manufacturers, assemblers, jobbers and dealers.

LEKTOPHONE CORPORATION
15 Exchange Place, Jersey City, New Jersey



MICARTA

for

Every Radio

Ever since the beginning of the radio era, Micarta has been the recognized standard for panels, sub-panels, tube panels, terminal strips, and other radio parts. ¶Micarta—the permanent panel material—assures better radio performance because of its high insulating qualities and strength. In addition, Micarta is not inflammable, nor is it affected by moisture or temperature changes. Micarta machines easily. The drill and the saw never chip it. ¶Micarta radio parts in any quantity—cut according to your specifications can be obtained from—

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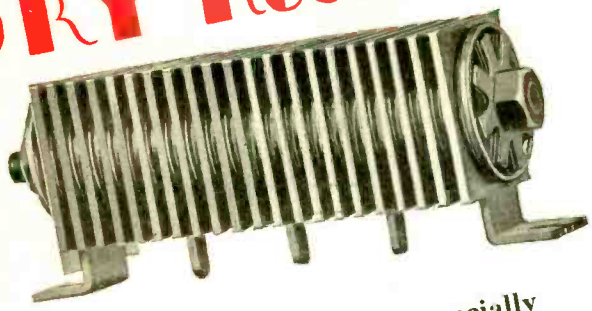
SMOOTH Power for Dynamic Speakers from the AC Line with the ELKON DRY Rectifier



Dynamic Speaker Series, especially designed to meet the needs of Manufacturers

THE Elkon Engineers have worked exceedingly closely with many of the manufacturers of dynamic speakers. The result of this work is an intimate knowledge of the problems of supplying smooth power to moving coils, and a complete series of rectifiers supplying just the voltage and current desired.

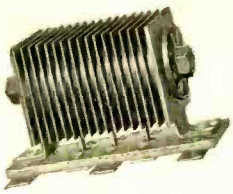
Already the Elkon Dry Rectifier has been specified by a majority of the Dynamic Speaker manufacturers. We would like to work with you as we have with them. Simply tell us your specifications, and we will submit a sample rectifier—May be supplied with or without power transformer.

Self healing, the Elkon Rectifiers have an exceptionally long life, are noiseless and require no attention or adjustment.

Let Rectifier Headquarters solve your problems. Send the coupon which will bring you the Engineering Bulletins on the Elkon Rectifiers and High Capacity Dry Condensers.

Radio Department
ELKON, *INC.*
Division of
P. R. Mallory & Co., Inc.
PORT CHESTER, N.Y.

Row upon row of Elkon Rectifiers being seasoned under the careful eyes of skilled workers



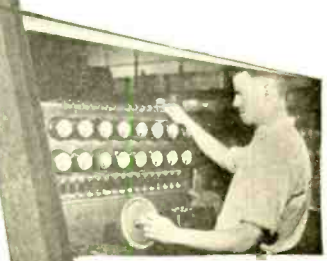
ELKON DRY RECTIFIER for "A" Eliminators

The Elkon Dry Rectifier has long been considered the ideal rectifier for "A" Eliminators. Standard equipment on the leading eliminators last year, and already specified this year by additional manufacturers.

The "A" Eliminator type is especially treated, ensuring smoothness and noiselessness. When used with the proper filter system including Elkon Dry Condensers the millivolt ripple is only from 3 to 6.

Elkon Rectifiers are Self Healing

Self healing, the Elkon Rectifiers have an exceptionally long life and require no attention or adjustments. Send the coupon for the Engineering Bulletins on Elkon Rectifiers and High Capacity Dry Condensers.



Every junction must have just the right pressure—16 meters to watch in this operation

Radio Department, ELKON, INC., 100 Fox Island Road, Port Chester, N.Y.
We are interested in Elkon Rectifiers for.....Dynamic Speakers
.....“A” Eliminators. Send the Engineering Bulletins to
.....
.....

The Engineering Rise in Radio

By Donald McNicol
Fellow A.I.E.E., Fellow I.R.E.
Past-President, Institute of Radio Engineers

IT IS with great pleasure that we present to our readers the first portion of Mr. McNicol's work which discloses the early chapters of scientific endeavor relating to the march of radio.

We do not believe a similar work has been undertaken—though it is true enough that the history of radio has been dealt with in various styles and forms, a few resembling in character and treatment the popular works "Microbe Hunters" and "The Story of Philosophy," and others of a fundamental nature designed for public consumption.

"The Engineering Rise in Radio" is not an attempt to romanticize the history of radio. It is a true and accurate account of the technical developments, dealing with facts rather than fancies.

We are confident that Mr. McNicol's document will survive other works of this nature and become the main source of reference.—THE EDITOR.

PART I.

Conductors and Insulators

STEPHEN GRAY, in England, in the year 1729, gathering up the meager items of prior knowledge, pointed out the difference between conductors and insulators of electricity. By experiment he demonstrated that certain substances, such as metals, are conductors, and that other substances, such as silk, are non-conductors, or insulators.

Galvani, in Italy, in the year 1786, experimenting with electricity, thought he had discovered it to be a *vital fluid*, a cause of vitality. His compatriot, Volta, reviewing Galvani's experimental results, learned that in fact the latter had discovered a new method of producing electricity, by chemical action.

The Primary Battery

Fourteen years elapsed from the time of Galvani's experiments until the appearance of Volta's first battery, and Volta had the rare distinction of not having any rival claimants to the invention of the primary battery.

Previous to the year 1800, investigators had as practical sources of electricity only the various forms of rotating cylinder, disk and globe machines, which were useful only for a very limited range of experiments.

With the new source of electricity at hand, Volta's battery, the philosophers of the time were enabled to extend their experiments, employing larger voltages and stronger currents than those previously available. Obviously a single cell of battery with unit voltage could serve as one of a series of cells, the number of cells, or pairs of plates, determining the total voltage available at the two terminals of the entire series.

Humphrey Davy, in England, in 1809, set up a battery of 2,000 cells. With this battery he was enabled to produce effects which had not previously been shown. With his 2,000 cell battery he demonstrated that a continuous electric arc could be maintained between conductors connected to the terminals of the battery, the conductors separated a short distance.

Electromagnetism

The advent of the chemical, primary battery brought to the colleges and laboratories the world over a dependable source of direct current with which, of course, most of the old experiments were repeated and checked and an entirely new line of investigation made possible.

Notwithstanding that the stage was set for giant steps forward in knowledge of electricity and magnetism, some years elapsed before, either by accident or design, advantage was taken of the availability of constant sources of direct-current to solve the mystery of the relationship existing between electricity and magnetism. The magnetic needle—the compass, was in use, and had been for centuries. The method of magnetizing needles and rods of iron and steel was to rub them on sections of the natural magnet, the lodestone. Electricity was one thing and magnetism was another, so far as the knowledge of the philosophers extended.

It is remarkable that nearly twenty years should intervene between the date of the chemical battery and the time of discovery of the relationship between electricity and magnetism. It is quite possible that an amateur experimenter, or an uncommunicative savant, somewhere tinkering with wires, batteries and compass needles had observed and was puzzled by unaccountable movements of magnetized needles, while his experiments continued.

Oersted's Discovery

Diligent search through the prints of the period 1800-1819 fails to bring to light any reference to this subject which would indicate that the truth had been uncovered. However, in the year 1813 the light was breaking through. In that year Hans Christian Oersted, a professor of natural philosophy, at Copenhagen, Denmark, published a work in German on the identity of chemical and electrical forces. In this work Oersted advanced conjectures concerning the relations subsisting between *electric, galvanic* and *magnetic fluids*, which he thought might differ from one another only in their respective degrees of *tension*.

Six years later (1819) Oersted, while addressing his students and while holding a wire carrying current above a compass needle, was astonished to observe the needle swing quickly from the normal North and South direction, coming to rest in a position at right angles to the wire.

Where could one look for more momentous evidence of the value of experimental investigation! For six years Oersted entertained the thought that electricity and magnetism were different *states* of a common phenomenon. Concentrated thinking on the subject prepared his mind to recognize any manifestation of this connection presented to him, and which easily might have escaped the notice of others. Oersted was forty-two years of age at the time he made his great discovery. He lived until he was seventy-four years of age, long enough to see the early telegraphs and early machine generators of electricity started toward that development which brought in the electric age.

There is here a circumstance worth noting, as it has a bearing on the whole progress of science. One might wonder why Oersted with his first-hand knowledge of the subject did not immediately proceed to extend and apply his discovery as was done a few months later by Ampere, and within the following eleven years by Sturgeon, Ohm and Faraday.

While there are in the history of science numerous instances of simultaneous, independent discoveries of important facts, the general advance has been conditioned upon a consecutive order of attack. One investigator contributes additions to existing knowledge of an art, and these new facts becoming known to other thinkers are taken up and carried to fronts further on where in turn fresh minds, taking advantage of existing knowledge of all prior contributions, are enabled to further contribute discoveries and inventions which carry an art forward.

Ampere's Contribution

Oersted's results were published in July, 1820. Two months later Andre Marie Ampere, in France, having learned of the Danish discoveries, duplicated the experiments, and on September 18, 1820, in a paper presented before the French Academy, announced the fundamental principles of the science of *Electro-Dynamics*.

As if to make up for the twenty unproductive years between Volta's and Ampere's discoveries, Ampere in one week of time extended Oersted's discovery to show that magnetic effects could be produced from electric current without the use of magnetized needles; showed that currents in opposite directions repel and that currents in the same direction attract each other. Ampere constructed a long spiral coil of wire called a solenoid, which when connected to the terminals of a battery exhibited characteristics of natural magnets. At this time Ampere was forty-five years of age. He died at the age of sixty-one years.

William Sturgeon, in England, in the year 1825, made the discovery that a bar of iron placed within the coil of wire (solenoid) acquired a magnetic strength many times greater than that of the solenoid alone; and, further, that when the circuit of the coil was opened the magnetism of the iron bar disappeared. Thus came into being the electro-magnet employed in a multitude of uses and now well understood by almost everyone.

The student of history may sense a hiatus in important discovery between the time of Ampere's work and the revolutionizing discoveries made by Faraday ten years later, but during these years many minds were at work on the problems of electricity and magnetism. Humphrey Davy and Dr. Wollaston, in England; M. Arago, in France, and others, carried on researches which added to the sum total of definite information available to the experimenter.

Coming down to the year 1830 we find that there were in hand for experimental research the wire conductor, the primary battery, the galvanometer, insulators, the electro-magnet, and the condenser (the Leyden jar invented by Von Kleist, Pomerania, 1745). Here were tools to work with, and within fifteen years thereafter the wire, battery and electro-magnet were employed in wire telegraph service.

In 1830 it is not likely that even the most advanced physicist was thinking about electric action at a distance without conducting wires. But, the scientific stage was set for further discoveries. What new knowledge, what new tools were required to suggest to the philosophers of that period that signaling could be established across space without connecting conductors? It is easy now for us to say: "As one condition, higher voltages and high-frequency currents, of course." And, although it may seem to us now that the scientists of that time were inexcusably obtuse mentally, the fact is that discoveries shortly to be made were to place in the hands of investigators, tools—mute in themselves, but pregnant with suggestion for new exploration.

The Induction Coil

For the purpose of following closely discoveries which contributed to the development of radio signaling we shall consider the experiments which led to the perfection of the induction coil rather than those which led to the invention of the dynamo. This, because regarded retrospectively the need was for very high voltages and high frequencies. Obviously, the rotating machine generator of electricity would for many years find at hand fields of utility which would be best served by generators of comparatively low voltages and large current capacity.

The need, then, was for a *multiplier*; an amplifier of voltage, even at the expense of reduction of current volume.

Faraday's Experiments

Michael Faraday, born in England in 1791, had been a newsboy and a bookbinder's apprentice prior to the time he entered the Royal Institution at twenty-two years of age as assistant to Humphrey Davy. During the first ten or twelve years there his duties were largely of a chemical nature, although he managed to keep well abreast of the times in knowledge of what had been accomplished in the study of electricity and magnetism.

Ampere had shown that by means of an electric circuit magnetism could be produced, and following some experiments carried out by Arago, in France, in 1825, Faraday became possessed of the idea that by means of magnetism electricity could be produced. The account of his experimental studies carried on between 1825 and 1831 discloses mainly a long series of failures. Perhaps on more than one occasion throughout these experiments the great truth was thundering for acceptance. The stumbling block was that Faraday had expected magnetism to produce a sustained electrical effect in a wire circuit.

Reasoning that current flowing in a wire has a continuous effect upon a suspended magnetic needle, Faraday's thought was that in some fashion it might be shown that a magnet could in turn create a continuous flow of current in a wire circuit. The generalization known as the principle of conservation of energy was not at that time available as a check upon hypothesis. However, the apparatus Faraday devised to investigate the matter, while it did not confirm his first notion, served as the instrumentality through which a more momentous truth was uncovered.

The apparatus employed consisted of an iron ring upon which was wound two coils of insulated wire. In present-day terminology we would recognize this as a one-to-one ratio transformer. With a galvanometer connected to the terminal wires of one coil, Faraday passed a current of electricity through the companion coil. We can realize that his feeling at first was one of dismay as the galvanometer needle "kicked" over to one side and then returned to its original position. Although current continued to flow through the coil connected to the battery, the magnetic needle gave no further indication of inductive effect. After a short observation Faraday disconnected one of the wires attached to the battery and noticed that now the galvanometer needle again moved away from, and back to, its normal position.

Here at last was the great discovery; the coil of the galvanometer was energized by electric current produced by magnetism. Close upon the heels of this discovery experiments were extended into various avenues of electrical inquiry, but the development which above others served as a step toward radio signaling was that of the induction coil. This instrument, made possible by Faraday's discovery, was destined, in the hands of the experimentalists, to become as revolutionary in its potentialities as was the lever of Archimedes to succeeding generations of mechanics—each discovery presented a key to the multiplication of force.

Advance in America

Joseph Henry, professor of mathematics and natural philosophy, in the Albany, New York, Academy, had, prior to the year 1831, conducted many experiments with magnetic coils and electro-magnets. He produced the earliest really useful magnets; those previously in use having but feeble attractive power, due to imperfection of design.

The development which at this time was impending was that of the induction coil, an assembly of elements consisting of an iron core, primary winding, secondary winding and an automatic circuit-breaker for the primary circuit.

During the five or six years following Faraday's employment of separate coils of wire on a common core of iron to produce secondary currents, scientific investigators in Europe and America devoted much time to studies of the principles involved and to the construction of all imaginable forms of electro-magnets, solenoids, and coils for producing electric shocks. In these years noteworthy improvements were made by Professor Forbes, of Edinburgh; Faraday and Sturgeon, in England; Professor Callan, in Ireland; M. Masson, in France; Dr. Neef, in Germany, and Joseph Henry and Charles G. Page, in America.

Henry and Faraday, independently, studied the phenomenon of the more intense spark at the *break* of circuit, over that observed when the circuit was *made*. Each learned that the longer the wire the larger would be the spark upon interrupting the cir-

cuit through the battery. Also, that when the circuit included the coil winding of an electromagner, the greater still would be the "shock" upon opening the circuit. The title of Henry's paper communicated to the American Philosophical Society, on January 16, 1835, was: "On the Influence of a Spiral Conductor in Increasing the Intensity of Electricity from a Single Cell of Battery."

Faraday had announced the same observation in the *Edinburgh Philosophical Magazine* of November, 1834 but Henry had previously, (*Annals of Philosophy*, May, 1832) (*Silliman's Journal*, July, 1832) reported experiments which pointed to the same conclusion.

Evidently the thought to the fore was to discover means of producing the most severe shock, or greatest spark by employing a single battery cell and an inductive circuit. In 1831, Faraday had employed separate coil windings on a common core: in effect a primary and a secondary winding, but as the length of wire used in forming each coil was the same, or nearly so, the sparking effect observed at the terminals of the secondary winding was not noticeably greater than that observed upon interruption of the primary circuit itself.

Obviously, of course, once an arrangement of wire and coil had been set up which would produce a maximum of spark, employing one cell of battery, this could be further increased in volume by adding additional battery cells in series.

Improvements in Induction Coil

Review of a mass of contemporary literature on the subject indicates that Professor N. J. Callan, of Maynooth College, Ireland, was the first to produce an induction coil with a relatively small amount of wire in the primary circuit: the secondary winding being made up of a largely increased number of convolutions. With this instrument Prof. Callan was able to produce shocks of great severity although the primary circuit, in which an interrupter was connected, was actuated by but a cell or two of battery.

The Callan instrument was exhibited and described in 1837. It was, in fact, a step-up transformer of the induction coil type—actuated by an interrupted direct-current in the primary circuit.

In the same year Backhoffer built a coil in which a bundle of small iron wires was used as the core in place of solid iron rods previously used, and about the same time Professor McGauley, of Dublin, Ireland, applied an automatic circuit-breaker as an interrupter in the primary winding.

Professor Charles G. Page, of Salem, Massachusetts, who had for some time experimented with "shock" coils, in 1838 communicated to *Silliman's Journal* a description of an induction coil with separated primary and secondary windings—the secondary having a greater length of wire than the primary. In this instrument the core consisted of a bundle of iron wires, and a circuit-breaker was employed in the primary circuit.

The utility of this new instrument for producing spectacular electrical effects was quickly recognized in all parts of the civilized world. No scientific laboratory was regarded as completely equipped until a high-powered induction coil was procured. In the hands of expert instrument makers the apparatus soon was issued in improved and finely finished forms. Ruhmkorff, in Germany, in 1851, materially improved the method of winding the secondary coil: setting it up in sections in order to reduce the likelihood of break-down of insularion when the coil was in operation. In 1853, Ruhmkorff added the final touch to the instrument by connecting a small condenser, due to Fizeau, across the contact points of the circuit-breaker.

In America, a well-known instrument maker of Boston, E. S. Ritchie, in 1852, constructed advanced types of induction coils. Early Ritchie coils produced secondary sparks six inches in length, and in the year 1857, an induction coil was made for the laboratories of Columbia University, New York, which produced a secondary spark ten and one-half inches in length.

Thus, subsequent to the year 1850, physicists had as a tool for experiment a practical high-tension induction coil which, in conjunction with Leyden jar condensers, afforded a means of generating and studying the effects of oscillating electric discharges on a scale not possible with the laboratory apparatus previously used.

In the march of events towards the radio age this matter of the oscillatory nature of electric discharges was of first importance, for by means of these oscillations electromagnetic waves are produced which are employed in setting up radio telegraph and radio telephone signaling.

The Condenser Discharge, Oscillatory

In the year 1827, Felix Savary, a savant of the time, submitted an hypothesis which suggested that the electric flow of discharge from a Leyden jar condenser might in truth be oscillatory. Other workers of the time undoubtedly were puzzled by observed characteristics of the condenser discharge through a circuit, differing as these do from the steady effects produced in a circuit supplied from a primary battery.

Joseph Henry, in 1840, produced high frequency oscillations, and on June 17, 1842, presented a paper to the American Philosophical Society recounting the results of an investigation carried on by him with the object of unravelling the mystery of the condenser discharge. The condenser could be given its charge from any available source of electricity, but the current of discharge, while somewhat spectacular in its effects, had few practical applications. The discharge would produce sparks, but many years were due to pass before what the sparks accomplished was to become common knowledge.

In the scientific paper here referred to, Henry stated: "The discharge, whatever may be its nature, is not correctly represented by the single transfer from one side of the jar to the other (from one plate of the condenser to the other). The phenomena require us to admit the existence of a principal discharge in one direction, and then several reflex actions, backward and forward, each more feeble than the preceding, until equilibrium is obtained."

The secret was out—the discharge of a condenser was, plainly, oscillatory. This discovery was of vastly greater importance than it was known to be at the time. Other investigators continued to experiment with the oscillatory discharge. Riess, Wollaston and Von Helmholtz,[1] particularly, continued to investigate: groping into the unknown for disclosures which were slow to come.

It remained for William Thomson[2] (Lord Kelvin) in the year 1853, to give out the first mathematical conception of the nature of the oscillatory discharge. He showed that in a given case the frequency of oscillation and the rate of dissipation can be calculated when the factors, inductance, capacitance and resistance are known in terms of their values. The formulas which resulted from these mathematical deductions have since then been tools in the hands of the electrical engineer.

Electromagnetic Waves

By the year 1853 electrical science had reached a stage where there was need for analytical attack by the advanced mathematician. In that year Thomson was twenty-nine years of age; Faraday, sixty-two; G. R. Kirchoff (in Germany) twenty-nine, and James Clerk Maxwell, twenty-two. Thomson, Kirchoff and Maxwell were well versed in the application of mathematical reasoning to physical problems.

Faraday's scientific achievements were more the result of experimental skill and scientific intuition, than of ability to reason mathematically. In the year 1827, writing to the youthful Maxwell, Faraday said: " . . . There is one thing I would like to ask you. When a mathematician engaged in investigating physical actions and results has arrived at his conclusions, may they not be expressed in common language as fully, clearly and definitely as in mathematical formulae? If so, would it not be a great boon to such as I to express them so?—translating them out of their hieroglyphics, that we also

[1] *Erhaltung der Kraft, Berlin*, 1847. *Tyndall's Scientific Memoirs, London*, 1853, *vol.* 1, *p.* 143.

[2] *L. E. Philosophical Magazine, June* 1853.

might work upon them by experiment."

Maxwell, with his great mathematical skill introduced to science new concepts of electrical and magnetic forces with special bearing upon what takes place in the neighborhood surrounding electrically charged conductors. His essay published in 1865, entitled "A Dynamical Theory of the Electromagnetic Field" that electromagnetic effects travel through space in the form of transverse waves, similar to those of light and having the same velocity; his theories in a fully developed form appearing in his great treatise on Electricity and Magnetism, published in 1873. His contemporaries, and those who followed immediately were not quick to realize the complete significance of Maxwell's theories. Perhaps the delay was due to the fact that Maxwell was not concerned in giving a mechanical explanation of electric and magnetic actions, contenting himself with the statement that such explanation was possible.

Maxwell and Hertz

In the span of seventy-five years, from Volta to Maxwell, as outlined in the foregoing, the science of electricity and magnetism had been supported by a succession of geniuses who were in each instance well fitted by natural ability and temperament to add to and to carry forward gains in knowledge, to the end that higher planes of achievement were successively reached.

The next important step toward the goal of radio was made in the year 1887, by Hertz, and from this date forward a new generation of scientists assumed the task of consolidating the discoveries and inventions of the past, adding by further invention that necessary to usher in practical radio signaling.

In the year 1887, of the scientists whose major achievements are described herein, the following had passed away: Ampere, Volta, Arago, Henry, Maxwell, Kirchoff, Ruhmkorff, Page, Faraway, Oersted and Ohm.

William Thomson (Kelvin) survived, and was becoming a veteran. Fortunately for the art there had been in training in various countries young men, then maturing, who were destined to contribute largely to the advancement of the radio idea.

Maxwell's equations dealing with the electromagnetic theory of light, and with wave propagation traveled the rounds of the colleges and laboratries for a period of ten or more years before the true significance of the deductions gained circulation. In 1885, ten years after Maxwell's complete publications, one of the small company who had sensed the full meaning of Maxwell's theories was Oliver Heaviside, then thirty-five years of age. Heaviside was Maxwell's first disciple; the first to vision future useful applications of Maxwell's theories. In his extensions of Maxwell's reasoning he treated of motions of electric charges at different velocities in relation to the speed of light rays. Hertz' demonstration in 1888 of the propagation of electromagnetic waves through free space, and their detection, was hailed by Heaviside as the first experimental proof of Maxwell's electromagnetic wave theory.

Wire Telephony

The wire line telephone was invented in 1876 by Alexander Graham Bell, in America, but other thinkers had during the previous fifteen years given thought to the possibility of transmitting speech over wire lines. Since the year 1845, telegraph lines had been extended to all parts of the world, and with the telegraph an accomplished fact it was quite natural that the electricians and the professors, who were the philosophers of the period 1860-1900, should run to earth every suggestion which pointed in the direction of telephony.

Philip Reis, in Germany, in 1861, discovered that a vibrating diaphragm

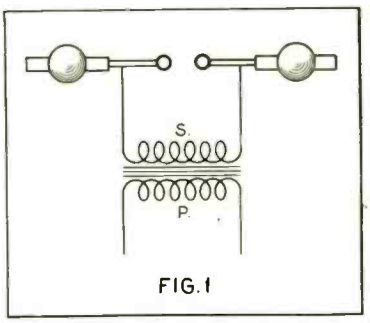


FIG. 1

An early type of Hertz oscillator.

could be actuated by the human voice so as to cause the pitch and rhythm of vocal sounds to be transmitted over a wire and reproduced at the distant point by means of electromagnetism. In a statement made by Reis in the year 1863, he said: "Two years ago I succeeded in effecting the possibility of the reproduction of tones by battery current and in setting up a convenient apparatus therefor. If sufficiently strong tones are produced before the sound aperture, the membrane and the angle-shaped little hammer upon it are set in motion by the vibrations; the circuit will be at once opened and closed for each full vibration, and thereby will be produced in the iron wire of the spiral the same number of vibrations which are there perceived as a tone or combination of tones."

Bell's invention for the transmission and reproduction of speech consisted of a device for superposing magneto-electric currents upon a battery circuit, and a receiver consisting of an iron diaphragm mounted in contact with, or in close proximity to, a soft iron magnet.

In 1874, Elisha Gray, in America, had been at work on the problem of telephony; inventing a method of electrical transmission by means of which the intensity of the tones, as well as their pitch and rhythm, could be reproduced at a distance; and subsequently conceived the idea of controlling the formation of electric waves by means of the vibratory motion of the diaphragm capable of responding to all of the tones of the human voice.

In 1876, Amos E. Dolbear, in America, substituted permanent magnets in place of the electromagnets and battery previously employed, and used the same instrument for both transmitting and receiving.

In 1877, Thomas A. Edison applied to the telephone a principle previously known to him, also to Emile Berliner, and perhaps others: the principle of the variation of resistance which carbon and various other substances undergo when subjected to change of mechanical pressure.

In order to stick closely to the story of the rise of radio we shall not here continue the history of telephony. It may logically be taken up again about thirty-five years later upon the advent of radio telephony.

The important thing at the moment is the phenomenon of variable resistance of a circuit which includes a small block of carbon in light contact.

Electric Wave Phenomena

It may readily be understood, following the prefection of the laboratory induction coil about 1855, that, in fact, electromagnetic waves were being produced daily in the laboratories—spreading uselessly through space in all directions from the source. Doubtless, on many occasions, experimenters observed sparks in places where there was no known reason for sparks to appear. And, on occasion, doubtless, many experimental circuits containing a number of elements not securely connected together electrically, gave indications of instability which puzzled and perplexed those carrying on the work.

But it was not until Maxwell's announcement in 1873 that the existence of electromagnetic waves was predicted on reasonable assumptions. Thenceforward the task was to detect electromagnetic waves in space in such manner that their interception, or presence, might sensibly be recognized.

David E. Hughes,[3] in England, in 1879, noted that when an interrupted electric current was actuating a magneric coil, a microphonic contact placed anywhere in the room was affected at every interruption of the primary circuit. Ludtge,[4] in Germany appears to have made a similar dis-

[3] *Hughes revived the word "Microphone," fifty years previously used by Wheatstone as the name of an acoustic apparatus for magnifying sounds.*

[4] *Ding'er's Polytechnisches Journal*, 229, 148, 1878.

covery at about the same time as Hughes.

Hughes, investigating further, found that various forms of microphonic joints were sensitive to electric action from a distance. He learned that a block of carbon resting on a bright steel surface was sensitive and self-restoring, while loose contact between metals, although equally sensitive, would cohere, remaining in electrical contact (minimum resistance) after the passage of an electric wave. In the year 1880, Hughes' results were shown to Sir George Stokes, and other well-known physicists, but the idea that the phenomena observed were a result of electric waves in space was rejected by Stokes, his opinion being that the effects were simply those of ordinary induction, as at that time understood.

As further evidence that Maxwell's ideas about electric waves were slowly but surely taking form in the minds of the professors, it may be recorded here that in 1883, Professor Fitzgerald, of Dublin, Ireland, suggested from theoretical considerations, that he believed it possible to excite electric waves in the *Ether* by means of discharges from Leyden jar condensers. The truth was that condensers had been doing that very thing for a hundred and thirty-eight years—since Von Kleist's time; and, since the perfection of the induction coil about 1850, electromagnetic waves in space were being propogated at one time or another in every physical laboratory equipped with this instrument.

Hertz Waves

Heinrich Hertz, professor of physics, in the technical high school at Carlsruhe, Germany, in 1887, while delivering a class lecture,[5] demonstrating with a Leyden jar condenser and two separate coils of wire, observed that the discharge of the jar through the coil attached to it caused electrification of the other coil, provided—and here is the great discovery awaited since 1873—provided *that there was a spark gap in the inducing circuit*, see Fig. 1. Hertz was then thirty years of age, and was undoubtedly one of the most accomplished physicists of the time. Following his discovery he soon proved that electricity can be transmitted in the form of electromagnetic waves, at the same speed as light. He proved that

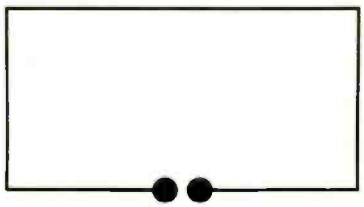


FIG. 2

A metallic loop nearly closed was employed by Hertz to detect the presence of electric waves in space.

electric waves show the phenomena of refraction, reflection, diffraction and polarization, as do light waves.

Hertz's experimental demonstrations were the desired confirmation of Maxwell's electromagnetic wave theories. Immediately in other countries the University and College laboratories saw an entirely new series of investigations begun. In England, Professor Oliver J. Lodge had, almost simultaneously with Hertz, detected electric waves transmitted along conducting wires.

[5] *After Hertz had continued his investigations for some time he learned that W. von Bezold, in 1870, had performed experiments with dischargers connected by wire to resonator rings, by means of which he observed the phenomena produced in a conductor by advancing and reflected oscillations. In* **Poggendorf's Annalen**, *Vol CXL, appeared a paper by von Bezold, entitled "Researches on the Electric Discharge."*

In his writings Hertz gave generous recognition to the pioneer work of von Bezold, but it should be remembered that Hertz's great step forward was in the use of **ISOLATED** *resonator loops. That is, receiving rings not connected by wire with the oscillator system.*

Naturally, it took the experimentalists some little time to get used to the iden of electromagnetic waves. They were familiar with the action of magnetic lines of force in the neighborhood of a conducting wire. With a strong current in the wire the inductive action might be detected at a considerable distance away from the charged wire when a sensirive magnetic needle type of indicating instrument was employed.

The splendid series of researches which followed Hertz's discovery disclosed that elements of an oscillating system are a capacity and an inductance, and means for charging the capacity; permitting it to discharge through the inducrance.

The resulting combination of electrostatic and magnetic fields moving outward into space constitutes an electromagnetic wave, traveling at the speed of light waves. Electromagnetic waves encountering obstacles consisting of non-conducting material pass through as light waves pass through glass. When electromagnetic waves propagated into space arrive at a wire system, or conductor, the magnetic lines of the wave set up electric oscillations in the conductor the effects of which depend upon the form of translation employed.

The detector, or receiver, used by Hertz in his classic experiments consisted of a metal ring which had been cut, the two ends being fitted with small metal knobs slightly separated as shown in Fig. 2. This, the first radio receiver, was particularly adapted to the needs of initial investigation. The ring could be given exact dimensions, as to diameter, thickness of wire, and size of air-gap, and while it was far from being an efficient absorber of energy it was a persistent oscillator, well designed to respond to waves of pre-determined length.

(*To be Continued*)

Radio Industry Presents Broadcasting Proposal

WITH a plan for the establishment of a broadcasting system of the United States which will give a greatly improved radio service, all branches of the radio industry joined in a report submitted April 23rd to the Federal Radio Commission and urged that such a goal be attained by natural evolution rather than by radical sweeping changes. Reduction in the number of broadcasting stations with a minimum of delay and also minimum disturbance in present broadcasting was recommended.

The industry proposal was presented by Attorney Frank D. Scott in behalf of the National Association of Broadcasters, the Radio Manufacturers' Association and The Federated Radio Trades Association, whose committees had met first separately and later jointly in Chicago. The report, invited by the Commission to aid it in administering the new "equal" allocation provision of the radio law, does not contain a completely evolved plan for the equal distribution of station licenses but rather provides a method of procedure, which is sufficiently flexible to meet the changing conditions in broadcasting.

The method calls for the use of basic "common denominators" which will be placed sufficiently high to accommodate the normal requirements of zones in respect to wave lengths, station licenses, power and periods of operation which must be equalized in accordance with amendments recently made by Congress to the Radio Law of 1927.

On the question of station licenses the industry is patently of the opinion that there are too many stations on the air at the present time and for that reason suggests the fixing of the "common denominator" at one-fifth of the total number of stations now in existence, or 140 in each zone, and that in working to the ideal, ultimately to be realized, to make use of the borrowing clause of the "equal allocation" amendment which permits the Federal Radio Commission to assign temporarily station licenses, power or wavelengths from zones where they are allotted on a quota basis to stations in other zones at present above their quotas.

R.M.A. PERSONALITIES

C. C. COLBY

PRESIDENT, R.M.A.

THE Radio Manufacturers Association Trade Show at the Hotel Stevens, Chicago, will be the largest gathering of the industry during 1928.

The members of this Association will display to the trade their entire line of latest models of sets and accessories, and the great step forward in stabilization of the industry and standardization of equipment taken during the past year, will be apparent to all.

Important as it is, this trade show is but one of the many things which the R.M.A. has been doing for the industry. It sponsors and assists in conducting the two national exhibitions which give to the user the opportunity of observing the advancement in the Radio art; it co-operates with the Institute of Radio Engineers in producing industry standards: it has published and secured wide distribution of a manual on "Better Radio Reception" to help in the elimination of "man made static;" it has been fostering and helping to develop training schools for the education of those planning a radio career: it has developed a plan for patent interchange among the industry that should afford the same advantages experienced by the Automotive Industry from a similar plan: it has been actively co-operating with the Federal Radio Commission for the improvement of Radio Broadcasting conditions and has been working in full accord with the other branches of the industry.

In short, through more than twenty five active committees, it is working incessantly to bring order and efficiency into the Radio field through sane, constructive lines of action.

C. C. Colby.

HOW THE R.M.A. IS FUNCTIONING TO HELP ITS MEMBERSHIP

By M. F. FLANAGAN,
Executive Secretary, R.M.A.

ASSOCIATION service is a strange force. Its intrinsic value can be measured only by the yardstick of individual co-ordination, and so, obviously, its effectiveness is never as uniform as disciples of cooperative work would like to see it. It is wholly dependent upon the varying ability and inclination of various members to apply it to their specific problems.

However, industries are fast learning that this is the day of cooperation, and that active competition for the consumers' favor is making associations one of the prime means of stemming the tide of economic intrusion.

Service is essentially the keynote of the R.M.A. in its plans and aims; an ideal of cooperation to safeguard present and future of a vast industry that has intrigued the wide world by universal adaption to its needs.

Numerous functions have been inaugurated that have promoted harmony and progress within the ranks of our members, and each year there is added divisions of service that are welding the classes of membership into stronger accord and understanding.

Chief among these is the Relations with Distributors, taking the form of aid and development of retail interests and general cooperation tending to build up better distributive methods. Out of this policy has come a close affiliation with powerful allied groups; patent interchange, patent research, fair trade practices, an engineering division, employment aid, traffic service, credit and collection service.

Through the last activity, the R.M.A. is assuming a great responsibility to its members and the industry.

By the appointment of the Honorable Frank D. Scott, the membership of the R.M.A. has in Washington a highly capable representative to protect its legislative interests. Each year also, under the auspices of the R.M.A. there is held a convention and trade show which brings together manufacturers, jobbers and dealers for interchange of ideas, fellowship, and to collectively determine the merchandising course for the ensuing season.

Among the growing activities which are assuming important proportions are the establishment of the Manufacturers' Transfer Bureau, the enlargement of the Traffic Department at headquarters with a Traffic Manager giving full time to interests of members, publication of the Interference Manual, "Better Radio Reception," Publicity Service and a new department providing window posters and other aids, publication of a membership list, with complete information concerning manufactured products of members, sources of distribution, credit information and patent information.

In addition to the specific activities referred to, the Association has done much that may be termed altruistic. This deals primarily with the Radio Art itself and the public's interest in education, as well as amusement. The future of our work looks bright.

A. J. CARTER

CHAIRMAN, R.M.A. PATENT INTERCHANGE AND PARTS COMMITTEES

TWO of the principal problems before the radio industry are a workable solution of the patent question and maintenance and promotion of the parts manufacturers' business. As chairman of the two R.M.A committees having these problems in hand there has been a double-barreled duty of firing and being fired at. This has been particularly true in connection with the patent problem. It is an explosive question when and wherever discussed. What

the R.M.A has been trying to do, now with reasonable prospects for success, is to evolve a patent cross-licensing plan which may have the same stabilizing effect upon the radio industry as a similar patent interchange plan has for the automotive industry. Instead of constant patent warfare, the aim of the R.M.A in development of the patent interchange plan has been to substitute for patent warfare a peaceful, reasonable community of patent interests, to be sanely administered, with the public and the common industry interests above private individual interests. For months the R.M.A. Patent Interchange Committee has been hard at work on the cross-licensing plan which, in finished form, we now hope to present to our membership and secure its approval and adoption.

A. J. Carter

H. B. RICHMOND

DIRECTOR, ENGINEERING DIVISION, R. M. A.

THE development of enginering standards gives the history of the art itself. This has been especially true in radio. The first problems covered just such simple ones as terminal designation, then interchangeability, test methods, and now finally the very classification of a complete set itself.

Progress has been remarkably rapid. It hardly seems possible that one short year ago standardization had come to a standstill because two associations were doing similar work. True enough that both associations are continuing their work, but in harmony, so that today the radio industry is operating under a truly industry standard.

It has been demonstrated more clearly than ever that while the radio industry must consider the work already done in other industries it cannot delay its progress until approval can be obtained from outside bodies. Its problems must be met promptly as they arise, and within the industry.

The next step is in the line of co-operative research and patent interchange. While it may take some time for such a program to become effective, today finds us marvelling at our standardization stupidity of a year ago,

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H. B. RICHMOND
Director of Engineering Division, R. M. A.

and thus a year hence will undoubtedly find in effect the next desired engineering step forward—research co-operation and patent interchange.

H. B. Richmond

THE NEW RADIO LAW

By BOND P. GEDDES
Executive Vice-Pres., R. M. A.

A STRIKING example of actual dollars and cents value to individual members of trade associations, and specifically, members of the R.M.A., has been given recently in connection with the new radio law passed by Congress and signed by President Coolidge.

The radio industry, as represented by the R.M.A. and associated organizations of the "triangle," the National Association of Broadcasters and the Federated Radio Trades Association, and the business of each individual member of the industry, as well as related interests, were guarded against serious financial damage threatened by the original legislation proposed in Congress.

While manufacturer members of the R.M.A. were busily engaged in their own work of producing radio sets, parts and accessories; which broadcasters were busy putting out their programs; and jobbers and dealers at work supplying the public with radio; editors of newspapers and trade magazines writing about radio, representatives of the radio trade associations were in a hot fight in Washington, lasting during the entire month of March, to avert financial losses to all radio interests threatened by pending legislation.

It was obviously impossible for the manufacturers, broadcasters, jobbers and dealers, and others in the radio industry to be in Washington to protect their own individual interests. It was a collective job, a trade association job; and it was highly successful.

What threatened every interest, and more, the interests of the entire radio public in its reception of broadcasting, was the unworkable, highly objectionable plan advanced by Representative Edwin L. Davis of Tullahoma, Tennessee. This proposed arbitrary, disastrous division "equally" of all radio broadcasting facilities into the five radio zones, regardless of broadcasting talent, capital to erect stations, or public demand therefore, and also regardless of every principle of radio.

It was instantly recognized by industry leaders as highly inimical to the public and industry interests. The original legislation would have dangerously disrupted broadcasting, damaged the public through inability to receive satisfactory programs, and reduced sales of radio while striking at broadcasting. An arbitrary "equal" distribution throughout the five zones of theatres, churches, singers, actors, lecturers and orchestras, or similar "equal" distribution of railroad cars, telephones or milk bottles would have been as logical, by mandate of Congress.

Radio association representatives on March 2nd began the fight which ended in material modification of the radio legislation, so that, it is hoped and believed, it can be administered by the Federal Radio Commission without material harm resulting to the public or to the industry.

LIST OF R.M.A. SHOW EXHIBITORS

Booth Locations: Plain Numbers—Exhibition Hall, Lower Lobby. Letter B preceding, Ball Room, 2nd floor south. Display Rooms, 4th to 25th floors.

Name of Exhibitors	Booth No.	Demonstration Room
Abox Company, The	158	513
Acme Elec. & Mfg. Co., The	54	524A
A-C Dayton Company, The	B–63	805A–806A
Acme Wire Company, The	B–8–9	
Adler Manufacturing Company	B–74–5–6	1005–1006
Aero Products, Inc.	B–42–43	
Aerovox Wireless Corp	B–83	
All-American Mohawk Corp	B–66–67	2100–2101–2101–A
Allen–Bradley Company	B–68	
Aluminum Company of America	61–62	
American Bosch Magneto Corp	B–11–12–13	2002 to 2010, Inc.
American Mechanical Labs., Inc	25	
Amrad Corporation, The	99–100	542A
Amsco Products Co	51	
Andrea, F. A. D., Inc	18–19	
Apex Electric Mfg. Company	B–87	444A

Name of Exhibitors	Booth No.	Demonstration Room
Arco Electrical Corp	22	
Arcturus Radio Company	B-30-31	
Argus Radio Corp	23	546A
Aston Cabinet Manufacturers	105	421A
Atwater Kent Mfg. Co	B-37-38-39	1700-1701 1701A-1721
Belden Manufacturing Co	144	
Benjamin Elec. Mfg. Co	56	
Best Manufacturing Co	14	451
Birnbach Radio Company	145	
Brach, L. S. Mfg. Company	B-57	560
Bremer-Tully Mfg. Company	B-3-4	557
Bright Star Battery Company	71	
Brooklyn Metal Stamping Co	146	
Brown & Caine, Inc	6	
Buckeye Mfg. Company, The	114	522
Buckingham Radio Corp	B-71	547
Bullens Company, D. K	52	
Burgess Battery Company	102	
Bush & Lane Piano Company	131-132	1005A-1006A
Carter Radio Company	66	
Case Electric Company	B-90-91	440A
Caswell Runyan Company, The	B-82	451A
C. E. Mfg. Company, Inc	107	1300-1301-1301A
Celeron Company, The	49-50	
Central Radio Corp	44	
Central Radio Laboratories	151	
Chicago-Jefferson Fuse & Elec. Co	96	
Chillicothe Furniture Company	80	
Columbia Phonograph Co., Inc	148-149	1605A-1606A
Consolidated Radio Corp	76	
Continental Fibre Company	B-28	
Cornish Wire Company	97-98	900-901-901A
Crosley Radio Corp	39-40	
Crowe Name Plate & Mfg. Co	134	2019
Cunningham Co., Inc., E. T	B-77-78	1805A-1806A
Day-Fan Electric Company	37	504
DeJur Products Company	73	
Deutschmann Co., Tobe	55	536
Diamond Electric Corp	7	
Diamond Vacuum Products Co	152	
Dongan Electric Mfg. Company	79	
Dooley Electrical Mfg. Co	B-10	
Dubilier Condenser Corp	133	
Eby, H. H. Mfg. Co., Inc	88	
Ekko Company, The	159	
Electrad, Inc	84	452A
Electrical Research Labs., Inc	75	
Elgin Cabinet Company	130	1404 1405-1406
Elkon Works, Inc	21	
Essenbee Radio Devices Co	B-64-65	512A
Excello Products Corp	11	
Fast, John E., Inc	85-86-87	600-601-601A
Fansteel Products Co., Inc	B-58-59	2102 to 2111 Inc.
Farrand Mfg. Co., Inc	B-60-61-62	1000-1001-1001A
Federal-Brandes, Inc	3	
Federal Furniture Factories, Inc	81-82	534
Federal Radio Corporation	9	
Ferranti, Inc	60	519-20A
Findlay Mfg. Co., Inc., Robert	150	
Formica Insulation Company	94-95	512
Freed-Eisemann Radio Corp	B-55-56	
French Battery Company	116-117	521A
Freshman, Chas., Inc	92	
Frost, Herbert H., Inc	12	
General Dry Batteries, Inc	13	
General Instrument Corp	B-5	536A
General Radio Company	35	526A
General Transformer Corp	72	561A-563A-564A
Grand Rapids Furniture Co	46-47	523
Gold Seal Electrical Company	65-A	
Grebe & Company, A. H	17	2222-2223
Greene-Brown Mfg. Company	64-65	
Grigsby-Grunow Company	1-2	
Hamilton Mfg. Company	24	
Hammarlund Mfg. Company	10	
High Frequency Labs	106	
Howard Radio Company	8	509
Hoyt Electrical Instrument Co	15	453A
Hubbell Mfg. Co., H. L	153	
Hyatt Electrical Corp	38	
International Resistance Co	B-50	507
Jewell Electrical Instrument Co	48	
Jensen Radio Mfg. Company	B-85	
Jones, Howard B	B-54	
Karas Electric Company	136	
Karpen, S. & Bros	B-25-26	718-726, Inc.
Kellogg Switchboard & Sup. Co	90	
Ken-Rad Corp., The	93	521
King Manufacturing Corp	128	
Kingston Products Co	155	
Knoxville Table & Chair Co., The	118	2200-2201-2201A 2202
Kodel Radio Corp	B-60-61-62	1000-1001-1001A
Kolster Radio Corp	141	
Lund, I. A. Corp	111	
Magnavox Company, The	B-6A	
Maring Wire Company	110	819A-820A
Marti Elec. & Mfg. Company	B-79	557A
McMillan Radio Corp	B-80	
Micarta Fabricators Company		

Name of Exhibitors	Booth No.	Demonstration Room
Minerva Radio Company	43	545
Molded Wood Products Company	B-29	450A
Muter, Leslie F. Co	B-48	532A
National Carbon Company, Inc	B-32-33	700-701-701A
National Company, Inc	B-98	439A
National Vulcanized Fibre Co	69	
Newcombe-Hawley, Inc	B-34-35-36	500-01-01A-560A
Northern Manufacturing Company	137	556A
Northwestern Cooperage & Lbr. Co	129	
O'Neil Manufacturing Co	77-78	1604-1605-1606
Operadio Manufacturing Co	63	705-706
Pacent Electric Company, Inc	B-51	619-620
Perryman Electric Company, Inc	53	502
Philadelphia Stor. Bat. Co	123-124-125	604A-605A-606A Display 1404A-1405A Headquarters 1406A
Pierson Company, The	115	
Pioneer Radio Corp	34	528A
Platter Cabinet Company	91	422A
Polymet Mfg. Co	143	
Pooley Co., The	B-40	1704-1705-1706
Potter Mfg. Co	45	
Precision Products Co	104	
Q. R. S. Music Company	109	
Racon Elec. Co., Inc	119	413
Radio Corp. of America	57-58-59	1400-1401-1401A 1402-1402A-1423
Radio Foundation, Inc	B-27	
Radio Master Corp	138-139-140	2205A-2206A
Radio Recepter Company	B-69	530A
Raytheon Mfg. Co	41	1900-1901-1901A
R. B. M. Mfg. Co	134-B	
Red Lion Cabinet Co	B-70	1704-1705-1706A
Reichmann Company	154	533
Roberts Company, H. T	B-44-45	800-801A-802A
Rola Company	B-86	539A
Samson Elec. Co	70	
Sandar Corp	101	
Sangamo Elec. Co	135-A	
Scovill Mfg. Co	B-23-24	
Sentinel Mfg. Company	B-52	537A
Shamrock Mfg. Co	156	532
Showers Brothers Co	B-1-2	
Silver-Marshall, Inc	B-6-7	435A
Slagle Radio Co	B-88-89	445A
Sleeper Radio & Mfg. Corp	5	546
Sonatron Tube Company	B-19	
Sparks-Withington Co	126-127	505-904-5-6
Splitdorf Radio Corp	B-72-73	1418-1419-1420A
Standard Radio Corp	26	515A-517A
Steinite Radio Corp	B-20-21-22	412
Sterling Mfg. Company	36	551A
Stevens & Company, Inc	157	453
Stewart Warner Speedometer Corp	B-46-47	423A
Sunlight Lamp Co	B-92	
Super-Ball Antenna Co	42	
Superior Cabinet Co	112-113	522
Superior Cabinet Corp	83	
St. Johns Table Co	16	548A
Sylvania Products Co	B-16-17-18	2000-01-01A-02A
Televocal Corp	B-84	539
Temple, Inc	108	457
Thordarson Elec. Mfg. Co	B-41	509A
Timmons Radio Products Corp	120-121-122	604A-605-606A Not Headqrs. 1404A-1405A-1406A
Tower Mfg. Corporation	B-53	513A
Transformer Corp. of America	B-81	516
Trav-Ler Mfg. Corp	B-93	544A
Tyrman Radio Corp	B-14	502A
Udell Works, The	142	553
United Cabinet Mfg. Co	B-95	605
United Radio Corp	67-68	2400-2401
Utah Radio Products Co	B-96	604-606
Ultratone Mfg. Company, Inc	34-A	
Victoreen Radio Company	147	
Walbert Mfg. Company	B-49	553A
Wasmuth-Goodrich Company	B-15	507A
Watsontown Table & Furn. Co	74	561
Webster Company	B-97	632
Webster Elec. Co	4	556
Wells-Gardner Company	103	537
Weston Electrical Instrument Corp	B-94	
Wilcox Laboratories	20	550A
Yale Electric Corp	134-A	819-820
Yaxley Mfg. Co	135	
Zenith Radio Corp	89	505A-705A-706A
Trade Papers		
Citizens Radio Call Book	33-A	
Electrical Dealer	28	
Experimenter Publ. Co	32	
Phono & Talking Mach. Weekly	27	
Radio Engineering	33	
Radio Retailing	30	
Talking Mach. Journal	31	
Talking Machine World	29	

The Sulphide Rectifier

An Explanation of Its Functioning and Its Application to Radio and Industrial Uses

*By Dr. H. Shoemaker**

THE Sulphide Rectifier was developed primarily for battery charging, but has found so many other uses that it has become necessary to build a complete line of rectifiers covering a range of output voltages from 2 to 50 volts, and output currents from .2 (two-tenths) to 3 amperes.

The voltage and current range can be extended to any desired amount by proper series and parallel connections.

The object of this article is to set forth a number of uses and give sufficient technical data to enable engineers and designers of appliances to properly use the rectifier.

The Sulphide rectifier is entirely dry and free from acid. It can be used in any position and lends itself to compact assembly with other appliances.

A few of the many uses of the rectifier are as follows:

Battery chargers,

Battery substitutes, entirely eliminating the battery,

A power units for radio use,

Time clocks,

Burglar alarm systems,

Energizing electro-magnets such as used in dynamic speakers.

Electroplating and other electro-chemical uses.

Fig. 1. The Cupric Sulphide Disc.

Used with a dry condenser of 750 mfd. capacity or over, and the proper inductance, smooth direct current will be delivered.

Principle of Operation

The operation of the sulphide rectifier is based on the physical fact that when relatively highly electropositive and electronegative bodies are brought into proper contact and current passed so that an electrochemical reaction takes place at their junction, an asymmetrically conducting film is formed at the junction which permits the passage of current in one direction only. These films can be formed and continuously maintained when proper electrical and physical conditions prevail at the junction.

To insure continuity of conditions in sulphide rectifiers, the electrode bodies are held tightly in close contact under a relatively high pressure by suitable means.

Superior operating characteristics are obtained in certain rectifiers by the use of magnesium as the electro-

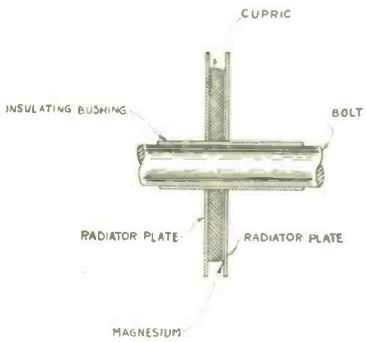


Fig. 3. Showing the construction of a sulphide rectifier and the relative position of the disc.

positive electrode body and cupric sulphide as the electronegative electrode body.

When a plate of cupric sulphide is held under sufficient pressure in contact with a plate of magnesium and an A.C. voltage of proper magnitude applied across the junction, the film which imparts rectifying characteristics is formed generally during the first cycle, after which rectified current will pass from the cupric plate to the magnesium plate. Cupric sulphide plates in sulphide rectifiers are formed to have the proper physical structure as well as proper chemical composition. The surface of the electropositive body is also treated so as to insure highly uniform operating characteristics.

When the couples, comprising discs of cupric sulphide and magnesium are held together by a pressure which insures substantially uniform contact throughout the junction, for example, a pressure of 200 pounds per square inch or more, the current blocking film which is formed is observed to unite these electrode discs as though they were fused together, forming a continuous conductor which has a relatively high resistance to the passage of current from the cupric sulphide to the magnesium disc. Careful measurements show that the ratio of these resistances are substantially in the order of 75 to 1, for example, in a given couple, the high resistance value is 30 ohms, whereas the value of the resistance to the passage of current in the other direction is but .4 of an ohm.

Sulphide Rectifiers Are Self Healing

Temporary overload under operating conditions might cause the rectifying film to break down. As soon as the overhead is removed, chemical reaction takes place and the rupture is healed.

Fig. 1 shows the form of the cupric sulphide disc used. This disc is called the cupric. Fig. 2 shows the form of the magnesium disc used and is called the magnesium.

Fig. 3 shows the relative position of the cupric and magnesium and the method of constructing the rectifiers.

It will be seen from Fig. 3 that the cupric and magnesium are in contact and placed between the two radiator plates. In practically all rectifiers, a number of these combinations are used in such a manner as to withstand the required voltage.

The cupric and magnesium combination is called a junction and a complete rectifier is made up of the necessary number of junctions to meet the required voltage conditions.

Construction of the Rectifier

Fig. 4 shows the complete rectifier in section. This rectifier consists of 16 junctions divided into 4 sections, each section consisting of 4 junctions. The radiator plates dividing the sections are called terminal plates. The two plates at the end of the rectifier which have projections or feet for mounting the rectifier are called end plates. It

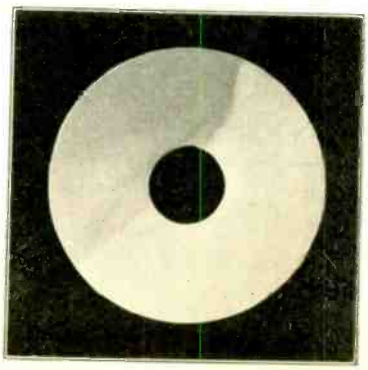


Fig. 2. The Magnesium Disc.

*Chief Engineer, Elkon, Inc.

will be seen from Fig. 4 that the magnesiums, the cuprics, the radiator plates, the terminal plates and the end plates are mounted on a bolt and insulated therefrom by an insulating tube. By means of washers, the bolt and the nut these junctions and plates can be held together under great pressure. In this particular type of rectifier the end plates are in contact through the bolt.

The two end plates form the positive output terminals and the center terminal plate forms the negative output terminal. The other two terminal plates are the A.C. terminals to which the A.C. input circuit is connected.

For convenience in mounting or connecting to appliances a base is generally attached to the rectifier which will be shown later. This type of rectifier is known as the bridge connected rectifier and is the type in most general use.

Another type of rectifier is used to some extent, which is similar in appearance and mechanical construction, but has only one terminal plate located in the center. The two end plates are also insulated from each other. This type of rectifier is known as the center tap rectifier and requires a special transformer to operate it. The advantages and the method of use of these two types of rectifier will be set forth later on.

The safe operating voltage per junction is 4 volts and must not be exceeded in operating conditions. Each junction, however, will stand a voltage of up to about 4¾ volts without injuring the rectifier if not maintained for too long a time. These voltages are R.M.S. values.

By connecting a number of junctions in series the rectifier can be built to withstand any voltage. Thus, a 16-section rectifier which has four junctions in series will operate on input voltages up to 16. In practice, however, this rectifier would be operated at a voltage of about 15, allowing approximately 1 volt for increased line voltages.

It has been found good practice to design the circuits for normal operation with approximately 3.6 volts per junction, as this gives a sufficient factor of safety for increased line voltages and prevents overloading of the rectifier.

In the bridge connected type of rectifier each section of the rectifier has to withstand the total voltage.

In the center type of rectifier each section must withstand twice the total voltage, but as it has twice as many junctions in series it readily withstands this increased voltage.

Two general methods of using rectifiers are now in use. One method, known as half-wave rectification, requires only one junction or one series of junctions as the voltage requirements may demand. The other method, known as the full-wave rectification, requires at least two junctions or two series of junctions as the voltage conditions may demand.

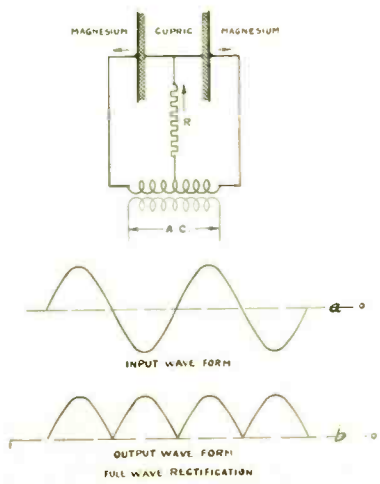


Fig. 6. Sulphide rectifier in a full-wave circuit and comparative wave forms.

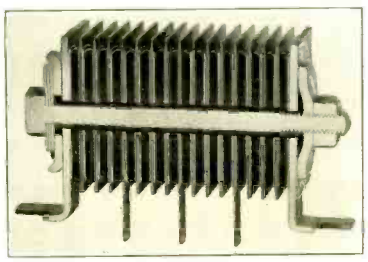


Fig. 4. Cross-sectional view of a complete sulphide rectifier consisting of 16 junctures divided into four equal sections.

Half Wave Rectification

Fig. 5 shows an elementary circuit for half-wave rectification. The A.C. energy is derived from the secondary of the transformer which gives the required voltage. In series with this secondary is a resistance R and a rectifier junction, or series of junctions. The resistance R can of course be replaced by a battery or any other form of load. The impressed wave form is shown at *a* and the rectified or output wave form is shown at *b*.

It will be seen from Fig. 5 that the current passes through the rectifier in one direction and is suppressed in the other direction, thus allowing a pulse or flow of current during one-half of the cycle and suppressing during the other half of the cycle. This type of rectifier has a number of disadvantages and is not used to any great extent.

Full Wave Rectification

Fig. 6 shows an elementary circuit for producing full-wave rectification. It will be seen from the figure that two rectifier junctions or two series of rectifier junctions are used in series with each other and in series with a transformer secondary, which delivers

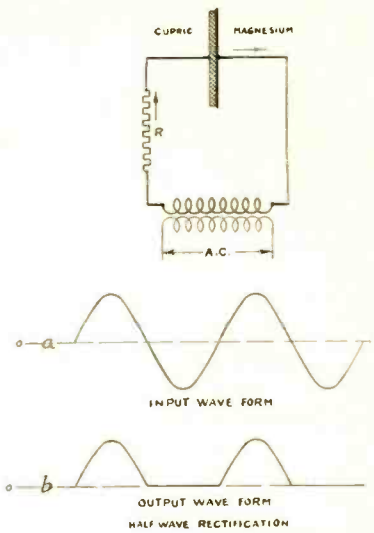


Fig. 5. Sulphide rectifier in a half-wave circuit and comparative wave forms.

the required voltage. It will also be seen that the load resistance R or storage battery, as the case may be, is connected from the center of the transformer secondary to a point in the circuit between the two rectifier junctions. The transformer used in this type of circuit is called a center tap transformer. This circuit is, in fact, a combination of two half wave rectifiers and each section of the transformer secondary must give sufficient voltage to force the required current through the resistance R or storage battery, as the case may be. Careful consideration of this figure will show that when the current flows in one direction, one set of junctions will oppose its flow and the other set of junctions allow the current to flow through it. When the direction of the current is reversed, the rectifier junction which allows the current to flow through it is reversed, which keeps the direction of the current through the resistance R the same for each half wave. *a* shows the wave form of the impressed E.M.F. delivered from the transformer terminals and *b* shows the wave form of the rectified current. It will be seen from Fig. 6 that both halves of the waves are rectified. The disadvantage of this method of rectification is due to the fact that the transformer requires a secondary which gives twice the voltage required for rectification, and which increases the cost of the transformer.

Bridge Connected Rectifiers

Fig. 7-A is an elementary circuit diagram of the bridge connected rectifier. There are two similar circuit diagrams shown in this figure. It will be seen from the diagrams that there are four separate rectifiers used, each rectifier being in an arm of the bridge. Each of these rectifiers represents a section or series of junctions in the rectifier such as shown in Fig. 4.

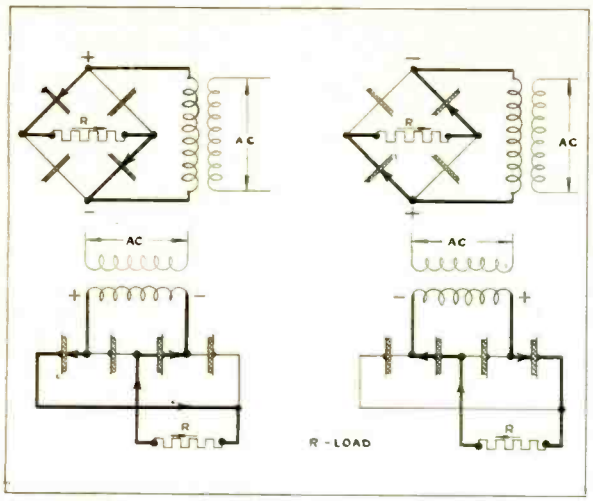


Fig. 7-A. Diagrams illustrating the functioning of a sulphide rectifier in a bridge connected rectification circuit. The current path is shown in both circuits in one of which the current is reversed

In the left hand diagram R represents a resistance or battery load. The arrows show the direction of current through the bridge arms and the heavy lines show the part of the circuit the current flows through when the input current flows in one direction. The right hand diagram shows the direction of current and the path through the rectifier when the input current is reversed. In Fig. 7-B, *a* shows the input wave form. *b* shows the rectified wave form corresponding to the left hand diagram. *c* shows the input wave form and *d* the output wave form, corresponding to the right hand diagram.

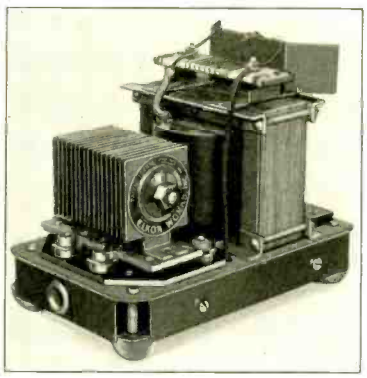
e shows the input wave form and *f* shows the rectified wave form due to full wave rectification.

The foregoing sets forth the general principles and method of use of the sulphide rectifier.

In the practical application of this rectifier it is necessary to give consideration to the relations between the input voltage and the output voltage, and the input current and output current. As the input voltage and input current are always alternating current, they will be R.M.S. values and should be measured by a type of meter which gives these values.

The output voltage and current consists of current pulses causing the current to flow in the same direction, but varying in amplitude from zero to a maximum. If this current is measured by direct current meters of the D'Arsonval type, average values will be obtained, which, for all practical purposes, is equivalent to a steady current of the value indicted by the meter. Therefore, all values for A.C. voltage and current will be R.M.S. values and all values for voltage and current on the output side of the rectifier will be average values.

The two general applications of the rectifier found in practice is for charging storage batteries and for converting the alternating into direct current to be used as delivered from the rectifier. In some cases, this pulsating current is smoothed out or converted into a direct current by means of inductances and capacities. In other cases, the pulsating direct current is used as delivered from the rectifier.



A complete battery charger employing a sulphide rectifier in a full-wave circuit.

Where the rectifier is used for charging storage batteries, the output voltage is approximately 63% of the input voltage and the output current is approximately 66% of the input current. In cases where the rectifiers are used with condensers and inductances such as the filter circuits, the current and voltage relations are practically the same as when used for charging storage batteries. When the rectifier is used on circuits consisting of a non-inductive resistance load the output voltage is approximately 50% of the input voltage, and the output current is approximately 90% of the input current.

Where the rectifier is used on circuits having an inducrance and resistance alone, the output voltage will be slightly under 50% of the input voltage and the output current may be as high as 95% of the input current.

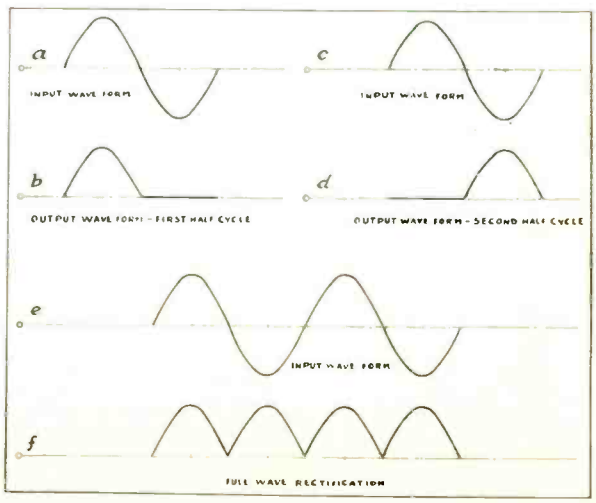


Fig. 7-B. Input and output wave forms relative to the bridge connected rectification circuit shown in Fig. 7-A. Note the input wave form e and the resultant full-wave form f.

Rectifier Circuits

Battery Chargers: The proper circuit for operating the rectifier depends on the purpose for which the rectifier is used and on the degree of regulation required.

Fig. 8 is a typical circuit used for battery chargers. This diagram shows a transformer which has the required capacity and secondary voltage. "R" is a resistance or reactance which may be variable if desired. "ACI" is an ammeter used to measure the A.C. input current. "ACV" is an alternating current voltmeter used to measure the voltage across the output terminals of the rectifier. "DCI" is a direct current ammeter used to measure the output current of the rectifier and is in series with the output terminal of the rectifier and the battery. In commercial apparatus, of course, these meters as a rule are not included and are shown in this diagram principally to show the location of the meters in the circuit when quantitative measurements are taken. In battery charging appliances it is essential that the resistance "R" be of sufficient value to maintain the charging current in the battery within required limits. Where these charging rates are to be varied, the resistance should be variable, or a tapped secondary be used so that the

voltage can be varied. A variable reactance (or reactor) may be used instead of the resistance. This has two advantages over the resistance in that it will give a voltage drop necessary for regulation without loss of energy and can be constructed without a sliding contact such as is necessary with a variable resistance.

For battery charging appliances, the resistance "R," or reactance, should give a voltage drop of at least 20% of the input voltage of the rectifier. As an example, if the rectifier input voltage required for a certain charging rate is 12 volts, the voltage delivered from the terminals of the transformer under full load conditions should be 120% of 12 volts, or 14.4 volts. In cases where the charging rate of the battery is to be maintained at a very constant rate over wide line voltage variations, this resistance should be increased sufficiently to get the required regulation.

The Filter Circuit

Fig. 9 is a typical circuit diagram of the circuits required for operating a filter circuit with the rectifier. By the use of this filter circuit, the rectified current is completely converted into a smooth direct current similar to that delivered by a battery. At the present time this type of circuit finds its greatest use in supplying current to the filaments of radio tubes. Its use, however, can be extended to any field requiring this kind of current supply. Fig. 9 is substantially the same as Fig. 8 up to the rectifier output terminals. Across the rectifier output terminals a condenser of 1500 mfd. is connected. Two separate inductances of approximately .1 henry each and a resistance of .3 of an ohm each are connected in series with the rectifier terminals and the load. Two additional condensers of 1500 mfd. each are connected as shown in the diagram. The resultant output is practically equal to that from a storage battery and has a value of from 3 to 6 millivolt ripple.

The resistance "R" should be variable and of sufficient value to give a drop of at least a volt. The transformer secondary should be tapped so as to give approximately 1 volt changes. By varying the resistance "R", the input voltage can be varied to any desired amount within limits. This enables the output current to be varied accordingly. The above circuit when used with an Elkon M-16 rectifier will deliver 2 amps at 6 volts at the output terminals of the filter circuit. At the rectifier output terminals the voltage will be 7½ volts and the current, 2 amps. At the input terminals of the rectifier, the voltage will be approximately 12½ and the input current, 3 amps.

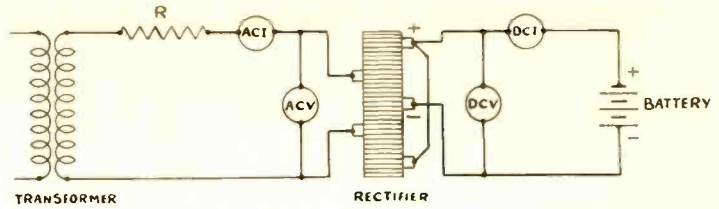


Fig. 8. Typical circuit, employing a sulphide rectifier, for battery charging.

Dynamic Speakers

Fig. 10 shows a circuit diagram where the rectifier is used for energizing electro-magnets which have both inductance and resistance, or where the load is entirely non-inductive. This type of circuit is used extensively for energizing the field coil of dynamic speakers. Very often the resistance "R" is omitted. Regulation will then depend solely on the resistance and reactance drop inherent to the transformer.

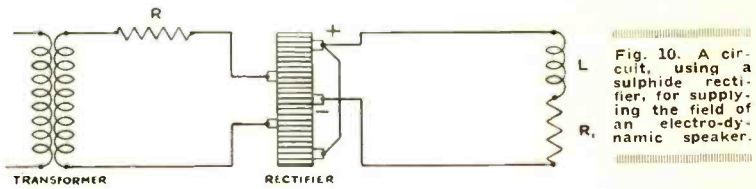


Fig. 10. A circuit, using a sulphide rectifier, for supplying the field of an electro-dynamic speaker.

Where the rectifier is used for battery chargers and it is desired to maintain a constant charging rate, the resistance "R" is generally constructed of nickel wire which has a large temperature coefficient at a comparatively low temperature, which makes it very desirable material to use for this purpose.

Effect of Moisture and Temperature

The sulphide rectifier is shipped to the user in moisture-proof containers and should be kept in these containers until such time as they are put in use. While moisture has practically no effect on the operation of the unit when it is used frequently, where the rectifier is exposed to moist atmospheric conditions when not being operated, its operating qualities are very frequently impaired. However, if the rectifier is operated continuously, moisture has no effect whatever on it unles water is actually spilled over the rectifier. It has ben found in actual service that practically no trouble is experienced from ordinary moisture conditions.

The sulphide rectifier under normal load conditions operates at a temperature of approximately 90° centigrade and will operate at temperatures as high as 150° centigrade without any injurious effects. In designing apparatus using the rectifier, sufficient ventilation should be allowed to maintain a temperature of approximately 90° under normal load conditions.

Life Which May Be Expected

The life of the sulphide rectifier depends to a great extent on the service required by it. For battery charging use, tests show a life of 5,000 hours and over. For A power work where extremely steady output is required, tests show a life of 1,500 hours and over.

Regulation

As there is slight decrease in output voltage after the first 200 or 300 hours of use, it is desirable to have means so that the input voltage can be slighly increased if it is necessary to maintain a constant output voltage. This can be accomplished by using a transformer with a tapped secondary or having enough resistance in the secondary circuit so that it can be varied in such manner as to increase the voltage. As an illustration, an A power was started with the input voltage so adjusted that the output voltage was 6 volts and the current 2 amps. After running approximately 300 hours the output voltage decreased to 5.8 volts. This output voltage then remained contsant for 1200 hours. If the input voltage in this case had been increased enough to bring the output voltage up to 6 volts, it would have remained constant for the 1200 hours.

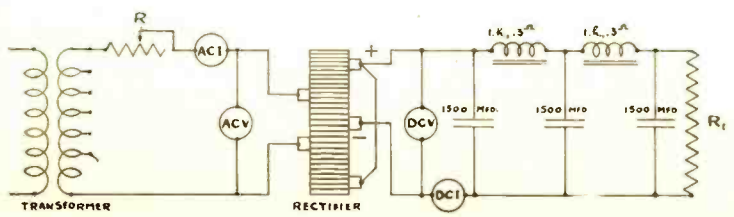


Fig. 9. A sulphide rectifier adapted to a standard filter circuit such as used in "A" Eliminators.

Selecting a Band of Radio Frequencies

The Theory, and Practical Design of a Band Selector Providing a Nearly Rectangular Resonance Curve

By G. F. Lampkin, E.E.

THE information necessary for making one of the new band selectors may be obtained from that old standby—Circular 74, of the Bureau of Standards. On pages 48 and 49 are curves and diagrams that show how coupled circuits may be used to select various frequencies.

In the particular case, the band selector, as its name would indicate, is used to transmit only a comparatively narrow band of frequencies, and suppress all other frequencies that may be present. Such action is necessary and desirable, because each broadcast station transmits not only its assigned carrier frequency but also sideband frequencies that extend 6,000 cycles, more or less, above and below the carrier frequency. The sideband frequencies are created in the process of modulation, where each particular note, or audio frequency, that is present in the speech or music combines with the carrier to form an upper- and a lower-sideband frequency. These sidebands are the intelligence carrying media—it is they, which, when detected at the receiver, form the audio frequencies that are passed on to the audio system. Fidelity of reproduction requires that these sidebands be received in their true proportion, exactly as they were transmitted; which in turn requires that the receiver respond to a band of frequencies some 10,000 or 12,000 cycles wide, centered at any desired carrier frequency. On the other hand, selectivity requires that outside this band the response be zero. Thus, if a curve of the response of the ideal receiver to various frequencies were plotted, it would be zero till the lower sideband limit were reached, would jump to a certain level, remain constant over the band, and drop vertically to zero again at the upper sideband limit—thus forming a rectangle.

The response of an ordinary tuned circuit is by no means of this desired rectangular type. Rather, it takes the form of a more or less peaked curve, the selectivity of the set being greater the sharper the peak. When the response peaks sharply to one frequency, the other desired frequencies are left out to a greater or lesser degree, so that in the usual set selectivity and fidelity are incompatible. A really selective set "cuts the sidebands," as the saying is.

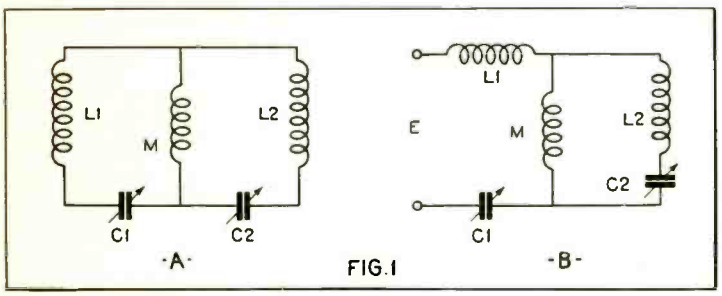


FIG. 1

A. Circuit of a band selector, composed of two resonant circuits L_1 C_1 and L_2 C_2 coupled by the mutual inductance M. B. Equivalent circuit, when a voltage is induced in L_1.

Principle of Band Selector

In the band selector two resonant circuits are loosely coupled by means of a small mutual inductance, or a rather large mutual capacity. The elements of the circuit are connected as in Fig. 1-A. The condenser and coil C_1 L_1, resonate to the same frequency as condenser C_2 and coil L_2. M is the mutual coupling reactance, in this case a small coil. The input voltage is introduced by coupling to L_1, and the output may be taken directly from C_2 or L_2, or by inductive coupling from L_2. Inducing a voltage in L_1 is comparable to placing the voltage in series with the coil, so that the equivalent circuit is as Fig. 1-B.

Use may be made of reactance diagrams to learn how the circuit of Fig. 1-B will respond to variable frequency. For any given setting of the condensers—which, in the case of the curves shown corresponds to a resonant frequency of 880 KC—the re-

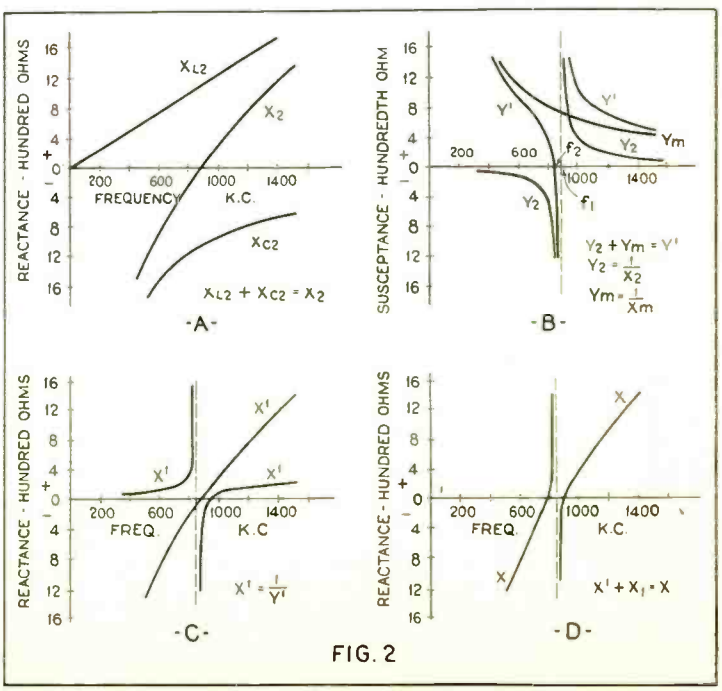
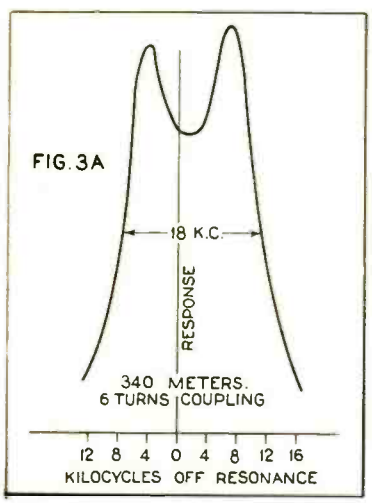


FIG. 2

A group of reactance and susceptance curves which serve to illustrate the properties of a band selector.

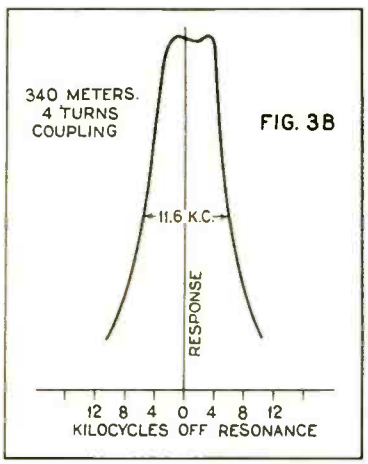
actances of the inductance and capacity elements are calculated, plotted, and combined. Inductive reactance, equal to $2\,fL$, is a linear function of frequency, and when plotted for L_2, in Fig. 2-A, results in the straight line through the origin. For capacity reactance, $\frac{1}{2\,f\,C}$, the inverse relation gives rise to the curve X_{c_2} for condenser C_2. These two elements, C_2 and L_2 are in series, so that their resultant reactance is obtained by adding algebraically the two curves, which determines the curve X_2; the graph indicates the well-known series resonance phenomena, where at resonance the reactance goes to zero.

In parallel with the branch "2" is the mutual reactance M, an inductance. When elements are in parallel, the total susceptance is obtained by adding algebraically the individual susceptances, where any susceptance is given by the reciprocal of the corresponding reactance; that is, susceptance, Y, is equal to $\frac{1}{X}$. The reactance of M is a positive, straight-line function of frequency; when plotted as susceptance, it takes the inverse form of Ym in Fig. 2-B. The susceptance of the "2" branch is derived from the



Resonance curve of a band selector with a mutual inductance (M in Fig. 1) having 6 turns.

X_2 curve of Fig. 2-A. Where this reactance became zero at 880 KC, the susceptance goes to infinity. The sum of the two susceptances shows the curve Y', the total susceptance for the combination of M, C_2, and L_2. The construction shows that at 880 KC the susceptance is infinity, and at a slightly lower frequency is zero; or, at respective frequencies, the reactance X_1 for the combination is zero, and infinity. The remaining circuit elements are C_1 and L_1, which are in series with the MC_2L_2 combination. The reactance curve for L_1 and C_1, in series, is X_1, similar to that for C_2L_2. Adding both series reactances yields the final overall curve, X, for the reactance of the band selector, which may be seen unencumbered in Fig. 2-D. The curves are plotted for a mutual reactance of 50 microhenries, which is many times the actual inductance necessary in the common branch. If plotted for a smaller inductance, the points of zero and infinite reactance would merge indistinguishably close. The actual values of reactance as scaled in the graphs are only approximately correct. Therein lies the usefulness of reactance diagrams; an accurate qualitative knowledge of circuit functioning may be had without tedious calculations.



The effect on the double peak produced by reducing the number of turns in the mutual inductance M.

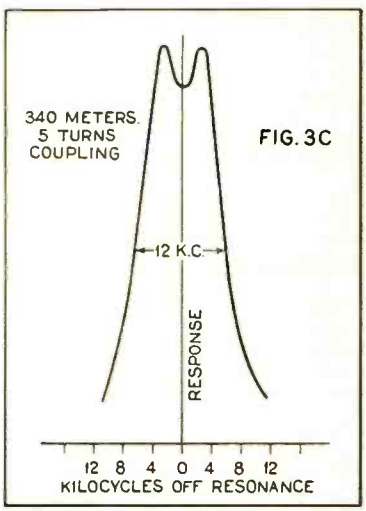
Double Resonance Peaks

For two values of frequency, close together, the reactance of the selector is zero. At an intermediate frequency, the reactance goes to infinity, and if reactance alone were considered, the current at this frequency should be zero. However, the resistance which is unavoidably present in the circuit limits the impedance so that it can never go to infinity, just as it can never go to zero. The consequence is a smoothing out of the current curves so that two resonant peaks occur at the points of zero reactance, and a more or less pronounced dip between them at the point of infinite reactance. The proximity of the peaks is determined by the value of the mutual impedance, or putting it another way, by the closeness of the coupling. As the value of the mutual inductance is increased, for any given frequency value, the coupling impedance goes up, and the peaks spread farther apart. On the other hand, increasing the capacity, when such is the common reactance, lowers the value of the coupling and the peaks come closer together. That changing the value of the common reactance changes the width of the selected band may be seen from the reactance curves. In Fig. 2-B, the point of zero susceptance, at f_3, is determined where the susceptance of M is equal and opposite to the susceptance of the C_2L_2 branch. The higher the susceptance of M, the closer this point moves in to the frequency f_0, and the narrower becomes the over all width of the selected band.

Because the band width varies with the value of the mutual reactance, for any given coupling inductance or capacity, the band width will vary for different broadcast carrier frequencies. Suppose the coupling has been adjusted for the desired band width at one particular carrier frequency; the band will be wider or narrower at higher or lower carrier frequencies, respectively, if the mutual reactance is a coil,—vice versa if a condenser—for the reason that the value of the reactance varies proportionally with the frequency.

Determination of Response

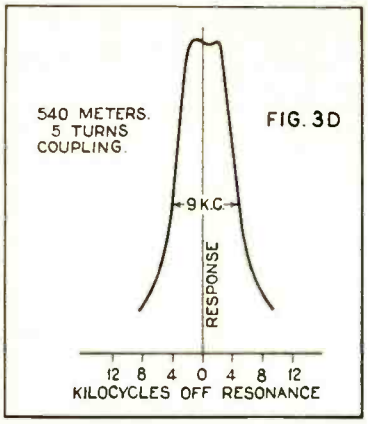
An experimental setup was utilized to determine the response of such a circuit as Fig. 1-A, and to get an idea of the correct constants for use in the circuit. A 50-watt oscillator was used as a local driver, and small variations in its frequency about an arbitrary



The mutual inductance affects both the difinition of the peaks and the width of the response band.

value were determined by measuring the beat note between it and a crystal oscillator. For each setting of the local oscillator the radio-frequency voltage across C_2 was measured with a vacuum-tube voltmeter.

The circuit of Fig. 1-B shows that the voltage must be introduced in L_1, and at that point only. Nor can there be any inductive coupling between any of the inductances of the selector. To that end, adequate shielding must be employed; with the present common usage of shielding, such a requirement



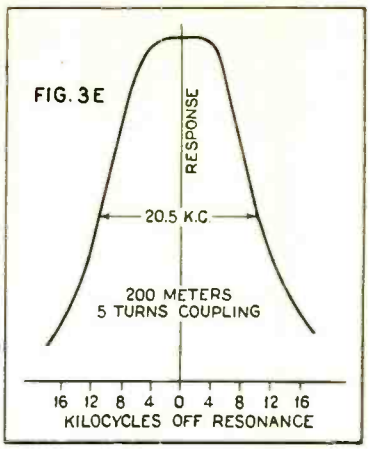
Resonance curve of band selector tuned to 540 meters. Compare this with the curve in Fig. 3C.

is not hard to satisfy. The first coil, L_1, may be unshielded, as it has to act as a pickup. Individual shields for the coil M and the second tuned circuit must be used. The coil M, as will appear later, may be rather small physically, so that it could be placed in a separate little cubicle of the C_2L_2 shielding. The use of a fixed condenser for the mutual reactance should obviate any necessity for shielding of this element.

The circuit as used to obtain the curves of Fig. 3 made use of coils of 47 turns of No. 24 SCE wire, each wound on a 3-inch form. The condensers were approximately .0003 mfd. maximum capacity each. One such coil and condenser made up the L_1C_1 and L_2C_2 branches. The coil M was wound on a 1-inch form, using the same wire as above, and with numbers of turns as given on the curves. The circuits were shielded as suggesred above.

Starting at a wave of 340 meters, the number of turns on coil M were changed from 6 to 5, and to 4; the corresponding response curves of Fig. 3-A, B and C, resulted. Close coupling, comparatively, gave the pronounced double peak and intermediate dip of the curve 3-A. Measuring the band width arbitrarily between the points where the response falls to half its maximum yields a figure of 18 kilocycles. With 4 turns on the common coil, the band width dropped to 11 kilocycles. Five turns on the coil were used as the optimum value—corresponding to the curve 3-C, which has only a slight center dip, and a band width of 12 kilocycles. At 540 meters the response curve was that of 3-D, still retaining the general form of 3-C but passing a narrower band of 9 kilocycles. At 200 meters the band width spread to somewhat over 20 kilocycles, and the curve shape was the less desirable form of a rounded top and sloping cutoff. The circuit constants for curves 3-D and 3-E were unchanged from those of 3-C.

Coils and condensers of varied electrical or mechanical dimensions may be used for the tuned circuits of the selector, so long as they fall within the usual broadcast range. The size of the coupling coil is rather important, as shown by the curves. The inductance of the 5-turn, 1-inch diameter coil is approximately 1.2 microhenries, which value should be rather closely adhered to. The equivalent condenser size is .025 mfd.



At 200 meters the response band is considerably widened. The width can be reduced by reducing the number of turns in the mutual inductance.

In view of the usual inherent broadness of receivers on the lower wavelengths, the use of condenser coupling may be the better method, for such coupling would tend to widen the band at the higher wavelengths and shorten it at the lower. Whichever way the band selection is attained, it certainly represents an improvement over ordinary resonating methods.

Book Review

WIRELESS PICTURES AND TELEVISION. By T. Thorne Baker, published by D. Van Nostrand, New York; 5" x 7", 188 pages including index, 99 illustrations, cloth cover. Price $2.50.

A decidedly interesting book and the first we have seen covering in a complete manner the history of television. The book opens with an historical account of the early attempts to transmit pictures over wires and discusses early systems developed by Bain, Blackwell and others.

The second Chapter deals with the selenium cell and the photo-electric cell, their applications and physical characteristics. Numerous forms of receiving devices such as galvanometers and oscillographs and the mechanical inker are covered in Chapter 3. Following Chapters deal with the photographic image, synchronizing devices, electric illuminants, the Korn system of Telephotography, the well-known Telautograph, Belin's Telestereograph, the halftone method of transmission, the Telectrograph and the Thorne-Baker system. A great deal of material is included on line pictures, auto-synchronization and distortion. The rest of the book is given over to detailed descriptions of the Bell system, which includes interesting information on impulse or step motors; Ranger's system, Color Television and Baird's system of Television. This is an excellent book for gaining knowledge of the early and modern systems of telephotography and television and should equip one with sufficient groundwork to carry on experiments in this field.

"A LABORATORY TREATISE ON B-ELIMINATOR DESIGN AND CONSTRUCTION." By John F. Rider. Published by Radio Treatise Co., 270 Madison Ave., New York City. 88 pages 8½ x 11 including index. 71 illustrations. Price $1.00.

This book was written expressly for B-eliminator owners, constructors and those interested in the servicing of these units. The treatise covers every phase of B-eliminator design and construction with detailed explanations of the function of each unit comprising the complete eliminator. The subject is treated in a comprehensible manner so that the non-technical and semi-technical man will be able to derive valuable information. After perusing this treatise, one is in a position to design an eliminator, calculate resistances and capacities necessary for eliminators and to adapt a B-eliminator unit to various receivers.

Some of the general subjects covered are wire, its properties, significance and calculation of temperature coefficient: the power transformer, its rating, type, types of windings, output limitations, means of reducing line voltage; filament and gaseous type of rectifier tubes, method of operation, current and voltage output limitations; fixed condensers, calculation of values, in parallel, in series, calculation of charge and voltage, operation in filter circuits, most economical selection; resistances, their calculation to provide various output voltages, wattage rating, calculation in parallel, in series; filter chokes, design, requisites, current limitations; rectifier systems, difference between full-wave and half-wave, advantages of each, and utility of tubes.

All of the calculations are illustrated by examples so that problems confronting the reader can be easily solved. This book recommends itself to all B eliminator owners, B-eliminator constructors, custom-set builders and service men.

THE GATEWAY TO BETTER RADIO. Published by American Mechanical Laboratories, Inc., 285-287 N. Sixth St., Brooklyn, N. Y.; 33 pages, illustrated. Price 25 cents.

One of the most useful instruments in radio is a resistor and this fact is brought out in "The Gateway to Better Radio." There are various means of improving reception through the introduction of resistances in various points in a circuit or power unit and these are pointed out in an excellent manner. Some of the sections are: The Clarostat—What It Is and What It Does; How to Build a Home-Made Eliminator, both A.C. and D.C.; How to Obtain Power Amplification; How to Apply A.C. Tubes; How to Receive Short Wave Signals, etc. There are also Chapters covering such timely subjects as Line Voltage Control; Volume and Tone Control; the Problem of Filament Current; "A-B-C" Power Units and Push-Pull Amplification. Each subject is given full coverage.

This booklet would doubtless give some new ideas to set builders, who want to have the latest thing in radio.

The Problem of Radio Set Power Supply

"The Power Supply of the Future"

By George B. Crouse*

PART VI

IT is proposed in this article to discuss the probable trend of development of radio power supply. The statement has been made before in these articles, but is worth repeating, that the power supply is the servant of the radio set and must meet the demands put upon it by that unit. Furthermore, the design of the radio set itself is largely dependent upon the properties of the amplifying tubes available.

Trend in Tube Design

This discussion, therefore, very logically starts with a discussion of the trend of tube design.

The variety of functions which the tube must perform in a receiver, starting with radio frequency amplification, detection, and audio frequency amplification and ending with the output tube, has brought about a differentiation of design and structure of the tubes to meet these various needs, and this differentiation is the most striking feature of the trend of tube design up to the present.

The tube in general use for radio frequency amplification at the present time is the 01-A type, or its equivalent for A.C. filament operation, the -26 type. Recently a third type for this purpose has made its appearance, having identical characteristics with the 01-A type, but having a cathode which requires only .125 ampere at 5 volts to energize it. This improvement has the advantage that the energy for the cathode may be obtained at practically no cost as a by-product of the plate supply energy, as will be pointed out in more detail later, and no precautions need be taken to prevent modulation of the radio signal due to A.C. fields existing in the tube.

As radio frequency amplifiers all three of these tubes have the serious disadvantage that their internal capacity is so high that special means are necessary to prevent feed-back of energy and consequent poor quality and instability. Much ingenuity has been expended in working out balancing means to prevent this effect and at the same time obtain a reasonable voltage gain per stage of amplification. The maximum gain which can be obtained with any of the arrangements so far worked out is far below that which may be obtained in the audio amplifier with the same tube.

This defect is entirely overcome with the new tubes of the screen-grid or -22 type, in which the internal capacity is neutralized by means of a fourth element in the tube. The experience gained with tubes of this type in the last few months indicates very clearly that this is the radio frequency amplifier tube of the future. We may sum up its advantages for this service by saying that it is perfectly practical to build amplifiers with a voltage gain of 1½ or more times the gain obtainable with the 01-A type of tube without the necessity of any special means for preventing feedback. Indeed no special precautions other than the shielding always necessary with a high gain amplifier, need be taken to produce a perfectly satisfactory combination.

The screen-grid tube was originally criticized by some radio engineers on two grounds. First, that multi-stage amplification was necessary in order to achieve adequate sharpness of tuning and therefore the 01-A type of tube was good enough, and second, that the high gain obtained with the new type brought about new problems of shielding. Neither of these objections is valid. Simply because a gain of 50 to 100 per stage is obtainable is no reason why such a gain should be used. The unused potentialities of the tube can be converted into a safety factor. Secondly, the difficulties of shielding with a given amplifier gain are no greater with the screen-grid tube than with the older type. The position of this new tube in the field may be briefly summed up by the statement that had the development of this tube been coeval with the 01-A type the latter would probably never have been used as a radio amplifier.

Detectors

For detection, there are four types available at present. For D.C. operation the 01-A and 00-A types, and for A.C. operation the -27 and 01-B types. Of the D.C. tubes the 00-A type has the advantage of high sensitivity, but is somewhat noisy and many samples

*Vice-president and Chief Engineer, Conner-Crouse Corp.

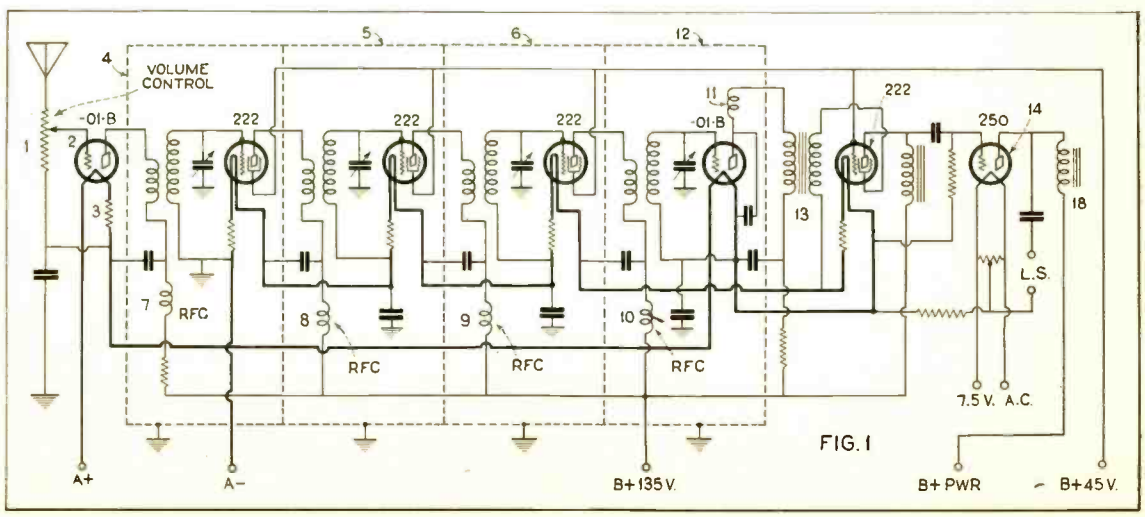


FIG. 1

Circuit diagram of a series filament operated receiver employing screen-grid tubes in conjunction with tubes of the -01-B type and a 250 amplifier tube in the output. Note that a 222 is used as a space-charge tube in the A. F. stage.

have a tendency to instability. For A.C. power operation the -27 type has not proved completely satisfactory. Despite the fact that in theory this tube is supposed not to introduce any ripple into the audio amplifier input, the presence of the electro-static and electro-magnetic field in the tube makes necessary a higher cut-off on the amplifier response curve than would otherwise be necessary. For this reason it seems probable that the 01-B type with its cathode energized as will later be described will replace the -27 type tube.

There is undoubtedly a need for a new detector tube which will be capable of handling a larger energy output than any of those now available. With the development of the high power output tube the probability of overload at high volume has been transferred from the output tube to the detector, and it seems probable that this difficulty will be met by the tube designers in the near future.

Audio Amplifier Tubes

The practice of employing only one intermediate amplifying stage between the detector and the output tube has been well established. The -26 type at present largely employed for this stage has the same disadvantage as discussed above in relation to the -27 type detector, in that it introduces ripple into the amplifier, and again the 01-B shows a distinct gain over the A.C. filament type. Both of these tubes have the disadvantage of a limited gain, which is particularly serious in case the output tube has a low voltage amplification constant. The -22 type again has possibilities. In this stage it may be used as a "space-charge tube" in connection with an impedance type repearing element and gains considerably in excess of those obtainable with the older tubes may be secured.

The tendency in the design of the output tube has been toward continually increasing undistorted power output which seems to mean a concomitant increase in plate voltage and grid bias. Starring with the 01-A as an output tube operating at 90 volts and 4½ volts "C" bias and having an undistorted output of about .2 watts, we have seen the steady progress to the -50 type, having an output of 4.65 watts and requiring plate and grid potentials of 450 and 80 volts respectively. It seems probable that this development has about reached its zenith, at least for tubes employed in radio sets and phonographs intended for operation in the home. While it is certainly advantageous to have available large volume possibilities, anything greater than 4½ watts into a good reproducer would be unbearably loud even on occasional crescendos.

The general trend of receiver design appears to be toward sharper tuning and the progress toward better quality of reproduction, which was interrupted by the advent of the A.C. tube, will be resumed. This will in all probability

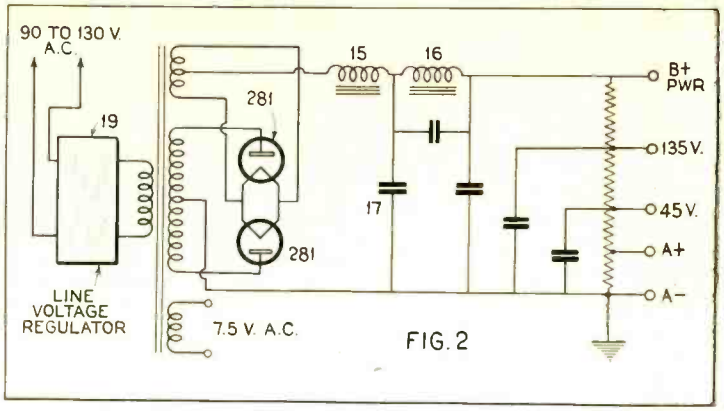


FIG. 2

Circuit diagram of the power supply unit designed for the special receiver described in the text. This unit meets the "A" and "B" requirements. The "C" voltages are obtained through voltage drops in the receiver circuit.

result in the adoption of 01-B or -22 type tubes in the detector and first audio stages, as otherwise it seems impractical to retain the advantages of compact power supply units and at the same time bring up the gain at the lower audio frequency.

Design Possibilities

The possibilities of the development which have been discussed above are well illustrated in a receiver which has just been developed by the Conner-Crouse Corporation for the Electrical Research Laboratories of Chicago, in which advantage has been taken of the latest features of tube design, and no better discussion of the future power supply can be given than a description of this set with its accompanying socket power device.

The electrical diagrams of the set and socket power are shown in Figs. 1 and 2.

The pick-up employed is a short antenna and ground connection, the volume being controlled by means of a potentiometer 1 inserted in the antenna-circuit and feeding energy to the input of the coupling tube 2 of the 01-B type, the necessary small grid bias on this tube being obtained by the series resistance 3 in the filament circuit.

Three shielded stages, 4, 5, and 6, of radio frequency amplification are employed, using -22 type tubes in the screen-grid connection, with 135 volts on the plates. The shields employed are of .028" sheet copper and no further precautions against inter-stage coupling are required other than the radio frequency chokes 7, 8, 9, 10 and 11 in the plate circuits.

The shielded detector stage is shown at 12 and employs an 01-B tube connected for plate circuit rectification. The output of the detector is repeated by means of the transformer 13 into a first audio stage employing a -22 type tube connected as a space-charge tube, the output of this stage being impedance coupled to the output tube 14 which is of the -50 type.

This receiver, of very simple design, embodies the advantages of simplicity of construction, sharp tuning, high sensitivity, and the best obtainable audio quality.

Attention is called particularly to the use of the -22 type tube in the first audio stage. When using a -50 type tube for this power stage, the requirements on the preceding stage are particularly severe, in that if the maximum output is to be obtained the preceding stage must have a very high undistorted gain. With tubes of the 01-A or -26 type the maximum gain is barely enough to energize the last tube to its full capacity. By the use of the -22 type an aerial safety factor is obtainable.

Power Demands

We may now consider the demands made by this set on the power supply, the requirements of which are as follows:

Circuit	*Output Voltage*	*Current*
Filaments	30	.130
Power plate (including power tube C bias)	530	.055
Radio and audio amplifier plates	135	.015
Detector plate	45	.002

Due to the low frequency cut-off of the audio amplifier employed in this set, a minimum amount of unfiltered ripple must be present in the power supply output, as otherwise an undesirable amount of hum will be present in the reproducer.

The plate voltages are high and the power supply design should therefore include a minimum of condensers subjected to these high voltages.

The exceedingly large signal energy flowing in the plate circuit of the last tube requires that careful precautions be taken to prevent inter-stage coupling occurring in the output mesh of the socket power.

The socket power shown in Fig. 2 satisfactorily meets all of these requirements. High filtering is obtained by scientific design of the inductive elements 15 and 16 and by the use of the principle described in a previous article of complete suppression of the fre-

quency of greatest amplitude present in the rectifier output.

Two -81 type rectifiers are employed and the amount of capacity is reduced by working these rectifiers directly into the coil 15, the intermediate condenser 17 being reduced in capacity by proper selection of the ratios of inductances of the coils.

The output mesh has been scientifically designed in relation to the choke coil 18 to reduce inter-stage coupling to a minimum.

The problem of voltage regulation, as a result of past seasons' experience with all types of A.C. equipment, has become very important, and a voltage regulator 19 of a new and very simple construction is employed in the primary side of the transformer. This regulator will satisfactorily handle line voltages between 90 and 130 volts. It can be employed with any type of A.C. equipment and since it adds less than 50 cents to the cost of the receiver, the coming season will probably see its widespread adoption.

Attention is particularly called to the fact that the power for energizing the cathode of all of the tubes, with the exception of the power tube, is smooth and filtered direct current and is obtained at practically no expense as a by-product of the large plate energy required for high volume output. As a result of this it has not been necessary to make any compromises in the design of the audio amplifier, while at the same time the set is truly an A.C. receiver, employing a power supply which is no larger than would be required with A.C. filament tubes and is considerably simpler, particularly in the wiring details.

The Solution of an Interference Problem

A Unique Arrangement Employed for Keeping a Constant Check on the Frequency of Station WICC

*By C. Harold Campbell**

THE broadcast listeners are not the only ones with interference problems. Perhaps, you are unfortunate enough to have a neighbor who has a squealing receiver, perhaps there is a power leak in your vicinity, or if you live near the sea coast, the ship-to-shore commercial traffic often mars the reception of your broadcast programs. The radio listener is seldom in a position to cope with these problems, and has to accept them with a smile, that is, if it is possible for one to smile under such conditions.

With the broadcaster it is different. The broadcasting station is a commercial enterprise and when trouble arises the engineering department is called on. It is business with them and they have to solve the problems one way or another. WICC is operating on 1130 kilocycles, which is a very crowded area in the broadcast spectrum. WHK uses the same frequency and their carrier wave is quite strong on the east coast at night. Then there are several on each side of the band which are apt to deviate a little. True, these changes are very small and are usually within the 500 cycle limit allowed by the Federal Radio Commission. However, it takes only a very small deviation in frequency between two stations to produce a heterodyne which will utterly ruin a radio program. Even when the difference in frequency is so slight as to not produce a whistle, there is the almost inaudible growl which makes the quality ragged or "fuzzy."

The studios of WICC are eight miles from the transmitting station. Therefore, a receiving set at the studio was far enough from the transmitter to pick up a heterodyne. By telephoning to the station, the engineer was often able to clear the interference by changing the wave slightly until the whistle disappears, or in other words, "beat" against the other station.

To make the system more satisfactory we later coupled the output of the receiver to one of our spare broadcast lines. A loud speaker was connected across the line at the transmitting station. The engineer could then listen to the heterodyne and adjust the transmitter to zero beat.

Automatically Controlled Receiver

However, the problem was not altogether solved. Our studios are right in the heart of the business section of Bridgeport. This, of course, means poor reception with plenty of interference from street cars, motors, electric signs, etc. Our own signals came in strong while distant reception was bad. We had a high signal-to-interference ratio that was not desired in this case. The solution of the problem was to move the receiver to a better location, preferably a little farther from the transmitter. Of course the operation had to be automatic and the diagram shows how it was done. The equipment was placed in a church which we broadcast from only on Sunday mornings. At all other times this remote line is used for checking our program.

The receiving set is always tuned to the peak of our station. As shown in the diagram, the output of this receiver is coupled to the line through a W.E. 120A output transformer. The 65 volt supply is from a "B" battery. When the switch is closed current is sent along the line which closes the sensitive telephone relay. This turns on the filament supply of the receiver, placing it in operation. Opening the switch will open the relay thereby shutting off the receiving set.

The W.E. type B3 relay draws very little current so the drain on the battery is not excessive. The 2.mfd. condenser provides a path for the signal across the relay. At the station the line is coupled through another W.E. 120A output transformer to one stage of high quality amplification which brings the signals up to loud speaker level.

Recently we have gone a step farther. By putting good audio frequency transformers in the receiving set and by carefully equalizing the line, we have succeeded in obtaining excellent quality from the system and have found it convenient to use for monitoring our programs.

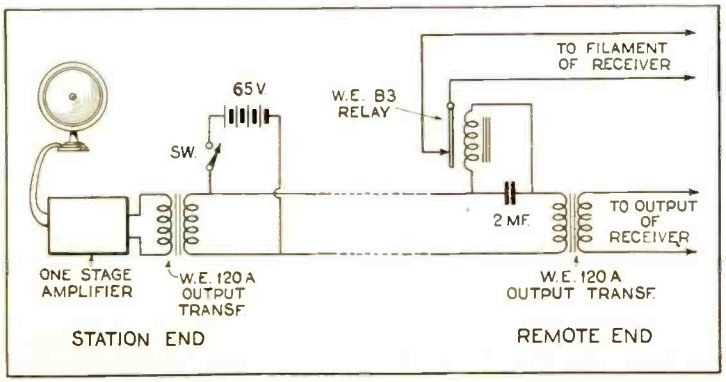


Diagram of the arrangement employed to check the frequency of station WICC and for the purpose of monitoring the programs.

* *Engineering Department, Station WICC.*

A. C. Tubes —vs.— Series Filament Operation

A Discussion on the Representative Systems, Including Practical Design Data

*By William P. Lear**

AT this time there is every indication of the revival of a better and more practical method of operating a radio receiver from the light socket, although it is generally supposed to be unpopular. Reference is made to the series filament system. It is not unpopular with the best engineering group in the country and is considered by them to be the best method of operating a radio from the light socket.

A recent advertisement published in a well-known trade paper by the R.C.A. stated that the method as used by themselves of obtaining A. C. operation from a light socket source was the result of the accumulated and combined research available to them through their laboratories and engineers and was acknowledged as being the best method. This advertisement had especial reference to their Radiola Superheterodyne models, which use a series filament hook-up for A. C. operation and obtain their current from a rectified and filtered source. Naturally they were in a position to make that type of statement, as they not only have the engineering ability but have a successful sales and service record behind them to substantiate it. They have been making and selling series-filament radio sets for nearly three years and have had very little trouble from the service standpoint and practically no resistance to sales, because the set did not happen to have A. C. tubes. The success enjoyed by them should be an incentive to some of the independents to bring out sets using the same method of A. C. operation.

Just prior to the announcement of the A. C. tubes a number of the independent manufacturers had developed series filament jobs. Because of pressure brought to bear through apparent demand and national publicity of A. C. tubes they were forced to abandon that type of operation for the A. C. tube. There was no fault to find with series filament operation. Its abandonment was caused entirely by necessity. Naturally the engineering departments were called upon to design a set or re-design their production model for A. C. tubes. This was in most cases a difficult job unless the set was of the bridge or neutralized type, and inherently stable. It was found that A. C. tubes would not work, if there was any regeneration present, without causing disagreeable noises, unstable operation and too much hum. This made it necessary to remove the regenerative characteristics from the set which materially affected the sensitivity and selectivity. The sets were then not as good performers as they were before, but they used A. C. tubes. Considering the problems encountered the engineers did wonders with A. C. tubes and are to be congratulated.

Low Current Tubes

An indication of the revival of series filament operation is the announcement of a new tube designated as the 201-B. The author has had the opportunity to measure and test one of these tubes and finds that they possess the same static and dynamic characteristics as the 201-A with the exception of the filament current, which is 125 milliamperes at five volts. It uses an oxide filament and should have a life equalling that of the 201-A. The announcement of this tube substantiates the position that series filaments are likely to assume in the industry. They anticipate a demand and are ready to supply a tube to be used as a detector or audio-frequency amplifier in conjunction with the screen-grid tube, whose filament current characteristics are such as to make a series arrangement possible and convenient.

Screen-grid tubes are as yet a direct-current operated tube and are lively to remain as such. It is possible to supply the electron emission for such a tube by an arrangement similar to the method used in the detector or 227-

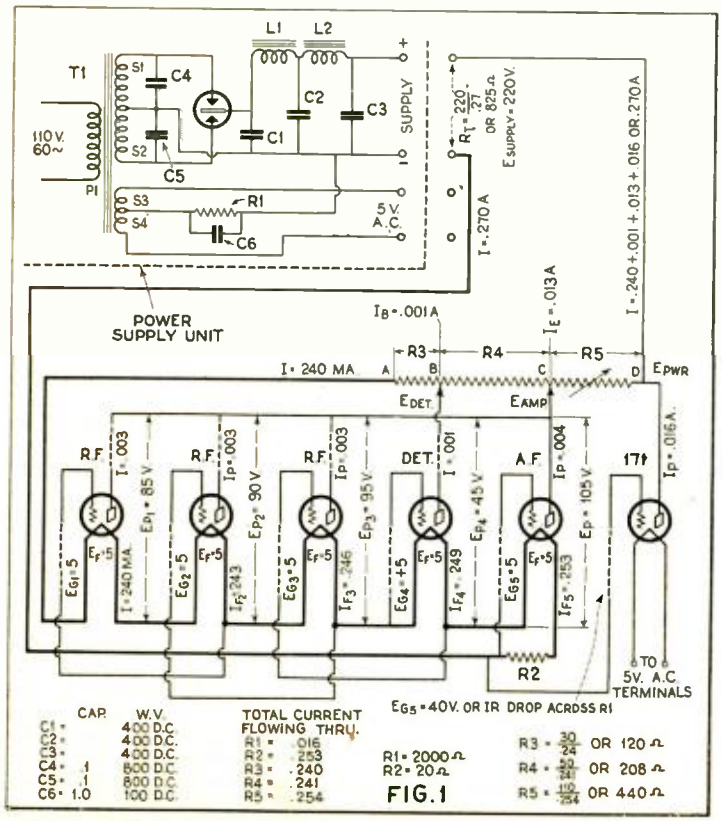


FIG. 1

Complete circuit diagram of a 6-tube series filament operated receiver and the attendant power supply unit employing a 350 m. a., full-wave rectifier. Aside from giving all the constants, the author has presented a mathematical analysis of each branch of the circuit.

* *Chief Engineer, King Lear Laboratories.*

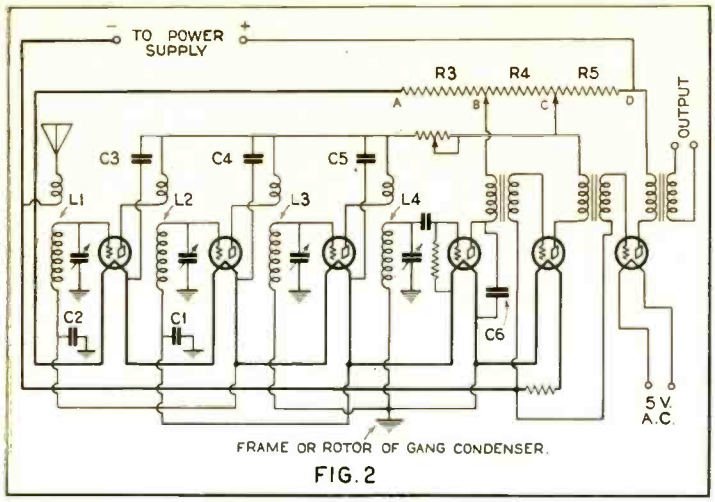


FIG. 2

Fundamentally the same circuit as shown in Fig. 1. In this instance the coupling devices are included. This is more in the nature of a wiring diagram rather than a basic design circuit, as Fig. 1.

type tube, but until the faults are eliminated in the 227 tube it would not seem advisable to complicate matters further by applying such construction to a tube, which is inherently more difficult to manufacture and control. If they remain a direct-current tube and a manufacturer wishes to use them he must provide the current in some way and about the only method open to him to do this is through a series filament system. Some one will say, "What about an 'A' rectifier and dry filter condensers?" This is a logical question but price difference answers it adequately although there is voltage regulation and bulk to consider besides price.

A series filament arrangement adapts itself readily to any kind of a radio circuit and often affords short cuts not possible with any other method of operation. It is not new and is accepted as reliable. It was used by the Army and Navy for their field radio telephone and telegraph sets and endorsed by the Western Electric Company. In order to illustrate the adaptability of this method of operation to those who are not fully informed on the subject the author has provided a few sketches and figures which are mostly self-explanatory.

Principle of Series Filament Operation

Fig. 1 is a skeleton potential circuit and illustrates the general method of wiring and sequence. Fig. 2 is the same circuit as Fig. 1 except the coupling devices are shown in place. A casual study of these sketches will enable the technical man who understands the fundamentals of radio to design or re-design a set to series-filament operation.

Observe that all the grid potentials are five volts negative with respect to the filament, except that of the detector which has a positive grid return. The grid potential is always with respect to the negative side of the filament of the tube under consideration. The positive grid return to the detector tube is effected by the grid leak. Note that in Fig. 2 two fixed condensers, C1 and C2, are connected from the filament end of coils, L1 and L2, to the common terminal or ground. These are used to eliminate the unnecessary losses caused by resistance in series with the closed oscillatory circuits, thereby increasing their selectivity and efficiency. By studying the sketches in Fig. 3 it is possible to see the reason for and functioning of these by-pass condensers.

Sketch A shows the LC circuit of the detector stage. It will be noticed that the filament end of the grid coil returns to the negative side of the detector filament while the leak is connected to the positive side of the same filament. The heavy lines indicate the closed oscillatory circuits. As the condensers used to tune all four of the grid circuits have a common electrical shaft and therefore the rotors of all condensers are common to each other, the shaft must be grounded to some common point in the filament circuit. Instead of each grid tuning coil being connected direct to the rotor of its condenser it must go to a point sufficiently negative with respect to its filament to insure the correct grid bias for proper operation. Should all of the grid coils return to the rotor and the rotor be connected to some point in the filament circuit, there would be a variation of grid bias amounting to 15 or 20 volts, which, of course, is not permissible. So the next thing to do is to connect the rotors of the condensers to a common point and return the filament ends of the grid tuning coils to their correct positions and then to eliminate resistance losses in the LC circuit by generous use of by-pass condensers such as C1 and C2 in Fig. 2.

The point in the filament circuit to which the rotors of the condensers are connected was not selected at random but after careful consideration. It could be connected at other points in the filament circuit but in its indicated position it was possible to decrease the number of by-pass condensers to a minimum of two and still reduce the losses greatly. There is no external resistance in the LC circuit of either the third R. F. coil or the detector coil. This makes it unnecessary to use by-pass condensers.

Sketch B in Fig. 3 shows the grid circuit of the third R. F. stage. This is

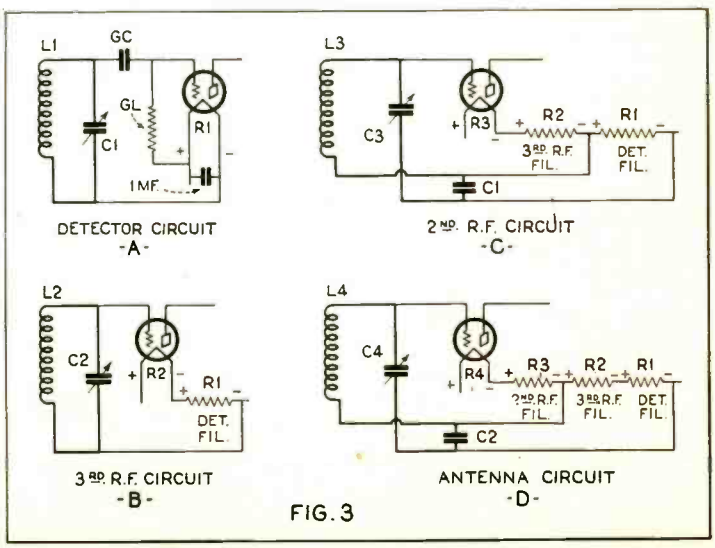


FIG. 3

Circuits illustrating the proper method of obtaining "C" bias voltages and means for elliminating the effect of resistance in the oscillatory circuits.

conventional except that instead of obtaining the bias from a "C" battery it is obtained by returning the filament end of the grid coil to a point sufficiently negative, as explained before. This point is five volts and is equal to the drop in voltage across one tube of the 201-A type.

Sketch C is the grid circuit of the second R. F. stage and begins to take on another aspect. There is now the external LC resistance to consider due to the resistance across the filament of the detector tube. This is equal to 20 ohms and sufficient to broaden the tuning of the LC circuit considerably. By shunting the resistance of the detector tube filament with a 1 mfd. condenser, as in diagram A, this loss is almost entirely eliminated. Sketch D shows the first stage of R. F. or antenna tuning stage. This stage has an included resistance of approximately 40 ohms in series with the LC circuit but the loss is reduced to a negligible amount by capacity C2.

The method as shown in Figs. 1 and 2 for using a gang condenser is only one of many possible ways to do the trick but the author has found it particularly adaptable to most of the circuits with which he has experimented. Fig. 4 shows another way of using a gang condenser with a series filament arrangement.

Trouble from R.F. Feedback

One of the few things that are apt to cause trouble in a series filament set is stray radio-frequency currents which are allowed to get into circuits where they do not belong and which cause bad feedbacks and howls. This is a condition which is not confined to series filament sets, but is noticeably present if not prevented. The judicious use of by-pass condensers is necessary in order to keep the R. F. currents in their proper circuits. In Fig. 2 these condensers are those marked C3, C4, and C5. These condensers eliminate undesirable feedback due to circuit coupling and materially aid stabilization.

With series filament circuits using 201-A type tubes there is always a potential difference of five volts between each plate circuit, but this does not make any difference in actual performance. It is a desirable feature when the tubes are arranged as in Figs. 1 and 2. Each succeeding tube has a five volt higher plate potential to work its natural increased load due to preceding amplification.

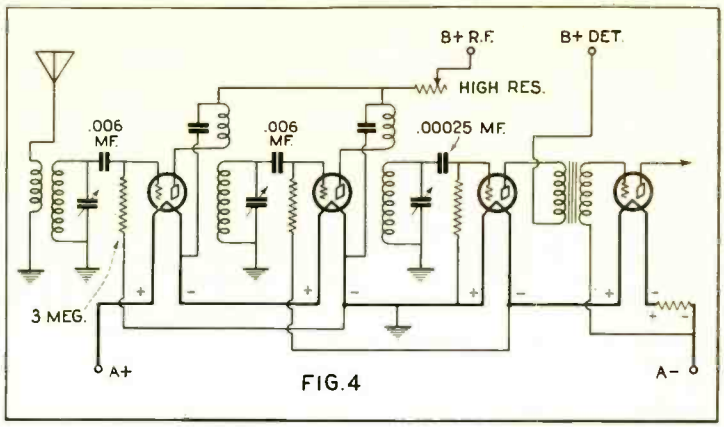


FIG.4

Diagram showing how a gang condenser may be utilized in a series filament operated tuned radio-frequency receiver without disarranging the "C" bias voltages obtained through the drop in voltage across the filaments.

With any kind of a radio it is desirable to use a power tube in the last stage of audio and have this tube operate with alternating current supplied from a step-down transformer or low voltage secondary. A 171-type tube will fill the requirement of most individuals but where additional amplification and handling ability is desired it will be necessary to use either a 210 or one of the new 250 tubes.

Rectifier and Filter Circuit

The rectifier and filter circuit necessary for operating a series of 201-A tubes need not be bulky nor expensive and certainly should be very economical to operate and maintain. A full-wave gaseous conduction rectifier tube is recommended for this purpose and good results will be obtained if the input voltage characteristics are the same as specified by the manufacturers.

The chokes used are not of a necessity huge in their proportions, as some would lead us to believe, but should be no larger than twice the size of a good "B"-eliminator choke. Very satisfactory results were obtained with a choke of only 3 henrys inductance in connection with a maximum of 10 mfd. in the filter circuit.

This filter circuit was used on a set having good audio-frequency transformers and with a well known type of loud speaker, which responds well to the lower register. The hum present was entirely within the allowable amount and considerably less than the same combination operating on A.C. tubes. More inductance and capacity could be used if desired but it is unnecessary if the filter is properly designed. It should be distinctly understood that no such amounts as 50 mfd. are necessary and it would be a flagrant waste and poor engineering to use such an amount. The condensers can be the same size and working voltage as used by an ordinary "B" eliminator. In many cases it would be possible to use lower working voltage condensers because of the absence of surge voltages in a series filament arrangement. The resistance of the entire circuit is of a necessity low. The load is large but constant. Where there is small fluctuation there are only small surges. The circuit is so designed that it is impossible to turn on the supply voltage to the filter without the filter load being attached to the output. This fact reduces to a minimum the chance of surge due to transient conditions, which exist in a transformer when no load is applied to the secondary and the current suddenly applied to the primary. Another reason for condenser insurance when using series filaments is explained below.

With a circuit whose resistance is as low as this type there is no tendency of audio circuits to "motorboat" when good audio coupling units are

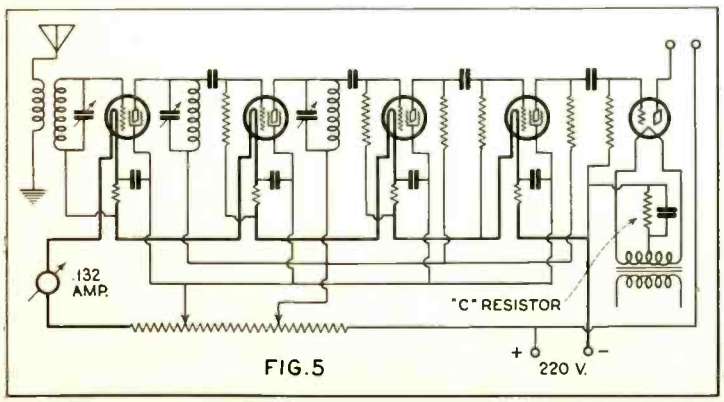


FIG.5

Circuit diagram of a series filament operated tuned radio-frequency receiver employing screen-grid tubes. This circuit is fundamentally the same as those previously shown.

used. "Tagging" effects are eliminated also because of the low resistance and high load current. "Tagging" is experienced where a power amplifier takes more current than the eliminator can supply momentarily and results in poor quality, but with this circuit it is impossible to detect the slightest evidence of "motorboating" or "tagging." The reason is apparent when the total plate current is compared to the total drain. The comparative relation is so small that even a fifty per cent change in plate current would not change the applied potential enough to be noticed.

Regeneration Safely Employed

One of the biggest things in favor of series filaments is that advantage can be taken of regeneration in the design. Without regeneration most of the manufactured sets, except the real high priced ones, are poor in performance when it comes to distant reception and selectivity. These same sets perform wonderfully when a slight amount of controlled regeneration is present. Regeneration has not been found desirable with A. C. tubes owing to the various and sundry hums, noises and "motorboating" experienced whenever it is present, even to a small degree. With series filaments it is easily controlled and does not unbalance the circuit.

The problem of neutralizing a series filament circuit is no more difficult than that of a parallel filament circuit. All the usual neutralizing circuits are workable, including the bridge circuits. Fig. 6 shows some of the better known methods actually applied.

The efficiency of series filaments compared to A. C. tubes is practically equal, although series filaments will be more economical in the long run because of the long life of the tubes and lower replacement cost.

A series filament circuit employing screen-grid tubes is shown in Fig. 5.

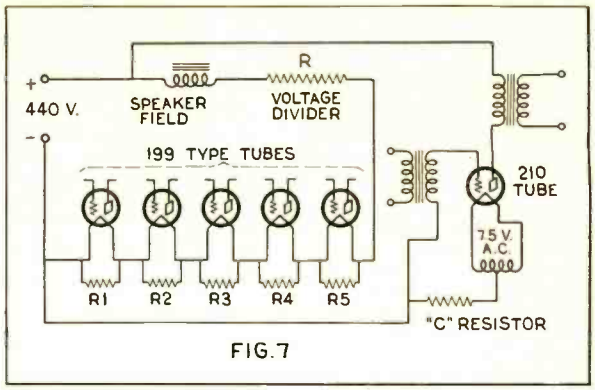


FIG. 7

Series circuit arrangement of the 199-type tubes in an A. C. Radiola Superheterodyne. R_1 to R_5 are the current by-pass or protective resistors. Note circuit position of the field of the electro-dynamic speaker.

The A.C. Radiola Superheterodynes

It is not generally known that the A. C. models of the Radiola Superheterodyne receivers are operated with their filaments connected in series. They have been operating them from the light socket for almost three years now and the results obtained have been perfectly satisfactory both from the standpoint of life and service. Very little trouble has been experienced with this arrangement. Tubes last almost indefinitely and the quality of operation is and has been always above reproach.

The sets are wired so that all filament connections come out to the back of the catacomb. They are not connected to each other inside the catacomb. The filament connection is effected by a terminal strip which connects them either in series or parallel. If the set is to be operated from the light socket a terminal strip is provided which is so designed as to connect the filaments in series with each other. If battery operation is desired a terminal strip is provided which connects the filaments in parallel. The strip which is provided when series connection is effected also holds the resistance units, which are connected across each filament to by-pass the plate current. These resistors serve a double purpose, the second purpose being that of a safety device to protect the condensers and tubes from burnouts and short circuits due to excessive potentials. To operate one of the Radiola Superheterodynes from the light socket it is necessary to have one of their Model 104 loud speakers which includes a full-wave rectifier and filter. This rectifier supplies approximately 130 milliamperes at 440 volts direct current. The 210 power amplifier tube only requires about 20 milliamperes, leaving almost a hundred for lighting the filaments of the 199-type tubes. These tubes operate at 60 to 63 milliamperes and the difference between the current at which they operate and the current available must be dissipated in some way. The resistors mentioned before as attached to the terminal strip are the ones shunted across each filament. These resistors are so designed as to by-pass the excess current around the filament of the tube and also to protect the circuit should one of the tubes be removed from the socket while the rectifier and filter is supplying current to the set. They must be capable of carrying between 80 to 90 milliamperes as that current, which ordinarily passes through the tube, is all passed through the resistor when the tube is removed and the set is on. The value of the resistance used across each tube is easily figured from well known and understood formulae.

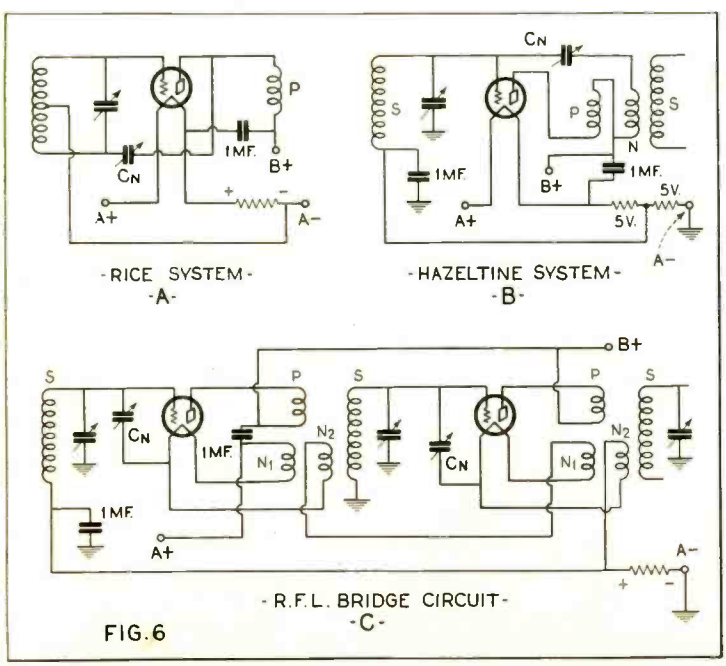


FIG. 6

Some of the better known neutralized circuits which are applicable to series filament operated receivers.

Series Arrangement with 199-Type Tubes

Fig. 7 shows a skeleton circuit of the loud speaker field, voltage divider resistor, and five 199-type tubes all of which are connected in series across a 440-volt D. C. supply. The resistance of a 199 tube when it is lighted is approximately 50 ohms and as the current will be limited to 60 milliamperes by the field and voltage divider resistor we can readily calculate the potential drop through the tube as 50 × .06 or 3 volts. The voltmeter will indicate this amount if a reading is taken across the filament of each tube in the series. There will be a similar drop across the field and resistor which will be equal again to the resistance of each unit times the current being passed. Most electrodynamic speaker fields have a D. C. resistance of around 2500 ohms and as we know the current to be equal in all parts of a series circuit the formula E=IR will determine this drop in voltage. 2500 × .06 or 150 volts. If the supply voltage is equal to 440 and we drop 150 volts through the speaker field and 3 × 5 or 15 volts across the tube filaments it will be necessary to have the voltage divider resistor of such a value to dissipate the difference between 165 volts and 440 volts, or 275 volts. As the current must not exceed 63 milliamperes nor be less than 60 milliamperes the resistor must have a value of 4500 ohms. The formula is simply Ohms law. R=E/I. R=275/.06 or 4586 ohms. As it is permissible to have more than 60 milliamperes by a slight margin without damaging the tubes the value of 4500 ohms mentioned above is about right. Another reason for selecting an even figure is because of the difficulty in obtaining resistances in quantity to within a tenth of one per cent accuracy.

The circuit referred to is a basic series filament circuit using 199-type tubes but no provisions have been made for protection of the tubes and condensers which must be included in the completed circuit. It is easy to see that if one of the tubes were removed while the supply current was on that there would be a potential equal to the total applied potential existing between each side of that tube and would injure any low voltage by-pass condenser which might be connected in the circuit. Some sort of protection must be provided against such a possibility. That is one of the purposes of the parallel resistors used across each filament of a series group, as shown in Fig. 7. With this protective resistance in place it is possible to remove a tube from its socket without actually opening the circuit. The only change that takes place is in the total resistance of that circuit. The current which formerly flowed through the tube filament is now forced to flow through its protective resistance. For this reason it is necessary that the protective resistor be capable of passing 70 to 80 milliamperes without damage to itself. The maximum variation experienced with this method of protecting the circuit against surges should not be over 10 to 12 volts. This amount of variation in voltage will never cause any trouble. It is possible to make one of these resistors variable and connect it across the tube which is most sensitive to filament temperature changes and employ it as the volume control for the set.

201-A Tubes in Series

It will be found that a series filament arrangement applied to 201-A type tubes has a number of advantages. When using 199-type tubes it is necessary to by-pass the preceding plate currents around the filaments of each tube because of the large ratio of plate current to filament current that is present. The ratio of plate current to filament current in a 201-A tube is so small that it can be neglected in designing a series filament set. It is also possible to protect a series of 201-A tubes by a single resistence unit which is an advantage over having to use individual resistors across each tube. Owing to the rugged construction of the 201-A tubes they are not easily damaged by momentary surges when they are placed in the circuit while the current is on. With a 199-type tube if no protective device were used across each tube there would be sufficient instantaneous current available, due to charged condensers, to burn out or injure them, should they be connected into the circuit while the supply current was on. Then, with the 201-A tube the additional advantage exists of practically equal operation with large degrees of current variations in the filament. It has been found that results are not materially changed with variations as large as 50 milliamperes. This makes it unnecessary to by-pass the preceding plate currents around the succeeding tubes. The fact that the voltage across each successive filament is slightly higher due to the added plate current from the preceding tubes is not a disadvantage. The increased current is not sufficient to harm the filaments.

Mention was made of a single protective resistor, this being indicated by R2 in Fig. 8. You will note that it is connected across the series of filaments and a small amount of current flows through it continually. The value of this resistance should be 4,000 or 5,000 ohms and it should have a current carrying capacity of 70 to 90 milliamperes. When all of the tubes are in place and lighted a potential of 25 to 30 volts will exist across this resistor (R2). The voltage across it depends upon the number of tubes in the series. Naturally each tube has a drop of 5 volts when operated at the correct current and five tubes will have a voltage drop across them of 25 volts, six tubes 30 volts and seven tubes 35 volts. With 25 volts across a resistor of 4,000 ohms a current of 25÷4000 or .00625 ampere will flow. Six or seven milliamperes can easily be sacrificed to safety and insurance against filter condenser failure. Should one be removed, a filament burn out, or the circuit otherwise opened anywhere between the terminals of R2 it will then have a voltage across it equal to the entire available potential minus the drop through R1, this resistor being approximately 700 to 800 ohms plus the 4,000 ohms in the protector resistor R2, providing a total of approximately 5,000 ohms. Considering the applied potential, (that delivered by the rectifier filter combination) as being 220 volts at normal load and that it will rise about 20 volts with a portion of the load removed, the current drain through R2 will equal the applied E.M.F. divided by the resistance. I = E/R. This load will be approximately 50 milliamperes. A 50 milliamperes load is sufficient to hold down any tendency of the filter or rectifier circuit to surge badly. The damaging surges take place only when the circuit is entirely opened. With this protective device the current load is always at least 20 per cent of the total.

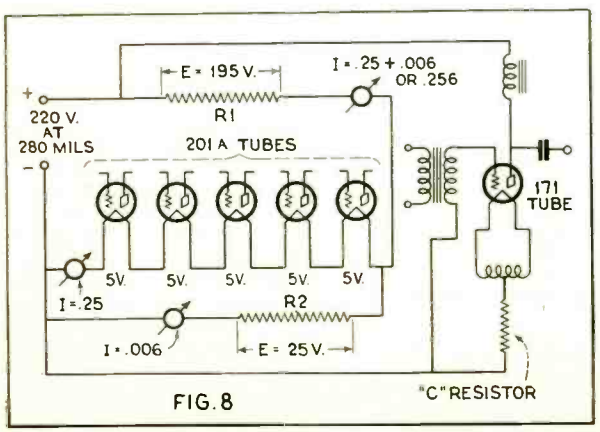


FIG. 8

Circuit arrangement similar to that of Fig. 7 but designed to employ 201-A tubes and a single protective resistor.

The Mathematics of Radio

The Calculation of Inductance and the Design of Coils for Short-Waves Together with an Introduction to Iron Core Coils

By John F. Rider, Associate Editor

PART VII

THE determination of the required capacity to make a certain coil resonant to a certain wavelength is made in like manner. The LC constant for the desired wavelength is obtained from the table published with our last article. Then the value of inductance in centimeters becomes the divisor and the quotient is the required value of capacity. For example.

We have a coil of 200 microhenrys inductance. Since the LC constant utilizes the term centimeters in the inductance calculation it is necessary to change the figure 200 microhenrys into centimeters. This is accomplished by multiplying the number of microhenrys by 1000, since 1000 centimeters equals 1 microhenry. (1,000,000 centimeters equals 1 millihenry). The result is 200,000 centimeters. We wish to make this coil part of a condenser-inductance circuit which will be resonant to 400 meters. The LC constant for 400 meters is 45. Dividing 45 by 200,000 we obtain the value .000225, which is the required value of capacity or .000225 microfarads. Let us prove this determination by multiplying the capacity in microfarads by the inductance in centimeters, and see if the result will be the LC constant for 400 meters. Incidently this is the means of determining the resonant wavelength. 200,000 x .000225 equals 45. Reading towards the left of this figure, we find that it is the LC constant for 400 meters.

Table I

Inductance Table of Short-Wave Coils

Wavelength (Meters)	.000025 Mfd.	.00005 Mfd.	.0001 Mfd
	Inductance (Microhenrys)		
10 ...	1.128	.564	.282
15 ...	2.440	1.270	.635
20 ...	4.516	2.258	1.129
25 ...	7.020	3.510	1.755
30 ...	10.120	5.060	2.530
35 ...	13.784	6.892	3.446
40 ...	18.	9.	4.5
45 ...	22.8	11.4	5.7
50 ...	28.	14.	7.
55 ...	34.04	17.02	8.5
60 ...	40.36	20.28	10.14
65 ...	.....	23.76	11.88
70 ...	.....	27.56	13.78
75 ...	.....	31.66	15.83
80 ...	.....	36.02	18.01
85 ...	.....	40.68	20.34
90 ...	.....	45.60	22.80
95 ...	.....	50.81	25.41
100 ...	.....	56.32	28.16

Consequently a capacity of 225 micro-microfarads placed in parallel with an inductance of 200 microhenrys (200,000 centimeters) will make the combination resonant to 400 meters.

Suppose we wanted this circuit resonant to 500 meters. What must be the value of capacity with an inductance of 350 microhenrys, (350,000 centimeters). According to the table the LC constant for 500 meters is 70.4. Dividing 70.4 by 350,000 we obtain the quotient .000211 plus, which is the required capacity in microfarads.

Inductance Charts and Tables

The table showing the wavelength and the relation between inductance and capacity to cover a definite waveband, makes calculation a relatively simple problem. Fortunately, however, a still simpler method is available, in the form of charts and tables which make calculation entirely unnecessary. We fully realize that these charts and tables constitute a digression from the original purpose of the "Mathematics of Radio," but such charts and tables are of immense value to the person interested in the calculation of inductances required to cover certain wavelength ranges. This is particularly true with the present developments in, and exploitation of, the short waves. Many powerful broadcasting stations are operating on short wavelengths, ranging from 10 to 100 meters, and because of the need to use several inductances to cover this waveband with one tuning capacity, the accompanying curves and tables will doubtless find many satisfied users.

Starting with the low wavelengths, we show the relation between inductance, capacity and wavelength for some of the values of tuning capacity utilized in short wave installations. The inductance values considered in Table 1 range from 0 to 50 microhenrys and the capacity values from 25 to 100 micro-microfarads or from .000025 to .0001 mfds. This table shows the maximum wavelength covered by any combination of these inductances and capacities. By utilizing this chart, the interested individual can select for himself, the desired values of inductance and capacity required to cover a certain waveband. The selection of the capacity will govern the extent of the band, the larger the maximum value of the condenser, the greater the waveband. The curves start at a figure greater than zero, since the fundamental wavelength of the coil itself, makes it impossible to start the curves at zero.

Referring to the curves in Fig. 37, we see the inductance in microhenrys plotted on the ordinate, the wavelength range on the abscissa and the curves are marked in capacity. To use this chart is simple. Let us say that we desire to cover a maximum wavelength of 30 meters, and we have a tuning capacity with a maximum of 50 micro-microfarads, or .00005 mfd. What value of inductance is necessary so that we can reach this wavelength with this capacity? Referring to the curve marked .00005 mfd. and following down until we meet the 30 meter ordinate line and then following to the left along this line we see that the required inductance is 5 microhenrys. Now, it is not good practice to arrange an LC circuit, where the desired wavelength is covered with the maximum condenser setting, therefore we would add about 10 or 20% to the required value of inductance.

Suppose we reverse the problem. What value of capacity is required to tune a coil of 22.5 microhenrys of inductance to 75 meters? Following out on the 22.5 microhenry inductance line until we reach the 75 meter wavelength ordinate, we find that it is practically midpoint between .00005 and .0001 mfd., or about .000075 mfd., if we had plotted such a curve. Since this value of capacity would permit reaching the desired wavelength with the maximum capacitance setting, we might just as well employ the .0001 mfd. condenser and reach the desired wavelength with some capacity to spare. Therefore we would select the .0001 mfd. condenser.

Table II

Inductance Table of Short-Wave Coils

Turns per inch	2 inch diameter	3 inch diameter
	Inductance	Inductance
2	208	.258
4	.8	1.
6	1.87	2.3
8	3.37	4.14
10	5.2	6.5
12	7.7	9.
14	10.	12.7
16	13.	16.6
18	16.9	21.
20	21.	26.5
22	25.2	31.3
24	30.	37.3
26	35.	
28	41.	
30	47.56	

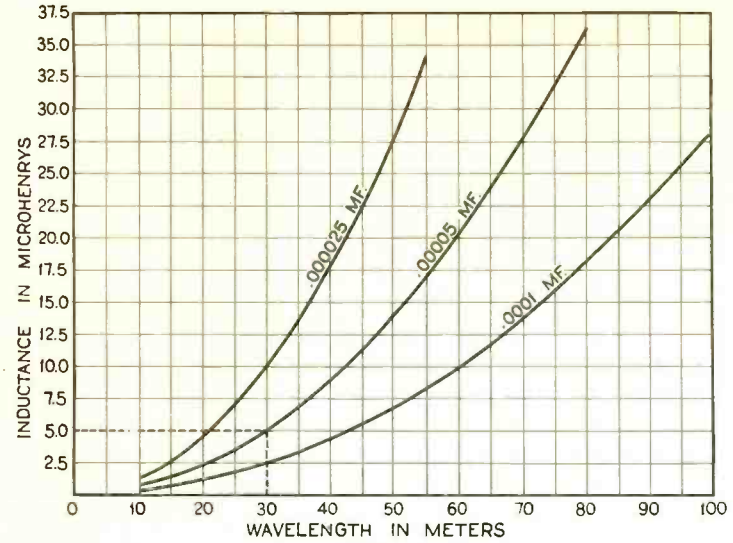


FIG. 37

An inductance-capacity chart from which one can determine the value of inductance, or capacity to cover a given short waveband.

Let us assume that we desire to know the wavelength range of an inductance of 17.50 microhenrys and a .000025 mfd. condenser. What would be the maximum wavelength covered by this combination? We follow up along the 17.50 microhenry inductance line toward the capacity curves, until we reach the curve representing the .000025 mfd. condenser. We follow down from this point of intersection and note that the maximum wavelength is 39.5 meters. It should be remembered that all of these figures may be determined by resorting to the table showing the product of inductance and capacity and its relation to wavelength, but the writer considers a chart of this type preferable, since it eliminates calculation. The short range of inductances was premeditated, since it gives the chart greater utility; particularly to the person interested in the selection of inductances for use in short-wave receivers.

Design of Coils

Having determined the inductances, let us now delve into the construction of such coils. We know what value of inductance is required; let us now determine just how many turns are necessary. Conventional practice has definitely decided upon the single layer solenoid as best for short-wave inductances, and we will not deviate from this decision. Here again, we can resort to the use of formulae, by constructing one inductance of a few turns, calculating the inductance by means of the Lorenz formula (18) or Nagaoka's formula, (19) previously published, and adding or subtracting turns. The chart shown in Fig. 38 obviates the necessity of calculation; this chart shows the relation between turns per inch and inductance with various coil diameters, for inductances suitable for the determination shown in the chart designated as Fig. 37. Two diameters are considered, namely 2" and 3". The inductance values covered range from .2 microhenry (200 centimeters) to 37.3 microhenrys (37,300 centimeters). These values have been selected for this table because they correspond with the values shown in the chart of Fig. 37. The data is arranged according to the number of turns per inch, increasing steps of two. The inductance values are shown on the ordinate and the number of turns per inch on the abscissa. The length of the winding is always taken as 1", and the formula employed to make the calculations was Lorenz's. The figures are fairly accurate, being more than an approximation.

The operation of this chart is very similar to that of Fig. 37. Here we determine the number of turns necessary for a certain inductance (short wave coils only in this table) or the available inductance from a certain number of turns per inch on 2" and 3" diameter winding forms. For example; we have ascertained that we require an inductance of 10 microhenrys to tune to a certain wavelength. Suppose we have also decided upon a certain diameter of winding form, say 2". How many turns per inch of winding (total length of winding is 1" in all cases quoted in this chart). We locate the inductance designation of 10 microhenrys, follow in until we meet the 2" diameter line. Reading down from the point of intersection will show us how many turns per inch we require which in this case is 14.

Conversely, suppose we have a wound coil, 3" in diameter, with 6 turns per inch (1" total winding). What is the inductance of this coil? Locate the 6 turns per inch on the abscissa and follow up to the point of intersection on either the 2" or 3"

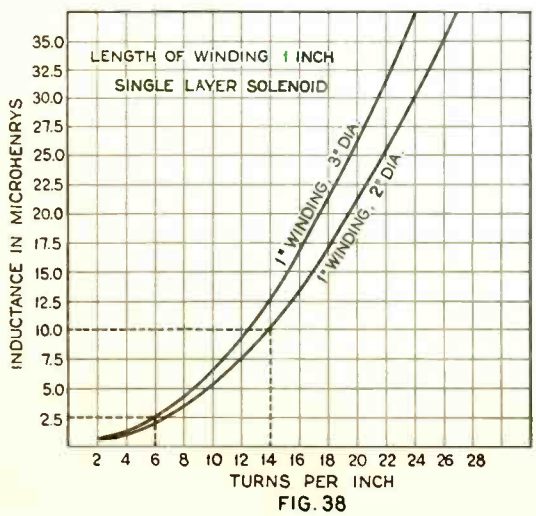


FIG. 38

Charts from which it is possible to determine the number of turns required on a given size coil form to give a certain value of inductance — or vice versa.

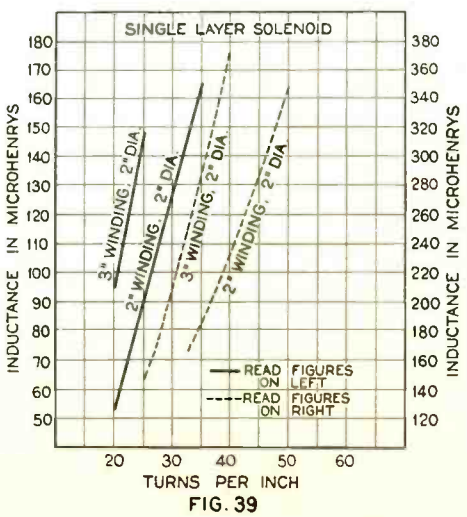


FIG. 39

diameter line. From this point of intersection follow to the left until the inductance line is reached. The new point of intersection shows the inductance of that 6 turn per inch coil.

For the benefit of those who do not wish to read charts, the following are the two tables used to compile the charts of Figs. 37 and 38. The former shows the inductance necessary to tune to wavelengths between 10 and 100 meters with capacities ranging from .000025 mfd. to .0001 mfd. The wavelength limit for the 25 m-mfds. condenser is 60 meters, since these condensers are seldom used to tune even this high. See Tables I and II.

In Fig. 39, we show the relation between inductance and the number of turns per inch winding for 2 and 3 inches of winding on 2 inch diameter forms. The ordinate on the right shows inductance values from 50 to 190 microhenrys and is associated with the solid lines in the chart. Two inches of winding with from 20 to 35 turns per inch afford inductance values from 53 to 175 microhenrys. Turns per inch in excess of 35 are shown in curve D and its associated inducrance designations are shown on the extreme right hand ordinate, which indicates inductance values from 100 to 400 microhenrys. This chart is useful in determining the total inductance for 2 and 3 inches of winding on 2 inch forms when the number of turns per inch varies from 20 to 50. The values given in Fig. 39 are suitable for the design of inductances to cover the broadcast band. The relation between inductance values from 50 to 400 microhenrys and standard capacity of .00025, .00035 and .0005 mfd. are shown in Fig. 40. For intermediate capacity values, the table showing the relation of wavelength and the product of inductance and capacity can be used. These values are not absolutely accurate but sufficiently so to permit their application in design.

The left ordinate shows the inductance values and the wavelength figures are shown on the lower abscissa. The upper abscissa shows wavelength values from 350 to 550 meters associated with inductance values from 100 to 300 microhenrys as indicated on the right hand ordinate. The solid lines (curves) are associated with the left hand ordinate and lower abscissa and the dotted lines (curves) are associated with the upper abscissa and the right hand ordinate.

Iron Core Coils

Coils employing some substance, possessing magnetic properties, as the winding form, are known as iron core coils or inductances; also as chokes, with various descriptive appellations defining the application of the winding or coil. The symbol for a coil of this type, was shown in Fig. 30-A and 30-B. The horizontal lines located above or below the loops designating the winding, or the horizontal lines penetrating the loops of the winding symbol indicate that the coil utilizes a core possessed of magnetic properties. The actual material utilized as the metal core varies in many cases. Some use iron, others silicon steel of varying grades, and still others use an alloy of several metals, with nickel as an important constituent.

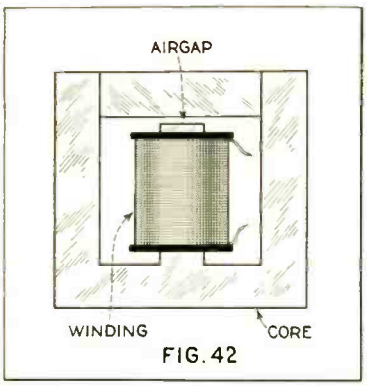


FIG. 42

An iron core inductance with a different form of laminated core.

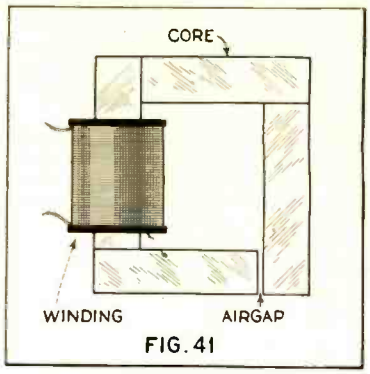


FIG. 41

An iron core inductance or choke with a laminated core and airgap.

The drawings of Fig. 30-A and 30-B are somewhat misleading, in that one is apt to imagine that this metal core is a straight piece of metal or a bundle of metal rods of small diameter, around which the wire is wound. Such cores have been utilized, but that design is now obsolete. The present type of choke is usually wound on a square four sided core as in Fig. 41, or upon a form as shown in Fig. 42.

The actual function of the choke, again does not intrigue us. We are concerned solely with the calculation of the choke, when one of a certain amount of inductance is necessary. It is, however, impossible when considering chokes to neglect a certain discussion. The use of a choke coil is primarily intended to retard or impede the flow of alternating currents, but at the same time to permit the flow of direct current. Therefore, in the design of an iron core inductance for use as a choke, we must face two considerations. First, we have the flux due to the alternating current, and then we have the flux due to the direct current. This is true in filter circuits, in plate circuits of audio amplifiers, etc. Consequently, the core material provides a path for two fluxes.

The presence of the direct current flux complicates the design of the choke, since provision must be made to preclude saturation of the core by the magneric flux created by the flow of D-C through the winding. The means of preventing saturation of the core due to the D-C flow, is to include an airgap in the core. This gap is illustrated in Figs. 41 and 42. The selection of the size of this gap is, however, a very important consideration. In the first place, the choke must possess a certain amount of inductance in order that it perform its required function. Second, no matter where it is used, it is obliged to pass a certain amount of direct current. The air gap, however, has a tendency to reduce the amount of inducrance, and if the gap is too great, because precaution against saturation is exercised, the in-

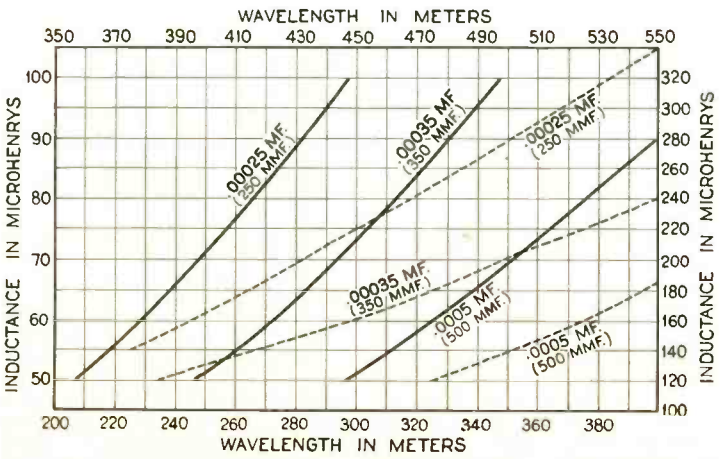


FIG. 40

An inductance-capacity chart, used in the same manner as the one in Fig. 37, but covering the wavebands from 200 to 550 meters.

ductance will be appreciably reduced, thus reducing the action of the choke. Conversely if the air gap is too small, danger from D-C saturation is imminent, thus again impairing the function of the choke.

Be that as it may, we can leave the selection of the air gap for subsequent discussion. The inductance of a choke is usually considered as proportional to the square of the number of turns in the winding, to the cross section area of the core and inversely to the air gap. The mathematical expression for these rules is

$$L = 3.2 \times \frac{N^2 A}{G \times 100{,}000{,}000} \text{ where}$$

L is the inductance in henrys.

N is the number of turns in the winding.

A is the net area of the cross section of the core in sq. inches.

G is the equivalent air gap in inches.

The selection of the gap provides a problem open to discussion, since it varies with the flux density and the current flow through the winding. For general considerations of filter chokes, since these units constitute the greatest use, an average air gap is approximately .005 inches. With respect to the air gap it is essential to remember that it is necessary in every choke utilized to retard the flow of A-C and to pass a reasonable amount of D-C. Examples of such chokes are the speaker-output tube coupling chokes, filter chokes used in B-eliminators and plate coupling chokes. The smaller the value of current flow, the smaller need be the air gap, but a minimum value is usually around .0025 inches.

A mathematical expression for determining the equivalent air gap is:

$$G = 3.2 \frac{I \times N}{B} \text{ where}$$

G is the equivalent air gap.

I is the current (D-C) in amperes.

N is the number of turns.

B is the flux density in lines per sq. inch.

The processes involved in the design of chokes, particularly for use in filter circuits will be discussed later.

(To be Continued)

Paper vs. Mica Condensers in R. F. Circuits

A Discussion on the Comparative Power Factors of Paper and Mica Condensers Used in R.F. Circuits

*By J. George Uzmann**

THERE has of late been a growing tendency on the part of many to substitute small paper condensers in place of mica dielectric types in various forms of radio frequency circuits.

Evidently this practice has been resorted to in the modern march of radio activities with the idea in mind of cost reduction. A little analysis easily shows that the difference in cost between small mica and paper dielectric condensers isn't great enough to warrant such a radical change.

Comparative Power Factors

Tests on various types of dielectric show that for all practical purposes mica condensers have power factors in the order of .01% or better as compared to .25% for high grade paper types. Now let us see just what results are obtained where they are used say in a typical tuned circuit.

Fig. 1 shows the circuit together with all necessary electrical data. It will be seen that a normal broadcast frequency of 350 meters or 857 KC is employed. The tuning inductance or secondary winding is assumed to be of ample inductance and have a high frequency resistance of 8 ohms.

Since the power factor of condensers is simply $\frac{R}{Z}$ or $R = PfZ$; let us first obtain its reactance.

$$Xc = \frac{10^6}{2\pi FC} = \frac{10^6}{6.28 \times 857{,}800 \times .0005} = 370 \text{ ohms}$$

and R the equivalent circuit resistance of the condenser is

$$R = PfXc$$

For mica condensers

$R = 370 \times .0025 = 0.925$ ohms

For paper condensers

$R = 370 \times .01 = 3.7$ ohms

Total circuit resistance, as above, with mica condenser is

$Rt = 8 + .925 = 8.925$ ohms

Total circuit resistance with paper condenser is

$Rt = 8 + 3.7 = 11.7$ ohms

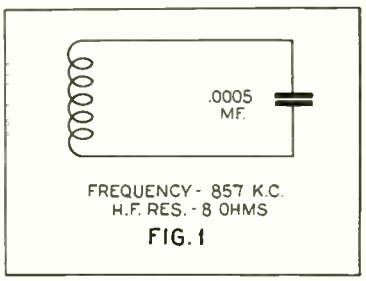


FIG. 1

A basic oscillatory circuit containing inductance, capacity and resistance.

Since the current at resonance is inversely proportional to the circuit resistance it will be seen that where mica condensers are employed we finally arrive at the following interesting results

$$\frac{11.7 - 8.93 \times 100\%}{8.93} = \frac{2.77 \times 100\%}{8.93} = 31\%$$

in other words mica condensers of proper design easily permit a gain of 31% greater current in the tuned circuit over that realized with paper dielectric capacities. This clearly shows how undesirable paper condensers are for this sort of work.

An inductance coil having a high frequency resistance of 8 ohms is one of fair efficiency, and from the above it is apparent that the lower the coil resistance (which is true for those of more modern construction) then the more pronounced will be the advantages shown in favor of mica condensers.

As a further example, assume the coil resistance to be 5 ohms; in this case the problem works out as follows:

Total circuit resistance with mica condenser

$Rt = 5 + .925 = 5.925$ ohms

Total circuit resistance with paper condenser

$Rt = 5 + 3.7 = 8.7$ ohms $=$

$$\frac{8.7 - 5.93 \times 100\%}{5.93} = \frac{2.77 \times 100\%}{5.93} = 47\%$$

which gives us some idea of the increase in current where the circuit is tuned to resonance using mica condensers instead of paper.

These figures are, of course, based upon a single tuned circuit and from this we can easily see the extremely poor results which would be obtained where several tuned circuits using paper condensers are employed.

In conclusion, we learn that not only do paper condensers in high frequency resonant circuits cause a most serious loss in energy in radio frequency amplifier, intermediate frequency amplifier, oscillator and filter circuits but because of the greater damping thereby introduced it is apparent less power must result in oscillators, while tuning and selectivity becomes "broad" in amplifiers, and all in all it is extremely doubtful whether paper dielectric condensers are even remotely suited for the circuits under discussion

* *Engineering Dept., Dubilier Condenser Corp.*

This section has been created to accommodate material on commercial developments and allied subjects relating to specialized progress which are becoming increasingly important. We feel that developments which stimulate broad activity and tend to enlarge the scope of the radio manufacturer should be tendered individual recognition. "Commercial Developments" will, therefore, be utilized as the medium for presenting such worthy subjects as may come to our attention and will be a monthly feature.—The Editor.

High Voltage Direct Current Generators

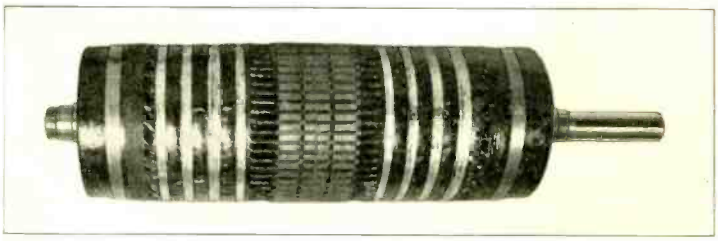
The Design of Small Capacity High Voltage D-C Generators for Radio Transmitters

*By J. H. Blakenbuehler**

DIRECT current generators for industrial usage are generally built for 125, 250 or 600 volts, and for railway applications generator voltages as high as 1500 have been used. Nearly all of these generators above 500 volts have had compensating pole face windings and all except the very smallest sizes have had commutating poles, as an aid to commutation.

Modern radio transmitters have, however, created a demand for small capacity high voltage generators. These sets use grid bias voltages as high as 1500 volts and plate voltages as high as 18,000 volts. In addition to merely being able to furnish a certain current at these high voltages, generators for this purpose must be so designed as to have other desirable qualities. Repeated instantaneous fluctuations of the load such as are encountered in this service must not disturb the commutation of the generator. Ripples or fluctuations in the terminal voltage due to pulsations of the flux caused by the variation of the magnetic paths as the slots pass the poles, and due to the variation of the number of bars short circuited by a brush as the armature rotates must be extremely small, preferably less than one quarter of one percent of the terminal voltage, and of such a frequency as not to produce annoying tones in the transmitter. If the generator does not commutate without sparks, these sparks will cause pulsations in the voltage, which will also produce audible sounds in the transmitter. Those pulsations producing the most annoying sounds have frequencies between five hundred and two thousand cycles per second with probably the most distressing tone occuring at eleven hundred cycles per second. Another necessary consideration is that any change in the plate voltage of a transmitter will change the frequency of the signal slightly. The voltage regularion of the plate supply generator must therefore be a minimum, preferably less than five percent of the rated voltage. Generators with poor regulation have been known to vary the signal frequency so much as to cause the reception by a heterodyne receiver to be very difficult.

* *Motor Engineering Dept., Westinghouse Electric & Manufacturing Company*



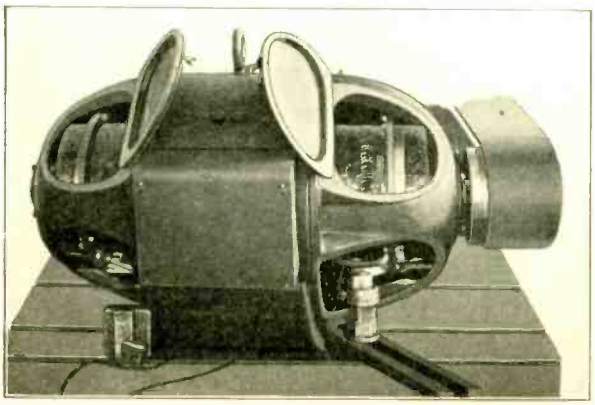


Fig. 1. Above: An armature having two windings and a double commutator, for obtaining a high voltage.

Fig. 2. Left: A double commutator, high voltage machine designed for use on airships.

Flashover Characteristics

Normally the designers of a generator with a terminal voltage of over 500 volts quite seriously consider the flashover characteristics of the generator. Every generator is susceptible to being short circuited and when this does happen generators of over 500 volts generally flash over unless some special construction is used to prevent flashover. This flashover, which generally takes the form of an electric arc

around the commutator between brushholders, may be so violent as to seriously damage the commutator or brush rigging. This difficulty has, however, rather cared for itself in the design of these small radio generators. It is necessary to have so much wire on the armature to generate these high voltages that the armature resistance is high enough to limit the short circuit current to so low a value as to preclude flashing or to render harmless any flashover that does take place. A generator of large capacity at these high voltages would present another problem entirely.

Nearly all of these relatively small capacity high voltage generators are built with only two main field poles. The principle reason for this is that for a given voltage and armature diameter with the two pole construction the distance between brushholders of opposite polarity around the commutator is approximately twice as great as on the four pole generator. This is because the brushes of opposite polarity are at diametrically opposite points on the commutator of the two pole generator, whereas on the four pole generator they are only ninety degrees apart. For this reason a flashover has about twice as far to travel on a two pole generator as on a four pole machine, assuming of course that

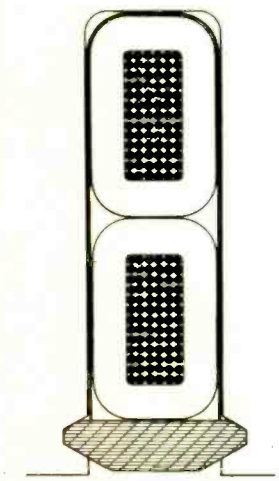


Fig. 3. Cross-section of the coil slots in a 7500-volt generator.

the grounded parts of the brushholder supports and the brackets are not so close to the live parts as to nullify the effect of the additional distance between brushes on the commutator. This larger flashover distance makes the two pole generator better able to withstand surges and fluctuations of the load.

Double Commutator Machines

When it is desired to get a higher voltage from a generator of a certain diameter than can be obtained from one commutator it is customary to put a commutator on each end of the generator with separate armature windings for each commutator in the same core, as is shown in Fig. 1. In most cases these armature windings are duplicates and may be connected externally in series so that their voltages add or in parallel to get

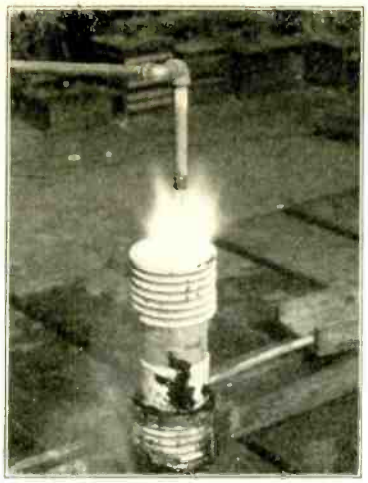


Fig. 5. Interesting view of a water barrel rheostat in service. Note the flame.

double current. In some instances, however, it is desirable to obtain two different voltages from the same generator and one armature winding differs from the other. An armature of this type is shown in Fig. 2. This generator was built for use on an air ship and is driven by a small propeller. It delivers both plate and filament supply voltages, which are 1200 and 12 volts respectively.

In some cases such as where the generator supplies a ship's transmitter it is desirable to have the motor generator set as small as possible. Most of these types of sets are driven by a direct current motor and a separate generator would have to be used to get the low voltage for filament lighting. It is more economical of space, however, to put alternating current slip rings on the motor which then acts as an inverted rotary converter supplying alternating current to the filaments, the voltage being stepped down by a transformer.

One constructional peculiarity which is sometimes used on these generators is to have the positive and negative brushes in different paths on the commutator and to have a barrier on the commutator between them. This prevents ring fire or sparks due to dirt being carried around the commutator from a brush of one polarity to one of the opposite polarity and also increases the distance the flashover arc must travel in the air.

The insulation engineer encounters some real problems in these machines since unlike high voltage induction motors or synchronous motors the rotor coils and the commutator must be insulated for the generated voltage and the stator, with the exception of the commutating pole and series coils has low voltage insulation for all these generators are separately excited at a low voltage. Since most of these generators rotate at rather high speeds the insulation of the commutator presents quite a problem, but the standard mica insulated "V" ring construction functions satisfactorily even on the very highest voltages.

Slot Insulation

The slot insulation is quite an important factor not only in determining the life of the machine but also in governing its size. The higher the voltage of the generator the thicker the insulation around the coil in the slot becomes. A section of the two coil sides in the slot of a 7500 volt generator is shown in Fig. 3. The copper area in the slot of this 7500 volt generator is only 14 percent of the area of the slot, and for a 15,000 volt generator this slot factor is only 6.8 percent. For a standard 250 volt generator this figure is approximately 50 percent. From these facts it is easy to see that the high voltage generators must be much larger physically to deliver a certain output than the corresponding industrial generator. There also seems to be a minimum economical size for a generator of each voltage. Generators built smaller than this minimum economical

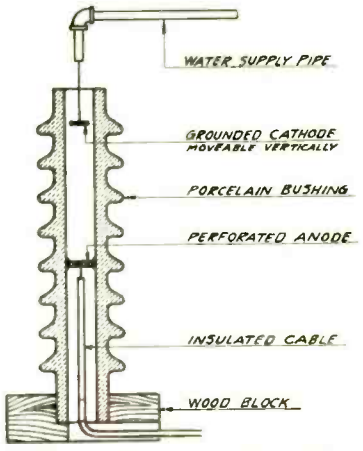


Fig. 4. Design of a water barrel rheostat used as a load on high voltage generators.

size, for smaller outputs, generally turn out to be all insulation and very little copper, and a large decrease in the output of the generator beyond this minimum economical output permits an extremely small decrease in physical size.

This thick insulation impedes the flow of heat from the armature conductors to the air and the armature ventilation must be carefully designed to avoid hot spots in the armature where the heat cannot get out. These hotspots will cause rapid deterioration of the insulation and subsequent breakdown. Although a machine may be built and insulated so as to pass its

initial tests these hotspots may cause it to break down after a very short period of operation. These armature coils of extremely fine wire must also be banded down very firmly so as to eliminate any possibility of the wires shifting and rubbing against each other at the high speeds at which these generators operate. This shifting of armature conductors also may not cause failure until the generator has been in operation on a short time.

Design Factors

These generators have a startling length of wire in their armature windings. The armature in Fig. 1 for example has 5 miles of wire on it. This armature was wound for use with a two pole stator but if the same core and commutators were used with a four pole stator and the armature was wound to generate the same voltage the length of wire would be decreased one-third and the axial length of the armature would be shortened one-fourth. A 15,000 volt ten kilowatt four pole generator with a single commutator has for instance only six miles of wire on its armature and two miles in the commutating pole coils. This decrease in the amount of wire on the armature by making it four pole incidentally decreases the armature resistance thereby materially improving the regulation of the generator. These four pole generators however, present the disadvantage of decreasing the flashover distance.

Loading these machines for test by standard resistance tubes would require about fifteen tubes per kilowatt rating of the generator with insulated mountings and switches for varying the load. This method was given up as too expensive and unsafe, and a special but simple type of water barrel rheoststat has been employed very successfully. A section of one of these rheostats is shown in Fig. 4. At very high voltages with a pointed cathode, the peculiar phenomenon shown in Fig. 5 was encountered. The current density at the cathode was evidently so high as to decompose the water into hydrogen and oxygen which recombined in a flame at the surface of the water. With these high direct current voltages it was quite easy to maintain an arc under water. The voltage of these machines during testing is measured by an ordinary voltmeter with several multiplying resistances in series with it.

Even at such high voltages these generators seem to have an unexpected margin of safety. Tests on a 7500 volt, 25 kilowatt generator show that it will carry several times its rated current at the rated voltage and still commutate absolutely sparklessly. The same machine was run at forty percent overspeed to get 12,000 volts at normal current and the commutation was excellent. This test also proved the mechanical construction of the generator to be very adequate. Instantaneous short circuit of this same generator caused flashover but no damage whatever.

The future promises considerable advance in the art of building these high voltage generators. Just how the data obtained in the construction of these generators will react on the design of the industrial motors and generators is a matter of conjecture at present, but it surely will reveal some important facts.

Through the Looking Glass

Sighted by Cervicdynia

Believe it or not—this is a real certified, grade-A Column. It was purchased from a South African newspaper that passed in the night.

We have been advised that magazines never, never, run Columns, that the Column is the sacred property of the newspaper.

Upon investigation we find this to be quite true—with one exception: Cynical Notes (misspelled Clinical Notes) by George G. Nathan, in the *American Mercury*.

Ergo—we are proud to be the second great publication to demonstrate rare originality.

* * *

Judging from the character of the results obtained by experimenters from the Screen-grid Tube we consider it only proper to pass a law, or something, changing its name to Scream-grid Tube.

* * *

Proof of the fact that radio is not in a state of chaos—and seemingly not even perturbed, is contained in the following masterpiece hauled from a recent copy of *The New Yorker*: "When her radio lapsed into an unbroken silence, a lady friend of ours took matters in hand and wrote a letter of complaint to the firm from which she had purchased the set. They phoned that they would send a repair man up. The days dragged on, and the long silent evenings. Finally in the mails came a letter. It was the sort of multigraphed form letter which leaves one sentence to be completed in long hand. This one required an insert by the repair man. The letter read:

"'Dear Madam: In response to your recent complaint regarding your radio which you purchased from us, we sent our service man to your home who found your set in perfect working condition. He also informed you at that time that the cause of the trouble was not due to any fault of the set but to . . . (and then in long hand) *failure to be at home at appointed hour.*'

"Broken-hearted and ashamed, the lady could hardly finish the letter, which ended up: 'We are sure that if you will judge this matter in the proper light you will see the justice of our position.'"

* * *

We have it on good authority that one of the boys (we cannot divulge his name) contrived a new form of high-voltage filter condenser under very odd circumstances.

Someone told him to mix raisins, sugar, yeast, etc. (complete formula not available) and let it stand, on its own character so to speak, until it indicated signs of life.

This he did and the results of his efforts were quite satisfactory—indeed, extraordinary—for in a few minutes after a sample of the brew he was compelled by a power stronger than his to turn three flips in mid-air.

During these fast-moving moments of hectic reverses he lapsed into a state of coma. He emerged from this distressing condition through channels of mental phantasmagoria which ended in a pronounced vision etched on a background of livid flame. . . .

The details of the vision have not been disclosed, but it has been reported that the new puncture-proof condensers will be ready in time for the fall trade.

* * *

A friend of ours went short on "Radio" common just two days before it started increasing in amplitude. He sunk $42,000 and at present is wandering aimlessly in the Jersey meadows.

If you will pardon us for saying it—this appears to be the only case on record where a low-powered "short" wave was socked for a loop by a "long" wave.

* * *

On the highest authority—the second assistant to the copy boy in the radio department of an eminent daily paper published not so many miles from the land of the baked bean, maple syrup, etc. —we have the latest television scoop.

This journal was sponsoring some television experiments and in a deserted house on the outskirts of the town were gathered a group of energetic engineers. Before an old moving-picture projector whirled a perforated disc. Before a bank of photoelectric cells and in the flickering light of the twittering arc stood a youth wildly *waving* a newspaper.

Nearby was a receiving outfit. Peering perserveringly at the plate of a nervous neon tube were another group of engineers. They communicated that there was less than minus zero coming across in the way of a picture. They admitted that they could see something resembling the ghost of night flash back and forth across the screen, but that was all.

The next day the eminent journal carried a story that in the experiments performed the *print on the paper could be read at the receiving end.*

This merely goes to show what can happen over night.

Incidently, if the eminent journal would be interested, we have down here a nice little device which pictures the working of the human mind. The device can be attached to any television machine or cub reporter. Fundamentally, it is much like the well-known—every well-known—psychopsyciatric X-ray.

* * *

Speaking of automatic radio receivers —we spit at our short-wave regenerator one evening which immediately shifted from KDKA to WGY.

We would be interested in hearing of similar reports from other liars.

Constructional Developments

National Screen Grid Short-Wave Receiver

By James Millen

THE National Screen Grid short-wave receiver comprises several rather unique features. One is the single tuning control. Another is the foundation unit design which permits an efficient layout of parts, with but a few connections to be made by the assembler. As a result of the 222 in the first stage, the sensitivity of the receiver in general is materially better than that of the plain regenerative detector type formerly so much in use. Furthermore, the use of the 222 ahead of the essential regenerative detector prevents radiation—a problem which would soon become quite serious if all the short wave receivers were of the radiating variety. Although heretofore rather carefully placed shielding has been considered essential to a receiver using the UX 222 tube, the advanced design of this receiver makes shielding unnecessary, resulting in ease of construction and operation. By means of a series of four readily interchangeable transformers the receiver will cover the band of the 100 to 15 meters (3 to 20 megacycles). A transformer for regular broadcast reception on the 200 to 600 meter band may also be obtained.

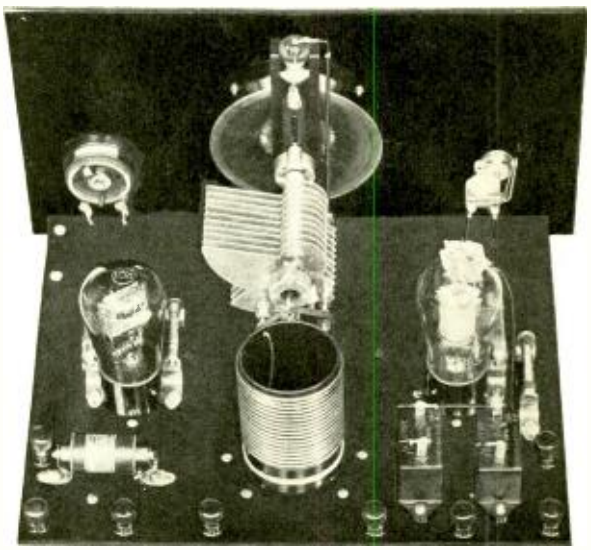
There are a very great many more stations to be heard with a short-wave receiver, and distance takes on an entirely new meaning. It is not uncommon to receive broadcasting from ANE, at Java, 3LO at Melbourne, Australia, 5SW at London, PCJJ in Holland, etc.; and static and fading are frequently entirely absent when reception on the regular broadcast band is exceedingly poor.

For instance, at Boston, Mass., it is seldom possible for the average broadcast listener to receive KDKA on its 360 meter wave with sufficient volume, freedom from fading, and freedom from static to permit enjoyable reception for an entire evening. With a good short-wave receiver, however, KDKA, on its 62.5 meter wave may nearly always be tuned in with good volume and with all the quality and freedom from disturbance of a good local.

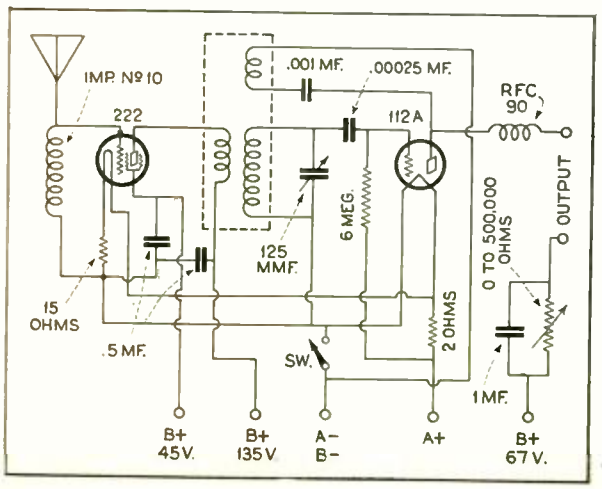
Aside from the reception of foreign broadcasting stations generally possible with a good short wave-receiver, reliable reception of such American short wave broadcasters as KDKA, WABC, WLW, and of long distance amateur, commercial, and naval code communication, there are, of late, also several stations sending out experimental "television signals."

One of the most important parts of a television reception system is a good short wave receiver for intercepting the signals. A special type of audio amplifier is then necessary to build up the signal to sufficient intensity and finally a means is required for converting the signal into an image. At present, many experimenters are employing a neon lamp and a revolving "scanning disc" for this latter purpose.

If the wiring diagram is carefully followed it is quite simple for anyone



Rear view of the National Screen-Grid Short-Wave Receiver. Note that it is virtually a single control set. Regeneration is controlled by the variable resistor mounted on the panel. The R. F. choke is mounted on the sub-base, directly in front of the 112-A tube. The inductance is of the plug-in type.



Circuit diagram of the National Screen-Grid Short-Wave Receiver. Grid bias for the 222 tube is obtained through the drop in voltage across the 15-ohm filament resistor. A transformer rather than an impedance is employed as a coupling medium between the 222 and 112-A tubes.

to obtain a very neat job. Needless to say, all connections should be carefully soldered. The two moulded mica condensers, located under the subpanel, are fastened in place by soldering their terminals directly to the socket and coil clips between which they are connected.

In order to make contact to the cap or control grid of the UX-222, use a short length of small, flexible, rubber-covered wire, or very fine single silk-covered wire, running in a piece of small spaghetti and ending in a fuse clip or similar home-made clip, to snap on at the top of the cap.

For headphone reception, it is recommended that a single stage of transformer coupled audio amplification be added to the output of the receiver as just described. While such an additional amplifier is not at all necessary, it will be found of considerable aid in receiving distant and weak signals.

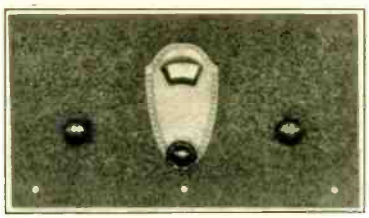
When loudspeaker operation from such short wave broadcasting stations as KDKA, WABC, etc., is desired, then the use is recommended of a high grade two stage transformer coupled audio amplifier of either the straight, or push-pull variety.

For experimental television work it is necessary to employ an especially designed amplifier of the resistance or impedance coupled type which will give a uniform response over the exceedingly wide audio frequency band of from about 20 to 30,000 cycles per second.

Operating Notes

At this time, there is no B battery substitute or eliminator suitable for use with a short-wave receiver. It is necessary for satisfactory results, therefore, to employ 135 volts of dry or storage "B" battery, in addition to the usual 6 volt storage "A" battery. If an audio amplifier of some sort is not to be employed, then a pair of "phones" should be connected to the "output" posts on the right-hand side of the sub panel.

A good ground should be connected to minus A.



Panel view of the National Screen-Grid Short-Wave Receiver.

For an antenna is recommended a single wire of from 35 to 100 feet in length and as high and free from surrounding objects as possible. Perhaps, until the operator has had a little experience in the operation of the receiver, it is well to practice by tuning in station KDKA on its 62.5 meter wave.

By means of the variable resistance regeneration control (right-hand knob) the detector tube may be made to oscillate, and then the carrier of the station received. A slight readjustment of both controls should then bring in the station.

LIST OF PARTS REQUIRED

1 National Foundation Unit. (Includes Westinghouse Micarta panels, sockets, gridleak and R. F. Choke Mounts, completely drilled, ready to assemble.)
1 National Dial, Type E, with Type 28 Illuminator.
1 National Condenser, Short Wave Type, 125 mmfd.
1 National Transformer Coil. (4 Coils are required to cover the range of 15 to 100 meters.)
1 National R. F. Choke No. 90.
1 National H. F. Impedance No. 10.
1 Aerovox Molded Mica Condenser .001 Mfd.
1 Aerovox Molded Mica Condenser .00025 Mfd.
2 Aerovox By-pass Condenser .5 Mfd.
1 Aerovox By-pass Condenser 1.0 Mfd.
1 Electrad Royalty Resistor No. L.
1 Lynch Equalizer No. 2.
1 Lynch Equalizer No. 15.
1 Lynch Gridleak—6 megohms.
1 Yaxley Filament Switch.
8 Eby Binding Posts.

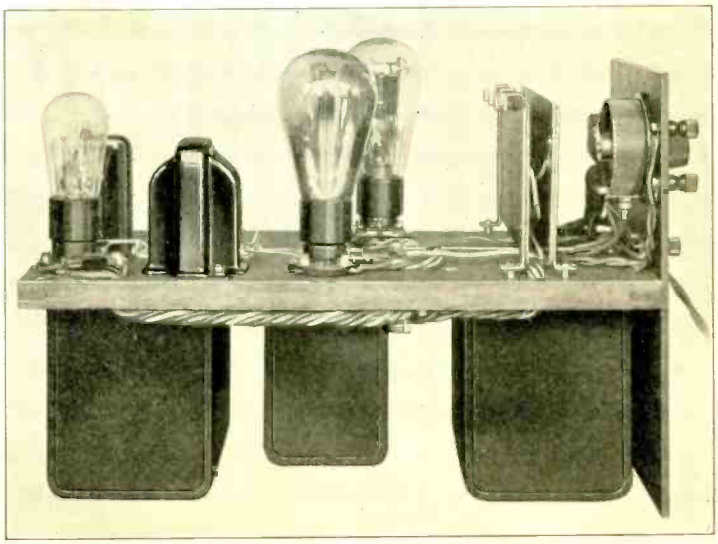
A Phonograph Amplifier

By A. R. Wilson

THE past year or two has seen remarkable strides being made in the design of audio amplifying equipment. Amplifiers and transformers have been developed to such a stage that it is difficult to see where an improvement in quality could be made. With the introduction of the new 250 power amplifier tube a far greater loud speaker volume is possible than heretofore since this tube is capable of delivering over three times the undistorted power of the 210 tube, long the favorite power tube for maximum volume and tone quality. These developments in the quality of radio transmission and reception have reacted on the phonograph industry and it became necessary for the designers of phonographs to look around for some means whereby their previously unchallenged supremacy could be regained. Thus came the electric phonograph known under various trade names as the Panatrope, the Electrola, etc. These machines all use as their basis the modern high-grade audio amplifier instead of the old-fashioned sound box and horn. The horn gave way to the cone type of reproducer and the sound box itself was replaced by the electro-magnetic pick-up.

This latter piece of apparatus, although the smallest in the make-up of the electrical phonograph, is probably the most interesting of all components. Its function is to translate into electrical energy the vibratory motion of a needle traveling over the surface of a phonograph record. The vibration of the needle is utilized to generate current in an electric circuit. These changes in current represent the vibrations of the needle which in turn represent the sound originally impressed on the phonograph record.

The action of the magnetic pick-up is a reversal of the action of a loud speaker. The selection of a good magnetic pick-up does not solve the



Side view of the Phonograph Amplifier which employs a 250-type power-tube and is A. C. operated.

problem of good reproduction because the audio frequency amplifier must be carefully built and use must be made of both a power tube and a speaker of good design. There are now on the market several types of very good magnetic pick-ups and it is the purpose of this article to describe an amplifier that was primarily designed for use with them.

In designing any audio amplifier, size, cost, etc., play a most important part in the final layout. The instrument desired in this case was a complete audio frequency amplifier capable of being used after the output of a standard magnetic pick-up and providing the speaker with a large degree of volume together with excellent tone quality and at the same time be combined with a plate supply, so that the complete unit might be operated from the standard 110 volt A.C. line. The final design of this amplifier involved a complete two-stage transformer coupled amplifier utilizing one 227 tube in the input stage and the new 250 power amplifier tube in the output stage.

The plate supply system consists of a half-wave rectifier, filter, and potentiometer device so designed as to furnish plate voltage for the 250 tube, together with lower plate voltages for the 227 tube, and, if so desired, plate potentials of 45 and 90 volts for the tubes of a receiver. In order to reduce size, the rectifying transformer and filter are made to serve as feet for the baseboard. This construction is fully illustrated in Fig 2. By this means the amplifier and the plate supply unit are kept more or less separate. The speaker filter together with the four 1 mfd. by-pass condensers are also placed underneath the baseboard. In the plate supply unit one 281 rectifier tube is used. The plate of this tube is connected to one side of the high-voltage secondary of the power transformer. The filament of the rectifier tube, as well as the filament of the 250 tube and the heater of the 227 tube, are all lighted by means of separate low voltage secondaries of the power transformer. The filter unit is a complete rectifier filter in itself and consists of suitable chokes and condensers. The 1500 ohm section of one of the voltage dividers is used as the resistance to obtain the bias voltage for the 250 tube. The 2500 ohm rheostat is used as the biasing resister for the 227 tube. All leads carrying alternating current should be twisted in order to reduce hum and kept as far away as possible from the audio transformers. Both the placement of parts and the actual wiring are clearly shown in the illustrations.

It is best in any amplifier to operate the first-stage tube with the lowest grid bias voltage that is permissible without distortion. The lower the bias voltage of any amplifier tube, assuming of course the same plate voltage, the lower the plate resistance. This means that there will be a greater

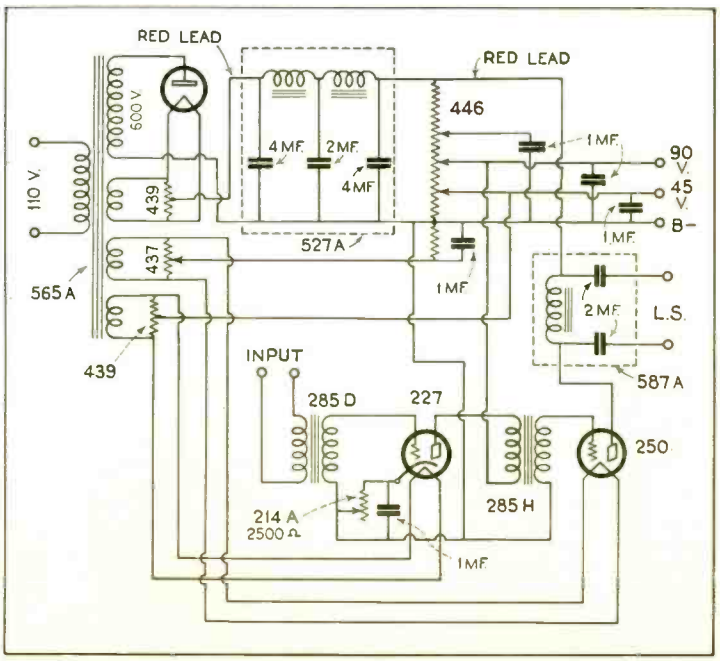
Front panel view of the Phonograph Amplifier. The knob controls the variable "C" bias resistor for the 227 tube.

transfer of voltages, particularly at the low frequencies. The bias voltages of both tubes should be adjusted with a high-resistance voltmeter connected directly across the biasing resistors. The correct voltage for the 250 tube is approximately 80 volts while that of the 227 tube is about 4 volts with a plate voltage of 90. Without a proper bias the best audio transformers are no better than the worst. With the right amount of grid bias, the grid is so negative to start with that the positive half of the wave never makes it positive: no grid current ever flows and both halves of the wave are amplified equally.

Several variations of this amplifier suggest themselves. For instance, it might be advisable in some cases to employ full-wave rectification, especially if this amplifier is used with a receiver that requires considerable plate current. The change from half- to full-wave rectification involves only a change in transformers and the addition of one socket. At the same time it will be necessary to utilize another low voltage transformer for the heater of the 227 tube. Adequate space has been left on the top of the base-board for additional equipment.

LISTS OF PARTS REQUIRED

1 General Radio type 565A Transformer
1 General Radio type 527A Filter
1 General Radio type 587A Speaker Filter
1 General Radio type 285 D Transformer
1 General Radio type 285H Transformer
2 General Radio type 439 Center tap resistances
1 General Radio type 438 Socket
2 General Radio type 446 Voltage Dividers
1 General Radio type 214A 2500 ohm Resistor
2 General Radio type 349 Sockets
1 General Radio type 437 Adjustable Center Tap Resistance
1 UX 250 or CX 350 tube
1 UX 281 or CX 381 tube
1 UY 227 or C 327 tube
1 Baseboard 8 x 16 x ¾"
1 Piece bakelite 8 x 11¼ x 3/16"
7 Binding Posts
1 Toggle Switch
4 1 mf Condensers
1 Cord and Plug



Schematic diagram of the Phonograph Amplifier. A single stage of transformer coupled amplification precedes the 250-power tube, which is sufficient for most purposes.

NEWS OF THE INDUSTRY

FANSTEEL APPOINTS NEW SALES REPRESENTATIVE

The Fansteel Products Co. announces that effective May 1st the Pittsburgh territory, which comprises all of Western Pennsylvania and West Virginia, and which has, for the past three years, been under the supervision of Mr. Wm. R. McElroy, as sales representative, will hereafter be in charge of Mr. Chas. F. Saenger.

Mr. Chas. F. Saenger has been connected with the Fansteel Products Company for the past five years as Ohio representative. Mr. Saenger is one of the oldest Balkite representatives and has spent many years prior to that time representing other interests in Western Pennsylvania and Ohio.

Mr. Saenger has not as yet established an office and address in Pittsburgh but maintains offices in Cleveland, Ohio, at 1109 Bolivar Road, and all correspondence in connection with sales may be forwarded to him at this address until further notice.

DUBILIER SALES AND ADVERTISING DEPARTMENTS MOVE INTO NEW YORK CITY

In order to maintain closer contact with the radio and electrical trades which it serves, the Dubilier Condenser Corporation has established an office at 10 East 43rd Street, New York City, for its sales and advertising departments. Heretofore, these departments have been included in the general office located on the ground floor of the Dubilier factory at Woodlawn or the northern end of the city.

At the New York City office will be found W. H. Lipscomb, the recently elected President of the Dubilier Condenser Corporation, G. E. Palmer, General Sales Manager, J. A. Fried, Industrial Sales Manager, and J. George Uzmann, Advertising Manager.

The factory, located in the company's own building amid the ideal surroundings of Woodlawn, will continue at the 4377 Bronx Boulevard address as heretofore.

R. C. A. MAKES CHANGES IN SALES DIVISION

Effective immediately Mr. J. L. Ray, General Sales Manager of the Radio Corporation of America, announces the following changes in the General Sales and District Offices of the RCA.

Mr. Quinton Adams, formerly manager Radiola Division, becomes manager of a new major sales division to be known as the Engineering Products Division, which will handle the sale of broadcasting stations, the sale of special apparatus and various sales contracts of the Radio Corporation.

Mr. E. A. Nicholas, formerly district sales manager at New York, becomes manager Radiola Division.

Mr. A. R. Beyer, formerly assistant district sales manager, Chicago, becomes district sales manager at New York.

Mr. D. A. Lewis becomes assistant district sales manager at Chicago.

ZENITH APPOINTS TWO NEW DISTRIBUTORS

The Zenith Radio Corporation announces the addition of two new distributors in the middle western territory. The W. M. Dutton & Sons Company, with main office located in Hastings, Nebraska, and Lindeman-Hoffer, Inc., with home office situated in the Davidson Bldg., Kansas City, Missouri.

The territory of W. M. Dutton & Sons Company will include the entire state of Nebraska, 17 counties in western Iowa, 13 counties in northern Kansas, and 3 counties in the northwest part of Missouri.

W. M. Dutton & Sons Company have opened a branch in Omaha and from there will handle the distribution of Zenith radio for Lincoln, Omaha, and Council Bluffs territory.

LESLIE G. THOMAS, NEW POLYMET FACTORY MANAGER

The Polymet Manufacturing Corporation, manufacturers of the Polymet line of power supply essentials, announces the appointment of Mr. Leslie G. Thomas as Factory Manager.

Mr. Thomas comes to Polymet with a broad experience gleaned from years in the electrical field and allied pursuits.

Receiving his engineering training at the Dickinson Technical School, Mr. Thomas started at once on his electrical career, being associated with such concerns as the Electro Importing Company, pioneers in the making of radio equipment, the Electro Dental Company of Philadelphia, and the Bromley-Merseles Company, manufacturers of electric dish-washing machines.

In 1917 he joined the staff of General Electric as Statistician and Assistant to the Head of the Piece Rate Department. Three years with General Electric during which time he worked on electrical equipment for airplanes in war service, he left to become Assistant Superintendent in charge of production for the Diamond Battery Company which position he held for three years.

About this time the lure of radio called Mr. Thomas. He left Diamond to become Factory Manager for the F. A. D. Andrea Company, makers of Fada products. Mr. Thomas left three years later to join the Freed-Eiseman Corporation.

From this concern, Mr. Thomas has now come with a record of consistent success behind him, to the Polymet Manufacturing Corporation, where he will assume complete charge of production and factory management. The background of his broad experience should prove invaluable in governing Polymet production with a view to speed and ever-improved quality.

FIVE MEN ADDED TO JENSEN SALES FORCE

Five apointments to the sales force of the Jensen Radio Manufacturing Company, Chicago, Ill., and Oakland, Calif., have been made by Thomas A. White, general sales manager. Four of the men have been assigned definite territory and will devote the greater part of their time to the jobbing trade while the fifth will call on manufacturers.

J. W. Sands, with headquarters at Dayton, Ohio, will contact the wholesale trade in Ohio, Michigan, Indiana, Kentucky and West Virginia. Mr. Sands was with the Magnavox Company at the same time Mr. White was with that organization. Prior to this recent appointment, he was with the sales department of the Splitdorf company.

The metropolitan New York city territory, in addition to the states of Pennsylvania, Delaware, New Jersey, Maryland and Washington, D. C., has been assigned to James A. Kennedy who will make his headquarters in New York. Mr. Kennedy resigned a short time ago from Arthur H. Lynch, Inc., to join the Jensen sales organization.

L. R. Hadin, prior to his appointment, was associated with Jack D. Underhill, manufacturer's agent for the Fansteel company. Mr. Hadin, with headquarters at Schenectady, will travel extensively in New York state and the New England states.

In the Northwest territory consisting of Wisconsin, Minnesota, Iowa, Nebraska, North and South Dakota, W. V. Crowley will be the Jensen sales representative. Mr. Crowley will make his headquarters at Chicago where he was formerly with Charles H. Freshman, Inc.

C. F. Crane, who up to the time he joined the Jensen organization, was assistant sales manager of the Briggs & Stratton Co., Milwaukee, will call on manufacturers. Mr. Crane will also travel out of the Chicago office.

NATIONAL CARBON INTRODUCES EVEREADY SETS

The National Carbon Company, Inc., has decided to enter the radio receiving set field. Both A.C. batteryless receiving sets and battery-operated receiving sets will be marketed by this company, under the trade name of Eveready receiving sets. The decision to produce the sets which will be marketed, has been arrived at as a result of considerable research and experimentation.

NEW COMPANY TO MANUFACTURE CERAMIC PRODUCTS

Henry L. Crowley, for many years President of the Isolantite Company of America, has sold his interest and resigned in order to form Henry L. Crowley & Company, Inc., with factory and main offices at 545 North Arlington Avenue, East Orange, N. J. For several years past Mr. Crowley has been creating new materials to fit specific needs. He has recognized the exceptional need for the application of modern American research and scientific production methods to the ceramic industry, in order to meet the requirements of the radio and electrical fields.

The new organization has assembled a skilled personnel as well as the necessary equipment to carry out out this plan of producing an extensive line of ceramic products under the general name of Crolite. Instead of producing a single material after an unalterable formula but subject to the variation of natural raw materials, Crolite is made from synthetic materials after one of several formulae, each intended to bring out some predominant characteristic or combination of characteristics, such as porosity, extreme electrical strength, heat shock resistivity, resistance to extreme temperatures, chemical immunity, a given coefficient of expansion, and so on in meeting specific needs. Crolite may be fabricated in rods, bars, slabs and other shapes, ranging from twin-hole tubing for A C heater tubes, to large tubes for resistance supports.

Mr. Crowley is in direct charge of sales, which will be based on technical developments and sound engineering co-operation, as well as the general administration of the organization. H. C. Holmes and Robert Crowley, long experienced in ceramic production, will be in charge of production and engineering.

BRACH CO. OBTAINS CORD CONNECTOR PATENT

The L. S. Brach Manufacturing Corporation have obtained patent number 1,669,038 on Cord Connectors which covers all types of Cord Connectors using the two flat moulded sides in combination with double ended contact springs. This is the popular type of Cord Connector now being used. The L. S. Brach Manufacturing Corporation are arranging for a limited number of licenses to be issued to interested companies.

Phone Plug patents employing the automatic grip features have been allowed to the Seaboard Engineering Company on patents No. 1,669,013 and No. 1,669,042. The Seaboard Engineering Company have obtained these patents by assignment from Cromartie, Nielson, Nowosielski and the Splitdorf Company. The Seaboard Engineering Company have issued a non-exclusive license to the L. S. Brach Manufacturing Corporation and are preparing to license others through their attorney, Mr. A. D. T. Libby of 392 High Street, Newark, N. J.

SAAL COMPANY CHANGES NAME

To indicate the present executive direction which has for some time past headed the affairs of the Saal Company, an interesting change of name has just been announced; the concern becomes the L. S. Gordon Company.

LEKTOPHONE CORPORATION EXTENDS POLICY OF LICENSING MANUFACTURERS

In accordance with a program recently adopted by the Lektophone Corporation, who own and control the basic patents and improvements on controlled-edge radio cone speakers, the company has extended its original policy of licensing and will make Lektophone patents available to all major radio manufacturers in the United States who can qualify to the company's standards, it was recently announced.

The Victor Talking Machine Co., Brunswick-Balke Collender Co., and Columbia Phonograph Co., use speakers licensed under Lektophone patents covering the employment of the Hopkins and Lektophone principles at the present time, and the following manufacturers have been licensed to build radio speakers and speaker chasses employing Lektophone patents: American Bosch Magneto Corp.; Amplion Corp. of America: Brandes Products Corp.; Farrand Manufacturing Co.: Marcus C. Hopkins: O'Neil Radio Corp.; Pathe Phonograph & Radio Corp.; Radio Corp. of America: Radio Foundation, Inc.: Stromberg-Carlson Telephone Manufacturing Co.: J. S. Timmons, Inc.: United Radio Corp., and Utah Radio Products Co.

GREBE ANNOUNCES APPOINTMENT OF DISTRIBUTOR

A. H. Grebe and Company, Incorporated, announce the appointment of A. K. Sutton, Incorporated, of No. 33 West First Street, Charlotte, North Carolina, as a distributor for the Grebe line of radio products.

R. A. Lewis has been appointed manager of the Cleveland Branch of the Detroit Electric Company, exclusive distributors of the products of A. H. Grebe and Company, Inc.

The Cleveland branch was established last year to take care of Grebe trade in this territory.

Lewis has served in technical and sales capacities with the Detroit Grebe distributor for a number of years.

CELORON CO. APPOINTS NEW FACTORY REPRESENTATIVE

The Celoron Company (Division of the Diamond State Fibre Company), Bridgeport, Pa., in conjunction with the opening of its new laboratory, and the introduction to the electrical, radio and automotive fields of Celoron molding compounds, announces the appointment of Mr. R. W. Wales as factory representative on molding powders and resins.

Mr. R. W. Wales enjoys a background of many years of experience in the developing and manufacture of molding compounds, having been connected with one of the largest manufacturers of this material for fifteen years.

LANDIS COMPANY TO HANDLE CARRYOLA ADVERTISING

Mr. O. L. Prime, President of Carryola Company of America has just announced the appointment of Reed G. Landis Company of Chicago to handle the advertising for Carryola Phonograph, Electric "Pick-ups" and the rest of the Carryola products.

This announcement, following so closely on the selection of Mr. Ray Reilly as Sales Manager, promises a forceful effective advertising and sales program for Carryola. That program will be the most extensive ever put behind the sale of so-called "portable" phonographs. It will not only cover the United States completely, but will extend into the world's export markets, where Carryola already enjoys a strong sale.

Major Reed G. Landis, the owner of the advertising company bearing his name, is not a stranger to the phonograph business. He was Advertising Manager of "Brunswick" when he entered the World War in which he shot down thirteen enemy aircrafts as a pursuit aviator, and rose from the rank of private to Major, commanding one of the crack American squadrons.

In addition to the Carryola business, the Reed G. Landis Company handles advertising for over thirty important concerns, among which are The Chicago and North Western Railway, Automotive Equipment Association, National Air Transport, Inc., and Campbell-Smith Ritchie Company, builders of the famous "Boone" Kitchen Cabinets.

THOMAS G. NEE MADE PRESIDENT OF THE ACME WIRE CO.

Mr. Nee is an engineering graduate of the University of Wisconsin, class of 1900. From 1905 to 1917 he was connected with the Mexican Telephone and Telegraph Company as Vice-President and Chief Engineer in full charge of all of the company's operations in Mexico. From 1917 to 1927 he was connected with the Allied Machinery Company of New York, which was owned by the American International Corporation of that city, as President of its most important subsidiary—The Horne

Thomas G. Nee
President, Acme Wire Co.

Company, Limited, in Japan. He made a notable success of this company, particularly during the trying years following the war.

Mr. Nee has had a long business training in lines that make him very familiar with the products of The Acme Wire Co. His long connection with the telephone and telegraph business familiarized him with coils, wire of all kinds, condensers and other electrical wire products. That he stepped from the position of chief engineer to executive leadership in both of the companies with which he has been connected, is a compliment to his business sagacity and to his practical engineering training.

BRYANT ELECTRIC COMPANY ACQUIRES HEMCO PLANT

Arrangements to purchase the Hemco plant, trade-marks, patents and processes by the Bryant Electric Company of Bridgeport, Conn., is a transaction, the news of which will be received with great interest by the electrical industry.

The Bryant Electric Company has been making wiring devices for forty years. It is the oldest and largest company of its kind in the world.

The line of Bryant material has grown from eight or ten devices made in 1888 to over 4,000 different devices in 1928, and the plant of the Bryant Company is one of the show places and landmarks of the city of Bridgeport, occupying over five acres of ground, with half a million square feet of floor space and employing upwards of 1,500 hands.

The Bryant line consists of metal shell and porcelain lamp receptacles and sockets and their accessories; and surface and flush switches; fuses and fuse holders; baseboard receptacles and plugs; rosettes; cord connectors; hospital signal equipment, etc.

The Hemco Electric Manufacturing Company has been in business as makers of moulded sockets, moulded plates and other composition parts for electrical purposes for many years. They are the originators of Phenolic moulded wiring devices. Their line is well and favorably known throughout the industry. It includes plural sockets, composition plates of a very attractive design, and miscellaneous moulded devices for electrical purposes.

It is the plan of the Bryant Company to expand this line and develop many new composition devices, and it will maintain its present policy of distributing all of this material through jobbers.

Stocks of Hemco material will be added to the Bryant stocks at Bridgeport, Chicago and San Francisco.

GENERAL RADIO CO. ISSUES CONDENSER LICENSES

The following companies have been issued licenses by the General Radio Company under all or part of the features covered by U. S. Patent No. 1,542,995, pertaining to methods of variable air condenser construction.

American Bosch Magneto Corporation
Amrad Corporation
Brandes Products Corporation
Samson Electric Company
Scovill Manufacturing Company
Silver-Marshall Company, Inc.
Stromberg-Carlson Telephone Mfg. Company

The Scovill Manufacturing Company of Waterbury, Connecticut, have issued to the General Radio Company a license under U. S. Patent No. 1,258,423. This patent was issued on March 5, 1918, to Fritz Lowenstein and covers the shaping of variable air condenser plates so as to give predetermined frequency variation, as opposed to uniform capacity variations such as would be obtained with semi-circular plates.

SILVER-MARSHALL APPOINTS NEW ADVERTISING MANAGER

A newcomer to the field of Radio is H. L. Williams who has recently assumed the duties of Advertising Manager of Silver-Marshall, Inc., Chicago parts manufacturers. Mr. Williams, however, brings to his new connection a wealth of advertising and promotional experience gleaned in the automobile field. As an engineer-writer of international experience he has occupied the editorial chair of some of the more prominent motor journals, in England and United States. He forsook that field only to organize and conduct the sales promotion department of Bendix Brake Company in putting over the Bendix airplane brakes and wheels. Since that time he has built up an enviable record in the service of the Diamond T Motor Car Company in establishing and putting on a profitmaking basis the service department of that large factory's many branches. Those who know Mr. Williams and Silver-Marshall predict that the hair will fly in the parts and kits field this fall.

HERMAN A. SMITH JOINS PEERLESS

The United Radio Corporation of Rochester, New York, manufacturers of the Peerless Reproducer, announces that Mr. Herman A. Smith, formerly Sales Manager of the Argus Radio Corporation, has just been appointed Eastern Sales Manager.

Mr. Smith is well known in Radio Trade circles. He was for three years in charge of Eastern sales for the Workrite Manufacturing Company and the Music Master Corporation, later becoming Southern Sales Manager for the latter concern.

In his new connection, Mr. Smith will have charge of the Atlantic Coast District south of New York, with headquarters at Baltimore. He takes up his new duties immediately.

KELLOGG COMPANY INCREASES SALES FORCE

The Kellogg Switchboard and Supply Company of Chicago, manufacturers of Kellogg A-C radio sets and A-C tubes has appointed Mr. W. E. Conners to represent them in their Northern Illinois and Indiana territory. Mr. Conners has had several years sales experience in the Middle West.

Another addition to the Kellogg force is Mr. B. H. Darst. He will represent his firm in Ohio and in parts of Pennsylvania, West Virginia, Kentucky, Indiana and Michigan. Mr. Darst has spent several years in specialty sales work with distributors and dealers. He has successfully filled the position of Crew Manager, handling sectional sales for a well known household article. Also he has marketed specialty products for a large department store.

Mr. C. W. Hunter has been appointed to represent the radio division of his firm in the states of California, Oregon, and Washington.

Mr. Hunter has made an excellent record in his former territory which consisted of Ohio, Michigan, and parts of Pennsylvania, West Virginia, Kentucky and Indiana, having established some excellent distributing agencies for Kellogg during the past several months.

For several years prior to his affiliation

with the Kellogg Company. Mr. Hunter acted as General Sales and Production Manager for the Malleable Steel Range Company of South Bend, Indiana, also, at one time he was in charge of sales for the Enameling Division of the Benjamin electric Company, of Chicago.

Mr. Hunter's California headquarters will be at offices of the Kellogg branch at 1054 Mission Street, San Francisco.

R. B. Nall, former Sales Manager of the Davidson Talking Machine Shop of Chicago has been selected to represent the Kellogg Radio Division of the Kellogg Switchboard & Supply Company of Chicago. His territory will include Northern Illinois and Indiana, exclusive of Chicago.

The retail experience gained in radio by Mr. Nall will make him especially valuable to the Kellogg Company.

Mr. J. E. Loeber has been appointed to represent the radio division of the Kellogg Switchboard & Supply Company on the great South Side of Chicago.

Since August, 1926, he has been Sales representative of the entire city territory for the All-American Radio Corporation. Previous to this he was connected with the Howard Radio Company in Chicago.

For seven years previous to his affiliation with the radio industry, Mr. Loeber served in the Advertising Department of the Herald-Examiner of Chicago.

F. D. WILLIAMS NEW RAYTHEON OFFICER

The Raytheon Manufacturing Company of Cambridge, Mass., recently announced the election of Mr. Fred D. Williams as vice-president of the company. For the past year he has been president of the Dubilier Condenser Corp. of New York and formerly he was director of sales for Grigsby-Grunow Hinds Co., of Chicago.

W. H. LIPSCOMBE HEADS DUBILIER

The Dubilier Condenser Corp. of New York City announced the election of William H. Lipscombe as president of the company to fill the office left vacant by the resignation of Mr. Williams. Mr. Lipscombe was previously connected with the Habirshaw Wire and Cable Co. and the U. S. Steel Products Co.

STEVENS & CO. MERGER BRINGS PLANS FOR EXPANSION

Stevens & Company, pioneers in the cone speaker field, have merged with Adams Sibley Development Corporation and is now called the "Stevens Manufacturing Corporation." The officers of the newly formed corporation are: Mr. Leslie Stevens, president; Mr. James T. Sibley, vice-president; Mr. Clifford E. Stevens, treasurer; Mr. Philip C. Adams, secretary; and Mr. J. B. Price sales and advertising manager is chairman of the board of directors, as in Stevens & Company, Inc.

Mr. James T. Sibley has had many years' experience in manufacturing phonographs and is a recognized expert in this field.

Stevens & Company, Inc., as well as Adams Sibley Development Corporation, are owners of very valuable patents on acoustic devices covering both radio loud speakers and phonographs. They have also developed an electric motor, which on account of its unique principle and size, will be used for portable phonographs as well as large phonographs and on this new item alone the new company has already large contract orders on which production will begin shortly. The Stevens Manufacturing Corporation is also bringing out an electro-magnetic pick-up as well as a capacity pick-up.

There are many other items in the development stage, applicable to the phonograph and radio which will be announced later. Plans are already under way for further developing the well-known and established loud speaker line of Stevens & Company, Inc. They have already presented four new speakers for 1928–1929 line, which have the double action principle, as well as a two-point suspension unit, specially designated to handle power amplification of the new powerful A.C. sets.

Two of these speakers are cabinet models—one a modernistic design, the other a Gothic model. The other two are dull bronze cones, with the "Golden Edge Chime," mounted on brown mahogany sounding boards.

TOBE'S NEW YORK OFFICE CHANGED

The New York office of the Tobe Deutschmann Co., formerly located at 126 Liberty St., has been moved to 117 Liberty St. The office is now in charge of Mr. A. J. Lyons who replaces Mr. Smally as New York representative.

OPERADIO MOVES TO LARGER QUARTERS

The need of additional space for manufacturing purposes has necessitated the removal of the Operadio Manufacturing Company to larger quarters at St. Charles, Illinois, forty miles out of Chicago. Although an addition was built on to the former factory last year, this was found to be inadequate to meet the increasing demands for Operadio products.

The new plant has been laid out to meet the specific requirements of the Company in the manufacture of its amplifiers and loud speakers, and was taken over on May 20th with no interruption in the output of Operadio bloc type speakers and power amplifiers.

The executive and sales office have also been moved to St. Charles, but a Sales and Service office has been maintained at 8 South Dearborn Street, Chicago.

The Zinke Company, 1323 South Michigan Avenue, Chicago, continues as sales representative for Operadio Speakers throughout the United States.

CHAMBERS AND HALLIGAN OPEN CHICAGO OFFICE

L. A. Chambers and W. J. Halligan, manufacturers' agents, have announced the opening of offices at 549 W. Washington Boulevard, Chicago, Ill., representing Silver-Marshall, Inc., and Potter Manufacturing Co. Mr. Halligan has until recently been identified with Tobe Deutschmann Co. of Cambridge, Mass., as Vice-President and Sales Manager.
vertising.

CHICAGO TRANSFORMER CORP.

The Chicago Transformer Corp., with offices at 4541 Ravenswood Ave., Chicago, Ill., has been formed for the purpose of manufacturing all types of transformers for the radio field. The officers are: W. J. Leidy, president; Earle Knight, vice-president; Arni Helfason, secretary; and G. R. Blackburn, treasurer.

The Chicago Transformer Corp. is incorporated for $50,000.

ACME ELECTRIC INSTALL NEW AUTOMATIC MACHINERY

The Acme Electric and Mfg. Company with general offices at 1444 Hamilton Ave., Cleveland, Ohio., are now making preparations to install many new production devices and automatic labor saving machinery to take care of the increased demand that is to exist for their new and attractive line of radio items that they are to manufacture and market this coming season.

BUCKINGHAM MOVING INTO LARGER QUARTERS

The Buckingham Radio Corporation, well known Chicago manufacturers of radio sets, is moving its offices and factory from 25 East Austin Avenue to 440 West Superior Street.

The new factory location will increase past production facilities five times.

Extensive installation of special machinery and equipment for the manufacture and finishing of all component parts and materials used in the Buckingham radio receivers is being rushed to completion.

Anticipation of a big demand for Buckingham products has necessitated not only a general expansion of manufacturing programs and equipment but extensive additions to personnel as well.

Paul McK. Deeley, for a number of years Chief Engineer of the Electrical Research Laboratories, has joined the Buckingham organization in the capacity of assistant to the president, and in charge of sales. Mr. McK. Deeley has been actively connected with the radio industry since about 1915 and brings to the Buckingham organization a world wide fund of experience in radio engineering, factory production and management, sales and ad-

SPLITDORF TAKES LARGER QUARTERS IN CANADA

The visit of Mr. G. Ryan, manager of the Splitdorf Branch in Toronto, Canada, to the headquarters of the Splitdorf Electrical Company in Newark, N. J., was made the occasion for the announcement that the manufacturing and assembly departments of the Splitdorf Electrical Company, Ltd., are now located in larger quarters in the Canadian city.

The Canadian branch now occupies, Mr. Ryan announced, the entire building at 44 Carlton Street, Toronto, where attention is devoted to both automotive and radio products. The Canadian company is making arrangements now to take care of large production both of radio receiving sets and of the automotive products of the Splitdorf company.

Mr. Ryan expressed the opinion while here that contemplated action as to government control of radio broadcasting in Canada would materially benefit the whole radio situation there. He looks forward to a banner year in radio business.

DETROIT RADIO SHOW

The 1928 Detroit Radio Show is rounding into shape with many reservations already in. The date has been set as October 15th to 20th inclusive and the place, Convention Hall, Detroit, Michigan.

This great merchandising event and largest of the consumer radio shows will appear this year in a new dress. Every one of the larger exhibitors will enjoy the use of a 24 x 24 ft. stage setting showing the various uses of radio and in various situations. Each of these beautiful stage settings will be different from the others, furniture equipped, lighted and spot lighted and decorated completely, including janitor service, all in the one moderate price. This is, as far as known, the most ambitious program for a unified display ever undertaken at a radio show. No individual decorations will be permitted along the thousand feet of these staged displays which are pointed for selling radio itself to the public.

The sixty or more smaller exhibits will have the use of metal frame booths of an entirely new type and may decorate in their own way.

The program will include a display of Television and radio electric stunts as well as broadcast headliners and the customary musical events.

Each of the larger exhibitors will have an official hostess in charge of their booth and a popularity contest will be conducted among them. The usual attendance prizes will be given and much excitement and interest is promised for the entire week of the show.

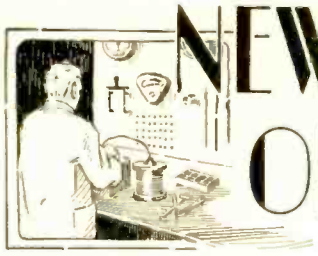
The Detroit Radio Show given each year by the Radio Trade Association of Michigan will be given this year as a strictly co-operative and profit-sharing venture among the exhibitors. The Show Committee in charge this year consists of Corley W. Kirby, of WGHP, Chairman, assisted by H. M. Grier of The Grier Sutherland Co., President of the Association; H. J. Van Raalen of Van's Auto Accessories; Warren F. Brennan of the Stewart Co.; D. W. Burke of the Radio Distributing Co.; Barney McEachen of the Aitken Radio Corp.; E. L. Tyson of the Detroit News; L. C. Knopp of Cunnings Bros.; H. E. Haggerty, Mfgs. Agent; Leslie A. Peck of the Northwestern Tire and Battery Co., and A. M. Edwards.

The show will again be under the management of A. M. Edwards, who has conducted this event for the past five years.

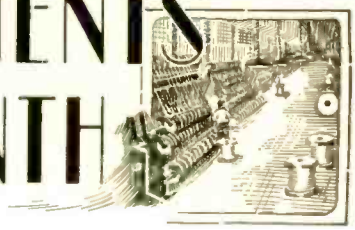
The Dealers Day Banquet held in connection with the Detroit Radio Show will be held on Tuesday evening, October 16th, but no public announcement will be made of the exact time or place. This is held as a pale dry secret.

PEERLESS NEW PRODUCER GOES TO NEW HOME

The United Radio Corporation, manufacturers of Radio Speakers, have outgrown their old quarters at Clarissa Avenue, although from a starting point of one-half a floor two years ago they now occupy three. On May 15, they moved to their new factory at Leighton, Atlantic and Crouth Avenues, Rochester, New York. The factory is a modern, fireproof brick building of single story, daylight construction. It has 800 feet frontage on Leighton Avenue and 53,000 square feet of space. Here the Peerless Gothic Cone Speaker and the new Peerless Dynamic will be manufactured.



NEW DEVELOPMENTS OF THE MONTH

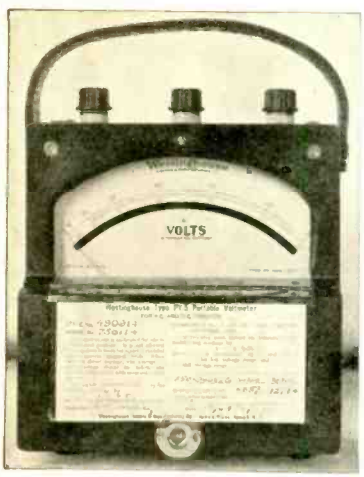


NEW WESTINGHOUSE PORTABLE ALTERNATING CURRENT INSTRUMENTS

The Westinghouse Electric & Manufacturing Company announces a new line of portable alternating current instruments designated as type PY5. They are of the direct-reading type and are applicable for general testing and laboratory work where high accuracy is required.

The voltmeters and single-phase wattmeters are of the electrodynometer type. The ammeters are of the moving iron type using vanes of non-residual metal. All instruments are shielded and are damped by an improved design of air damper making possible accurate measurements on fluctuating loads.

The ammeters have a double range which can be changed while the meter is in use by a series-parallel switch mounted in the case. The movements are mechanically strong and will successfully stand high momentary overloads. They may be used on circuits up to 500 cycles and also on direct current with but slight reduction in accuracy.



Westinghouse Type PY5 Portable Voltmeter.

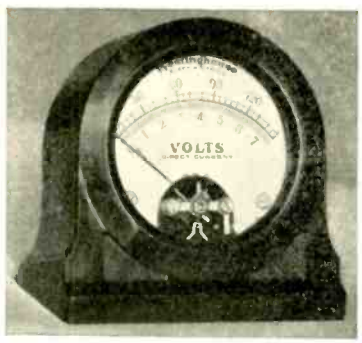
The voltmeters have an accuracy of ¼ per cent and can be used without appreciable error on direct current and on alternating current up to 133 cycles. They are provided with a push-button for closing the circuit. This can be locked in the closed position when using the instrument for continuous service.

The single-phase wattmeters have an accuracy of ¼ per cent and may be used on circuits up to 400 cycles without requiring correction for phase displacement. The current circuits are double range with series-parallel arrangement of coils, and are controlled by a switch inside the instrument operated by a knob in a recess in the case. Voltage ranges are changed by changing the terminal connections. The voltage circuit contains a push-button switch which may be locked in the closed position.

NEW WESTINGHOUSE PORTABLE DIRECT CURRENT INSTRUMENTS

A new line of portable direct-current instruments has recently been developed by the Westinghouse Electric and Manufacturing Company. These instruments, known as type PX2, are compact, accurate, and are particularly suitable for automobile, battery, radio, and miscellaneous testing.

They are of the permanent magnet moving-coil type and operate on the D'Arsonval principle. The moving coil rests on



Westinghouse PX2 Voltmeter

hardened steel pivots moving in sapphire jewel bearings. The mechanism is mounted on a molded micarta base and has a case of the same material. A mirrored dial and a knife edge pointer facilitate accurate reading.

This line of instruments includes multivoltmeters, double-range voltmeters, milliammeters, ammeters, radio frequency ammeters, and galvanometers.

DRESNER SHORT WAVE COILS

The Dresner Radio Mfg. Corp., of 564 Southern Boulevard, Bronx, N. Y., have shown considerable originality in the design of their new kit of four plug-in short wave coils just introduced to the trade.

It will be observed from the accompanying illustration that the coil forms, molded from genuine bakelite, are much like extended vacuum tube bases. The four prongs, two of which are wide and two narrow, permitting them to fit a standard UX type tube socket, extend through the base of the coil form at which point connections are made to the primary and secondary windings.

Following accepted practice, both the primary and secondary coils are space-wound, this being effectively accomplished by threading the bakelite forms. The secondary coils are wound on the lower section of the forms.

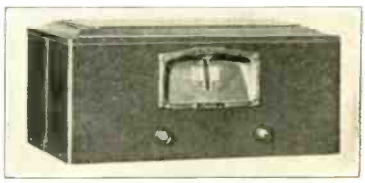
With the complete set of four coils, in conjunction with a .00015 mfd. variable condenser, it is possible to effectively cover a range of 16 to 210 meters.

A novel feature is incorporated—each coil form is a different color of bakelite. The black coil covers the range from 16 to 32 meters; brown coil, 29 to 58 meters; blue coil, 54 to 110 meters and the red coil, 103 to 210 meters.

The Dresner coils are particularly adaptable to universal short wave receiver circuits and short wave converters.

FANSTEEL ANNOUNCES THE NEW BALKITE RECEIVERS

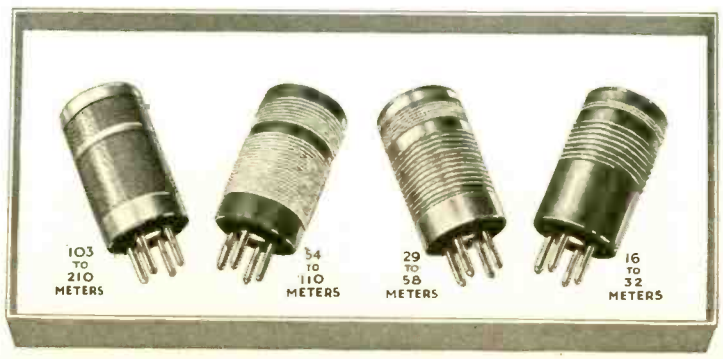
The Fansteel Products Company, of Chicago, Ill., have announced the new line of Balkite A.C. Sets. In the point of appearance, all Balkite sets will be housed in furniture built by Berkey & Gay and designed by their artists. With regard to ease of operation the Balkite set carries this point almost to the extreme. There are but three controls; a station selector, a volume control and an "on and off" switch. This number could easily have been reduced to two by incorporating the "on and off" switch in the volume control but after much consideration it was decided that there was more actual convenience in having them separate.



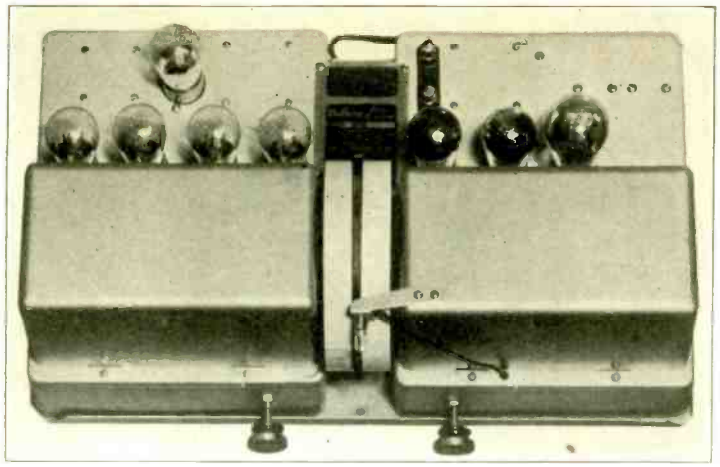
The New Balkite A. C. Set

The Balkite receiver is an A.C. set in the strictest sense of that rather loosely employed phrase. To operate it one has simply to plug it in to a light socket. In other words the power pack is integral with the set proper and all connections between the two are made at the factory.

The power pack uses a 280 type tube for rectification of the "B" current and employs the unique dry electrolytic condenser which is the result of two years research work in the Balkite laboratories.



Dresner short-wave plug-in coils.

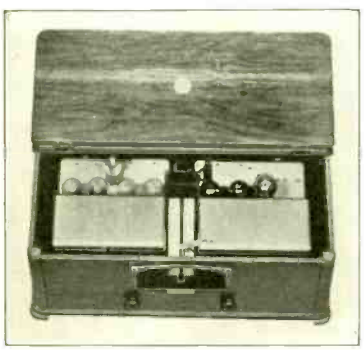


Chassis of the new 7 tube Balkite A. C. Set.

As can be seen in the accompanying photograph the set proper and the power pack, while they are both part of the same chassis, are independantly housed. Of course the set, independant of the metal container, is completely shielded from any stray magnetic or electric fields.

The receiver itself is a neutrodyne of the Hazeltine type with three stages of radio frequency, a detector and two stages of audio amplification. The neutrodyne circuit was chosen because with it one can avoid any possibility of squeals or howls, obtain any desired degree of selectivity, and achieve the greatest simplicity of control.

In the radio frequency, detector and first audio stages, the set uses five UY-227 type tubes, the last audio stage which is in push-pull uses two 112-A type tubes. Thus the set uses seven tubes, exclusive, of course,



Another view of the Balkite Receiver

of the 280 type rectifier tube. This was found to be the minimum number of tubes with which one could combine distortion-free reproduction with great amplication and at the same time operate each tube well below the overlonding point.

The 227-type tubes were chosen over the cheaper 226-type because it was found impossible to use the latter type in front of a really accurate audio amplifier and dynamic speaker without getting a slight A.C. hum.

The usual distortion of the low frequency waves in the audio amplifier is completely avoided in this set by using the very highest grade audio transformers especially designed for the Balkite set. The greater part of the amplification occurs in the high frequency end of the set with the result that every note in the musical scale is delivered to the speaker at its proper value.

In addition to the general excellence of the engineering of the Balkite set there are several rather ingenious refinements which should prove very popular. For instance there is a filtered power supply for the field of a dynamic speaker built into the set. Also there is a jack into which a magnetic phonograph pick-up may be plugged. This makes it unnecessary to remove the detector tube every time the phonograph pick-up is to be used.

There is a switch on the power pack which enables the set to function equally well on high or low line voltages. The actual voltage range over which the set will operate with full efficiency is from 100 to 130 volts.

The ruggedness of the mechanical construction and the quality of parts used in the Balkite make it seem very probable that this is a receiver which, given a few fresh tubes from time to time, will operate at peak efficiency for a long period of years.

NEW ROLA DYNAMIC SPEAKER

The Rola Company, Oakland Cal., manufacturers of Rola loudspeakers, is showing a new Rola Dynamic Power speaker at the Chicago show. This speaker is being built in a console table for alternating-current excitation and for the battery type, and in a table model for A.C. sets and battery sets. Units will be available for socket power sets and for 90 volt D.C. sets. These models are in addition to the magnetic speakers made in table, cabinet and pedestal types. Magnetic units for built-in cabinet sets will also be continued.

The manufacturer claims that the new Rola Dynamic reproduces with equal intensity all frequencies from below thirty cycles per second to twelve thousand cycles per second. In production, the upper range will be cut off by a filter to suppress tube distortion, giving the Rola Dynamic a flat response curve within the usual limits. An exclusive feature of the Rola Dynamic in its response range is an almost complete absence of not only resonance peaks but resonance blind spots.

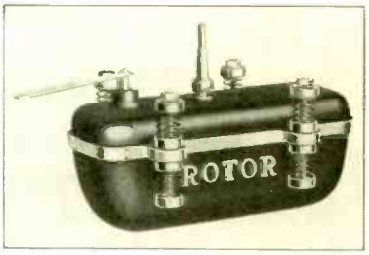
The diaphragm is corrugated and waterproofed by a new process. A special and exclusive Rola development in the supporting spider insures positive and permanent alignment of the vibrating coil and eliminates any possibility of unstabling strains being set up in the tortional members. All windings will be carefully tested for insulation and impregnated to prevent deterioration under all climatic conditions. It is stated that by a new system of damping, the Rola Dynamic diaphragm cannot rattle or blast at any power up to and including the output of several type 250 tubes in push-pull combination.

Rola Dynamic Speaker

SYNCHRONOUS PHONOGRAPH MOTOR

The Rotor Corp. of Dayton, Ohio, has announced a new motor for turning the turntable of talking machines. This motor is of the synchronous type and therefore runs only off 110-volt A.C. lines.

The manufacturer states that the speed is absolutely constant and is independent of the action of a governor, this latter being a rather weak element in phonograph motors. The vibrations have been so balanced out that all springs hitherto found necessary are eliminated. The space necessary for the installation of the motor is 1⅝ inches in height. Due to the type of motor it will attain full speed within one revolution, if given a slight push with the hand.



The "Rotor" Phonograph Motor

After installation the motor is said to require no further attention, as the oiling system has been so worked out that changes of lubrication are unnecessary. Also the single moving part of the motor is totally inclosed and therefore there is no noise to interfere with the reproduction of the music.

NEW CARTER WIRE-WOUND TAPERED RHEOSTATS AND POTENTIOMETERS

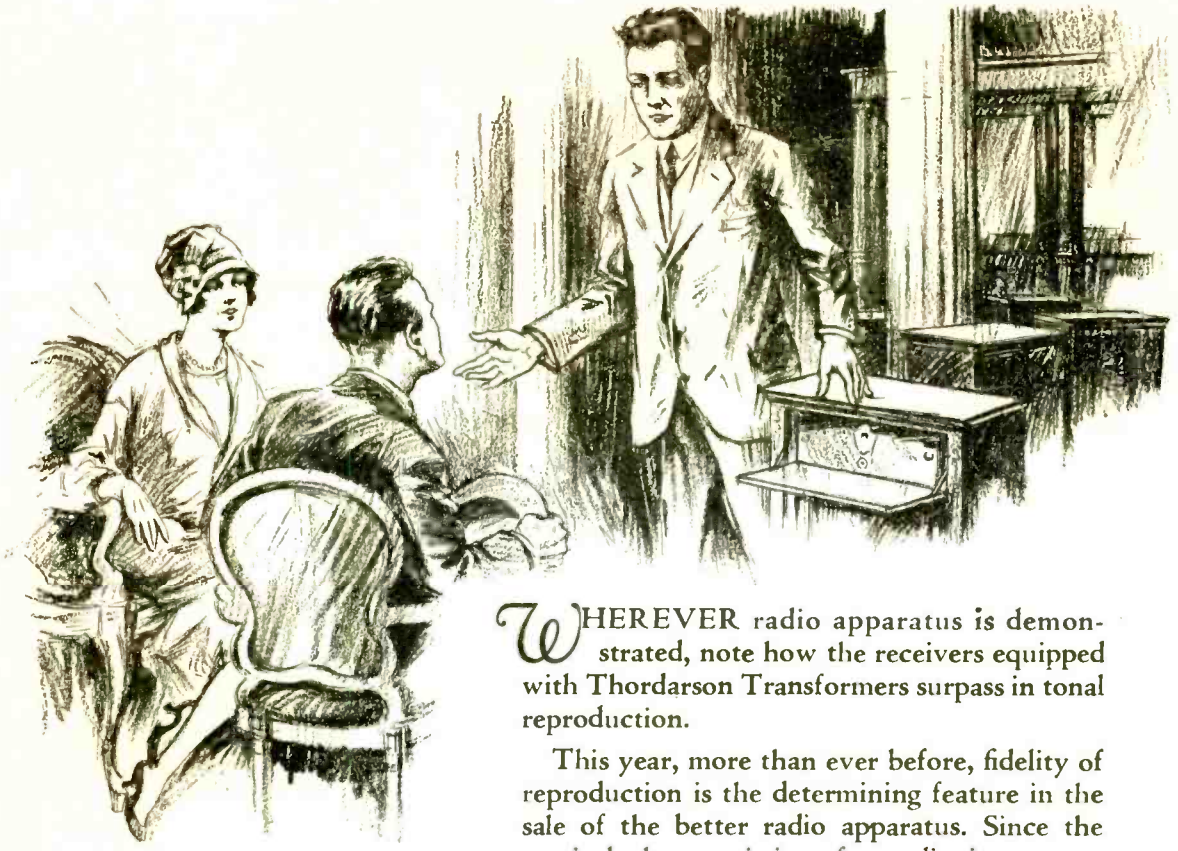
These variable resistors, which are manufactured by the Carter Radio Co., 300 S. Racine St., Chicago, Ill., were designed for

The new type Carter wire-wound tapered rheostat.

circuits where the useful range of adjustment is crowded into a small arc or portion of the knob's rotation. A curved line, or tapered resistance characteristic, is obtained by tapering the strip and at the same time increasing the spacing between the turns of wire at the narrow end of the strip, which is inserted in a bakelite frame 1¾ inches in diameter and of standard Carter construction. Both types of resistance are principally used for volume control and are available in values from 400 to 10,000 ohms. The maximum dissipation is 5 watts.

CARTER SCREEN-GRID TUBE SHIELD

The Carter Radio Co., 300 S. Racine St., Chicago, Ill., have a tube shield and shielded connector for use with the 222-type of screen-grid tube. The tube shield completely covers the tube and the base,



WHEREVER radio apparatus is demonstrated, note how the receivers equipped with Thordarson Transformers surpass in tonal reproduction.

This year, more than ever before, fidelity of reproduction is the determining feature in the sale of the better radio apparatus. Since the musical characteristics of a radio instrument depend to such a great extent on a wise selection of the audio and power supply transformers, it is significant that so many leading manufacturers have turned to Thordarson as the logical transformer source.

Equally significant is the fact that not once since Thordarson transformers became available to radio manufacturers has any other transformer approached the manufacturer popularity of Thordarson.

These quality instruments are Thordarson equipped:

ZENITH
SPARTON
Howard
Philco
Willard
Stromberg-Carlson
GILFILLAN
KENNEDY
MAGNAVOX
Neutrowound
Prest-O-Lite
RADIODYNE
Mohawk
Buckingham
MURDOCK
WALBERT
OZARKA
ARGUS
AUDIOLA
ERLA
and many others

THORDARSON

RADIO TRANSFORMERS

Supreme in musical performance

Thordarson transformers are universally available to custom set builders as well as manufacturers. Wherever radio parts are sold, there you will find a complete stock of Thordarson Audio and Power Supply apparatus. If you are building for real musical performance, insist on Thordarson Transformers.

THORDARSON ELECTRIC MANUFACTURING CO.

Transformer Specialists Since 1895

WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS

Huron and Kingsbury Streets — Chicago, Ill. U.S.A.

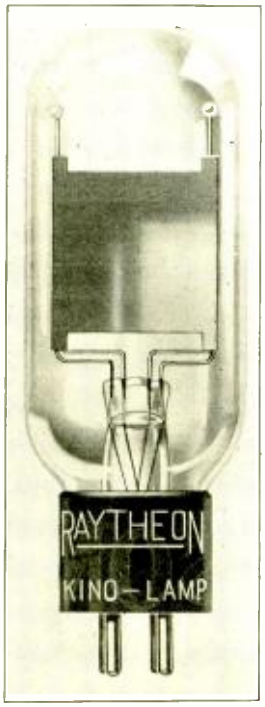
the top of the tube shield being removable in order to facilitate placing the connector on the grid terminal at the top. Connection to this terminal is made by means of a brass connector, which is slotted to make a firm spring contact. The wire

The new Carter screen-grid tube shield, made of copper. It is supplied with a special connector cap and shielded grid wire.

from the connector is shielded. An adapter ring is also used in connection with the socket to hold the tube shield in position. The shield proper is made of spun copper.

RAYTHEON PRODUCES NEON LAMP AND PHOTO-ELECTRIC CELL FOR TELEVISION

Realizing that before television becomes commercially practical, much experimental and development work must yet be done, the Raytheon Manufacturing Company, of Cambridge, Mass., has placed on the market two new products—the Kino-Lamp and



The Raytheon Kino-Lamp.

the Foto Cel—to aid the radio amateurs, scientists, and other experimenters, in this development work. The Raytheon Laboratories are also closely following television developments and their products will reflect the latest refinements.

The Kino-Lamp, as will be seen from the accompanying illustration, comprises two flat metal plates, placed parallel and very close together. Rigidity of the plates is obtained as a result of the novel system of bracing. The plates are approximately 1½ inches square and the glow over the cathode plate is exceedingly uniform. Either plate may be used as the cathode by interchanging the base connections.

The tube has been so designed as to have a dynamic impedance of about 1,500 ohms in order to permit its operation directly in the plate circuit of a 171 amplifier tube without resorting to the use of impedance adjusting transformers. The Kino-Lamp draws 15 ma. at 222 volts.

The new Raytheon Foto Cel is an improvement on former types of hard vacuum photo electric cells, in that high sensitivity for this type of cell has been successfully combined with rugged construction and

The Raytheon Foto-Cell.

small size. This cell should not be confused with the gaseous type of photo-electric cells, which are also being developed, and in which the sensitivity can be increased many times. The uniform response of the hard vacuum Foto-Cel makes it the ideal type for television requirements.

NEW AERO PLUG-IN COILS

Further improvements in their plug-in coils have been announced by Aero Products, Inc., 1768 Wilson Ave., Chicago, Ill. Two types of coils are made, one covering the broadcast waveband and another the band from 13 to 130 meters.

These coils are wound on bakelite skeleton forms with air spaced turns, resulting in a dielectric consisting mainly of air and thereby reducing the losses below those with other types of windings. For the broadcast band the coils are made in two types—one to be used with .00035 mfd. condensers and one with .0005 mfd. condensers. The primaries of these transformers are so arranged that the plate impedance of the preceding tube can be matched by adjusting the primary coil impedance.

The same type of conductor support and air spacing have been retained on the secondary coil, but a larger size of wire is used, resulting in a lower resistance and also in a stronger coil from a mechanical viewpoint. The diameter of the coils has been reduced to two inches, thereby giving a much greater efficiency because the field of the coils is much smaller, permitting them to be mounted more closely to the other pieces of apparatus in the set than has been the case in the past. The space-wound feature has been extended to the primary, which has now similar construction to the secondary.

NEW ACME VOLTAGE REGULATOR

A voltage regulator for receivers using A.C. tubes has been announced by the Acme Apparatus Co., Cambridge, Mass. It was found that a great deal of the poor reception, variation in volume, in A.C. operated sets was due to the varying of the line voltage. In fact in some localities the variation was as great as 20 or 30%, this causing, of course, a corresponding change in the "A" and "B" voltages.

The voltage regulator has been designed so that it has an output voltage with a maximum variation from 109 to 111, this being the case even though the input to the regulator varies from 90 to 150 volts. This is 2% variation although the input may vary as much as 50%.

The size of the regulator is 3½ by 7¼ by 6¾ inches high. Its installation consists of plugging it in between the set and the A.C. main line. A switch is included

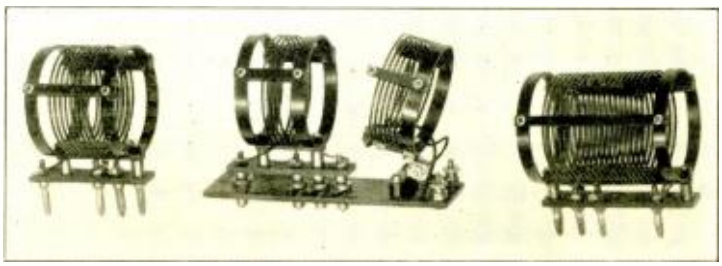
Acme Voltage Regulator.

in the cable to the 110-volt line for switching off the power and a receptacle is provided into which the line from the set can be plugged.

ARCTURUS ANNOUNCES A.C. SCREEN-GRID TUBE

The tremendous advantages of the screen-grid tube, with its enormous amplification with stability in the high frequency circuits, have appealed to radio fans generally. To adapt this higher efficiency to modern electric sets, an A.C. screen-grid tube has just been placed on the market by the Arcturus Radio Company, A.C. tube manufacturers of Newark, N. J.

In the Arcturus A.C. screen-grid tube there is one more element than in the standard tube. The filament draws a current of 0.35 ampere and its normal oper



New Aero-Plug-In Coils for Short Wave Work.

ating potential is 15 volts. The additional element, i. e., the screen grid, is a combination grid interposed between the usual plate and control grid and a fine mesh arrangement completely enclosing the whole tube structure, thus introducing a completely shielded tube.

The addition of a fourth element to the new tube makes necessary five terminals to each tube. The tube is mounted in a standard UX base and the terminals are connected as usual, except that the screen-grid is connected to the regular grid terminal at the base and the control grid is connected to a special terminal, mounted on the top of the tube.

The manufacturer supplies the following characteristics:

Amplification constant	400
Mutual conductance	445
Plate to control grid capacity	0.04 Mmf.
Filament voltage	15.0
Heater current	0.35
Plate voltage	135
Shield grid voltage	30.0
Control grid bias	1.0
Plate impedance	900,000

BELDEN SHIELDED HOOKUP WIRE

A new wire made by the Belden Manufacturing Company of Chicago, has been placed on the market for use on the new screen grid tubes. This new wire consists of the well known Belden Flexible Colorubber Hookup Wire, shielded with a braid of tinned copper. When the tinned copper braid is grounded, it proves a very effective shield for the grid and plate leads.

RACON AIR-COLUMN DRUM SPEAKER

The Racon Electric Co., Inc., of 18 Washington Place, New York City, announce an exponential horn of the drum type, loud speaker. The diameter of the speaker is 11½ inches and the depth 7½. The length of the air column of the horn is 66 inches. The manufacturer of this speaker claims for it natural reproduction of the highest quality.

NEW BODINE ELECTRIC TURNTABLE FOR RADIO-PHONOGRAPH COMBINATIONS

The Bodine Electric Company, 2256 West Ohio Street, Chicago, Ill., announces the new Bodine Model RC 10 Electric Turntable, which has been designed espe-

Bodine Electric Phonograph Turntable.

cially for use in radio-phonograph combinations. The model unit is equipped with a single phase induction motor that has no commutator or brushes, and therefore cannot introduce interference in the loud speaker, usually caused by sparking at the brushes.

The modern trend to use an electric phonograph pickup in conjunction with the amplifier in a radio receiver for electrical reproduction of phonograph records has created a demand for an electric turntable which will not create disturbances in the electrical circuit which operates not only the electric turntable, but also the radio amplifier and rectifier units.

The new Bodine Model RC 10 Electric Turntable will be furnished to manufacturers of electric phonographs and also will be merchandised through the regular jobbing channels.

JEWELL A.C. AND D.C. RADIO SERVICE SET

A new radio service set or radio set analyzer, which it is claimed has many superior and desirable features not found in similar radio service equipment, is now ready for dealers and their service men. This is manufactured by the Jewell Electrical Instrument Co. of Chicago and will be distributed by jobbers.

This radio set analyzer Pattern No. 199 has been designed for the rapid analysis of the circuit condition in a radio set, whether battery operated or operated from the alternating current line. It will test all tubes used in commercial radio sets

Jewell A.C. and D.C. Radio Service Set.

today, including all types of direct current tubes and all types of alternating current tubes, including tubes with 15 volt filaments, as well as those running down to 1.5 volts. All plate voltages up to 600 volts are taken care of by a high resistance voltmeter having 1000 ohms per volt.

The test set is arranged to read all the various values of current and voltage in connection with each tube and its socket simply by plugging the special plug, with four foot cord into the tube socket and pressing special push button switches on the panel. These buttons are plainly marked to identify the test or range being used. No harm can result from pressing more than one button, although the practice is not recommended.

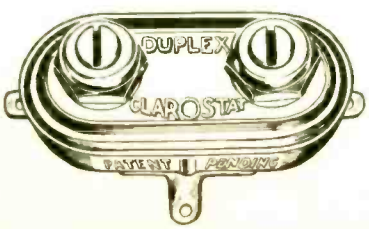
Ranges of the instruments are—A.C., 0-4-8-16-160 volts;—D.C., 0-7.5-75-300-600 volts and 0-15-150 milliamperes. All ranges are brought to binding posts and special leads are provided for making continuity test.

Some advantages claimed for this set analyzer over other types commercially available are an accurate tube test, cathode voltage test for A.C. tubes, 5 prong plug for A.C. tubes instead of the conventional 4 prong plug, and simple plainly marked push button switches, enabling instant testing.

THE DUPLEX CLAROSTAT

Comprising two variable resistors in one, each independently adjustable over a wide range, the Duplex Clarostat is a unique device with many applications. It is the latest addition to the Clarostat line, manufactured by the American Mechanical Laboratories, Inc., 285-7 North Sixth Street, Brooklyn, N. Y.

Instead of knobs, either section of the Duplex Clarostat is adjustable by means of



The New Duplex Clarostat.

an ordinary screw-driver the blade of which engages with the recessed slotted shaft. Fixed resistance values are provided, without knobs to cause constant tinkering. The stout metal shell may be mounted on a panel, by slipping the threaded nipples through two holes and drawing the decorative nuts up tightly, or on a baseboard by means of the special bracket supplied.

There are three terminals, representing the two outside connections and the center connection between the two variable resistors. It is therefore apparent that the Duplex Clarostat can serve as:

Two separate and distinct variable resistances, with a common terminal. Two variable resistances with very high series resistance or greatly increased current-handling capacity when used in parallel. A resistance network with two variable voltage taps, simplifying the usual output circuit of a radio power unit. A potentiometer or balancing resistance, with *variable total resistance* and *variable mid-point*.

The Duplex Clarostat may be employed singly or in gangs. It has a universal resistance range, of from practically zero to several megohms for each section.

CLAROSTAT LIGHT SOCKET ANTENNA PLUG

Several novel features are incorporated in the Clarostat Light Socket Antenna Plug just introduced by the American Mechanical Laboratories, Inc., 285-7 North Sixth Street, Brooklyn, N. Y., manufactureres of the well-known Clarostat variable resistors.

This device converts any electric-light socket or convenience outlet into a good antenna, doing away with the trouble and cost of the usual outdoor antenna. The ground connection may be made to the electric light system in a manner described in the instructions accompanying the device, further simplifying the radio installation. The Clarostat Light Socket Antenna Plug is provided with an unique condenser made up of brass plates and mica for greatest mechanical as well as electrical strength. A detachable screw

Clarostat Light Socket Antenna Plug.

base permits of utilizing either side of the electric line for the antenna. A long flexible cord, permanently connected with the antenna plug, provides a simple and positive means of connection with the radio set. This device will operate with practically any radio set, under any and every condition it is claimed.

THE WEBSTER ADAPTOFORMER

A device for supplying filament current for A.C. tubes has been developed by the Webster Co., of 850 Blackhawk St., Chicago, Ill. This unit is designed for sets which utilize the alternating current tubes and is used with a power unit for supplying plate voltages. Also all grid-bias voltages are supplied, as well as by-pass condensers and a center-tapped resistor for the neutral grid return.

The Webster Adaptoformer.

The unit is equipped with seven binding posts, six of which are for filament connections and the seventh is connected to the negative "B" terminal on the "B" unit. The "B" socket power unit is connected to the set in the usual manner and the 110-volt supply line is plugged into the receptacle provided in the "A" power unit. A pendant switch attached to the latter unit controls the entire equipment. The size of the unit is 4 inches wide, 6 inches high and weighs 6 pounds.

POLYMET ANNOUNCES NEW PRODUCTS

In line with the new condenser and resistance requirements of up-to-the-minute radio manufacturers and set builders, the engineering department of the Polymet Manufacturing Corporation announces several interesting new products.

Center-Tapped Resistances:

Made in all standard sizes from 10 ohms to 100 ohms. Center mounting hole distance can be made to suit requirements. Handy combination soldering and mount-

ing lug. Delicate laboratory instruments control accurately to a very close degree to insure proper balance of the grid of the highly sensitive A.C. tubes.

Resistance Strips—Flat and Flexible:

Two types—Resistance element wound on a flat insulating strip and equipped with a unique combination soldering and mounting lug; or on a flexible non-inductive tubing and covered with an insulating sleeve. The flexible strip is equipped with a tinned soldering lug. Light in construction,

highly accurate and can be usefully employed wherever a low current carrying capacity of resistance of low ohmage is required. Flat strip made in all sizes from 1 ohm to 2000 ohms. Flexible resistance made in all sizes from 1 ohm to 5000 ohms.

Metallized Grid Leak With Pig-Tail Soldering Connection:

Polymet has succeeded in developing a method of making a positive contact between the resistance element and an external soldering connection. The grid leak can now be soldered directly into the circuit without the need of a Bakelite mounting. This means fewer production operations and saves the cost of a mounting.

New Small Moulded Bakelite Condenser:

Combines all the electrical and constructional features of the large sized

moulded Bakelite Condenser into a light, compact unit for easy mounting in any position. Made in all standard sizes.

THE JONES MULTI-PLUG

Howard B. Jones, 2226 Wabansia Ave., Chicago, Ill., will exhibit at Booth B85, R.M.A. Trade Show, a new line of heavy duty plugs in addition to the standard line. Many improvements will be noted in the standard line, and set manufacturers or, in fact, anyone interested will be amply repaid by visiting the exhibit.

The Muti-plug or separable connector cable for radio sets originated in 1923, or over five years ago. At that time Howard B. Jones foresaw the practical need of a neat cable for connecting radio receiving sets with the power supply. During the five years that have elapsed this company has adhered to this one idea and has manufactured nothing else. To indicate that the idea was practical, one only needs to be told that during the last season a crew of 250 men were employed to manufacture this one item, and during the entire season it was necessary to work nights in order to fill orders. For the present season plant capacity for 15,000 plugs and cables per day has been arranged.

Such concerns as Zenith, Crosley, Grigsby Grunow Hinds, Brandes Products Corp., All-American Radio Corp., Mohawk, Erla, Sonora, King Mfg. Co., Apex, and in excess of fifty other companies are using Jones Multi-Plugs as standard equipment.

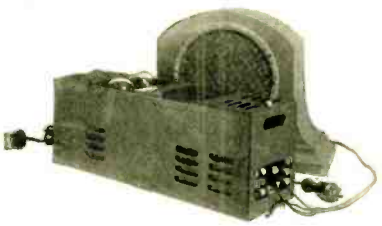
This concern caters to the manufacturing business, and its engineering staff is at the service of set and power pack manufacturers for designing special plug connectors for particular requirements.

RADIO RECEPTOR COMPANY ANNOUNCES NEW POWERIZERS

The Radio Receptor Co., 106 Seventh Ave., New York City, announce that they have new socket power units for the coming season.

The Powerizer A supplies filament and grid bias for a set using UX-226 tubes, two UX-227 tubes, one or two UX-171 tubes. This unit can be wired into a set or a harness with a volume control.

In addition to this they announce the Powerizer Junior. This unit is designed for those who wish to convert a battery set into an ordinary electric, employing the 171 Radiotron in the last stage, such as the Atwater-Kent or Radiola No. 17 or No. 18. This model supplies current for seven or eight 226 tubes, two to three 227's, and two 171's; it also furnishes



New Receptrad Powerizer.

grid bias for all these tubes and "B" voltage, all necessary terminals and, in addition, a hum control and means for extending a switch to any part of the set.

The D. C. Tube Powerizer is for those sets which operate only with the UX-199 tubes and UX-222 screen-grid tubes. This unit is produced for making house current application to the semi-portable Superheterodyne No. 812 Radiola Grand, Radiola No. 26, and also to the Victor Combination 7-3 (Victor Combination and Radiola No. 20 Set). This unit will operate the Radiola No. 20 using the present UX-199 tubes in the radio frequency, detector and first audio, and the 210 in the last audio stage. This unit will also handle three or four UX-222 screen-grid tubes and will be very useful to those who contemplate the building of sets with this type of tube. This unit requires no rewiring or changing of tubes of any other kind and its application can be made within ten minutes if the "A," "B" and "C" wires are accessible in the same manner as though they were to be left open for batteries.

They also announce a two-stage Powerizer, which uses the UX-226 tube in the first stage, and the UX-210 in the second.

There is also a special Powerizer, with power pack designed exclusively for Radiola No. 25 and No. 28.

OPERADIO ANNOUNCE NEW SPEAKERS

The Operadio Manufacturing Company, of St. Charles, Illinois, have introduced to the market three new manufacturers' type speakers with air columns varying in length from 30 inches to 84 inches.

The Model No. 30 has a 30 inch air column and measures 7 inches high, 8 inches wide, 7 inches deep, weight 6 pounds. The Model No. 54-A has a 54 inch air column; measures 12¼ inches high, 14½ inches wide, 7 inches deep, and weighs 10 pounds, including bracket feet for mounting. The Model 84-A has an 84 inch air column and measures 16 inches high, 20 inches wide, 12 inches deep; weight 24 pounds, including bracket feet.

These speakers are built of a light weight composition cast en bloc. This monolithic bloc construction prohibits absorption and side wall vibration, giving a remarkable acoustic response. Models 84-A and 54-A are provided with lugs ready for lug screws or bolts, simplifying installation. The speakers are designed to operate with or without power tube, and on A.C. or D.C. sets.

Several new models of air column speakers are also being offered.

The new Senior Speaker has a 54 inch air column and is 12 inches high, 14 inches wide, and 6¾ inches deep. The familiar sunburst design of the Operadio has been carried out in this model with the sun rays embossed, giving a beautiful effect. The Speakers are obtainable in a crackle finish—leatherized.

An entirely new model is the Westminster, with a tone chamber measuring 61 inches in length. The Gothic motif, from which the speaker takes its name, is both dignified and pleasing in appearance, while the finish is in keeping with the spirit of the design. The Westminster measures 15⅞ inches high, 13½ inches wide, and 8 inches deep.

The Junior Speaker is a replica of the New Senior in general design, but smaller in size. The tone chamber has a length of 30 inches, but the speaker is only 7 inches high, 8 inches wide, and 6¾ inches deep. In finish, too, it differs from the Senior in that it is obtainable in bright colors.

The tone chambers of all these speakers are cast en bloc of an inert, light-weight composition, giving a monolithic structure which prohibits absorption and side wall vibration. Changing weather conditions have no effect whatever upon the tone chambers.

NEW PEERLESS DYNAMIC SPEAKER

The United Radio Corporation of Rochester, N. Y., maker of the Peerless Speaker, announces several new models for the coming season. Foremost among these is a dynamic speaker, incorporating several new principles of dynamic design. It is equipped with a rectifier element providing for light socket operation. It handles the output of any tubes.

The dynamic speaker is offered in three models. The Model 17-A is a mahogany Gothic cabinet, similar in conception to the reproducers of past years but considerably larger. The Model 19-T is a complete built-in Speaker Table. Finally, there is a Manufacturer's Model, 17-C, for built-in use in Console Sets.

New Peerless Dynamic Speaker.

In addition to these, a new Model, 7-T, which is a built-in Speaker Table using the Model 7 chassis is offered. Both this Table and the dynamic speaker Table carry out in design the Gothic lines which are characteristic of Peerless Speakers.

NEW TEMPLE AIR-CHROME LOUD SPEAKERS

Temple, Inc., 1925 South Western Ave., Chicago, Ill., have announced a line of Air-Chrome type loud speakers. These speakers are made in three sizes: Model J, 24 inches square; Model K, 14 inches square, and Model F, 18 by 23 inches. Model J is 9 inches deep and the other two are 7 and 8½ inches respectively. The weight of the first is 16 pounds and the others weigh 8½ pounds.

The Temple Air-Chrome is of the open radiator type. Its diaphragm is so arranged that the larger front half is tuned to the lower frequencies and the smaller, or back half, to the higher frequencies. This type of construction makes possible the balanced tension principle, whereby the slightest impulse is carried from the driving unit to the diaphragm without any loss. The manufacturer claims that the stretched skin diaphragm is not affected whatsoever by climatic changes.

Buyers Directory of Equipment and Apparatus

Readers interested in products not listed in these columns are invited to tell us of their wants, and we will inform the proper manufacturers. Address Readers' Information Bureau.

Addresses of companies listed below, can be found in their advertisements—see index on page 86.

ADAPTERS:
Carter Radio Co.

AMMETERS
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.

ANTENNAE, LAMP SOCKET
Electrad, Inc.

ARRESTERS, LIGHTNING:
Electrad, Inc.,
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.

BASES, VACUUM TUBE:
Formica Insulation Co.

BINDING POSTS:
Arrow Automatic Products Corp.
Eby, H. H., Co.
X-L Radio Labs.

BOOKS
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INDEX OF ADVERTISERS

A	PAGE
Acheson Products Sales Co., Inc.	81
Acme Electric and Mfg. Co.	80
Ad. Auriema, Inc.	83
Aerovox Wireless Corp.	Second Cover
Airchrome Products Co.	17
Air-King Products Co.	78
Allen Bradley Co.	85
Allied Engineering Institute	82
Aluminum Co. of Amer.	14
American Mechanical Labs.	20
American Transformer Co.	77
Amplion Co. of America	78
Amsco Products, Inc.	19
Arcturus Radio Co.	79
Arrow Automatic Products Corp.	81
Automatic Electric, Inc.	22

B	
Bakelite Corp.	Back Cover
Baltimore Brass Co.	78
Brown and Caine Co.	72
Burt A. G., Jr.	22
Burt, Dr. Robert C.	78
Buyers Directory	84-85

C	
Cardwell, Allen D. Mfg. Co.	21
Carter Radio Co.	79
Central Radio Laboratories	75
Condenser Corp. of Amer.	69
Copper and Brass Research Assn.	10
Cunningham, E. T., Inc.	71

D	
DeJur Products Co.	74
Deutschmann, Tobe, Co.	79
Dexter, C. H. & Sons, Inc.	75
Dongan Elec. Mfg. Co.	Third Cover
Dudlo Mfg. Co.	7
Dresner Radio Mfg. Co.	79

E	
Eastern Tube and Tool Co.	76
Eby, H. H. Co.	12
Electrical Testing Labs.	11
Elkon Co.	25

F	PAGE
Fahnstock Electric Co.	80
Fan Speaker Co.	78
Fast, John E. & Co.	78
Ferranti, Inc.	86
Flechtheim, A. M. Co., Inc.	78
Formica Insulation Co.	1

G	
General Etching and Mfg. Co.	81
General Instrument Corp.	73
General Plastics, Inc.	5
General Radio Co.	76
General Transformer Co.	88
Gordon, L. S., Co.	71

H	
Hammarlund Mfg. Co.	76
Hardwick-Field Co.	77
Holyoke Co., Inc.	80
Howard, A. U. Co.	80

I	
Independent Laboratories	80
International Resistance Co.	8

J	
Jewell Elec. Inst. Co.	69
Jones, Howard B.	67

L	
Lamination Stamping Co.	80
Lautz Mfg. Co.	72
Leeds Radio Co.	83
Lektophone Corporation	23

M	
Mallory P. R. & Co. (Elkon Div.)	25

O	
Operadio Mfg. Co.	13

P	
Pierce-Airo, Inc.	77
Polymet Mfg. Corp.	73

R	PAGE
Radiall Corp.	86
Radio Products Laboratory	16
Radio Receptor Co.	76
Radio Treatise Co.	82
Roebling J. A. Son's Co.	78

S	
Samson Electric Co.	15
Scovill Mfg. Co.	3
Seymour Paper Co.	81
Shakeproof Lock Washer Co.	6
Skidmore Co.	82
Sterling Elec. Co.	74
Stevens, Eugene	83
Strype, Fred C. Co.	81

T	
Temple, Inc.	18
Thordarson Electric Mfg. Co.	65
Tifft Bros.	80
Transformer Co. of America	74

U	
United Radio Corp.	4
United Scientific Labs.	77
United States Foil Co.	81

V	
Vitalitone Radio Corp.	79

W	
Walker, J. V., Co.	83
Webster Co.	9
Westinghouse Elec. and Mfg. Co.	24
Wiley, John, Co.	83

X	
X-L Radio Labs.	79

Z	
Zapon Co., The	26

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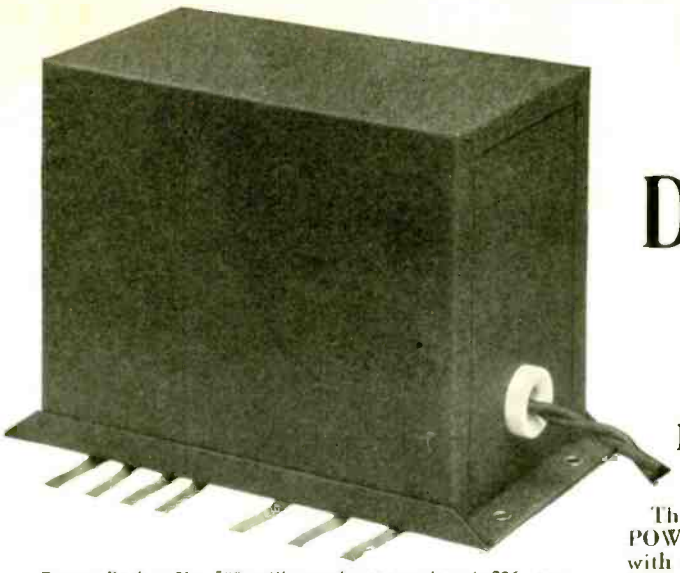

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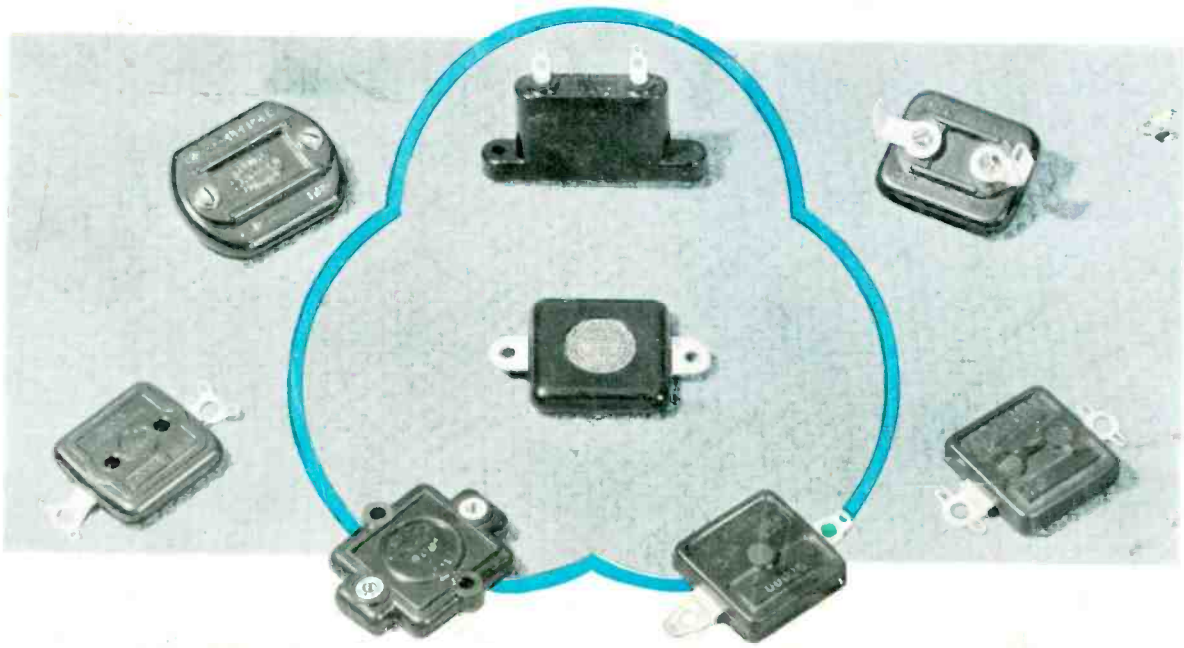

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