February, 1921

25 Cents

The WIRELESS AGE

Volume 8

Number 5

Mme. Luisa Tetrazzini, Operatic Soprano, Singing by Radiophone to Sailors of the American Navy Aboard Ship

AMATEUR SPARK AND C. W. TRANSMISSION

Second Article by J. O. Smith

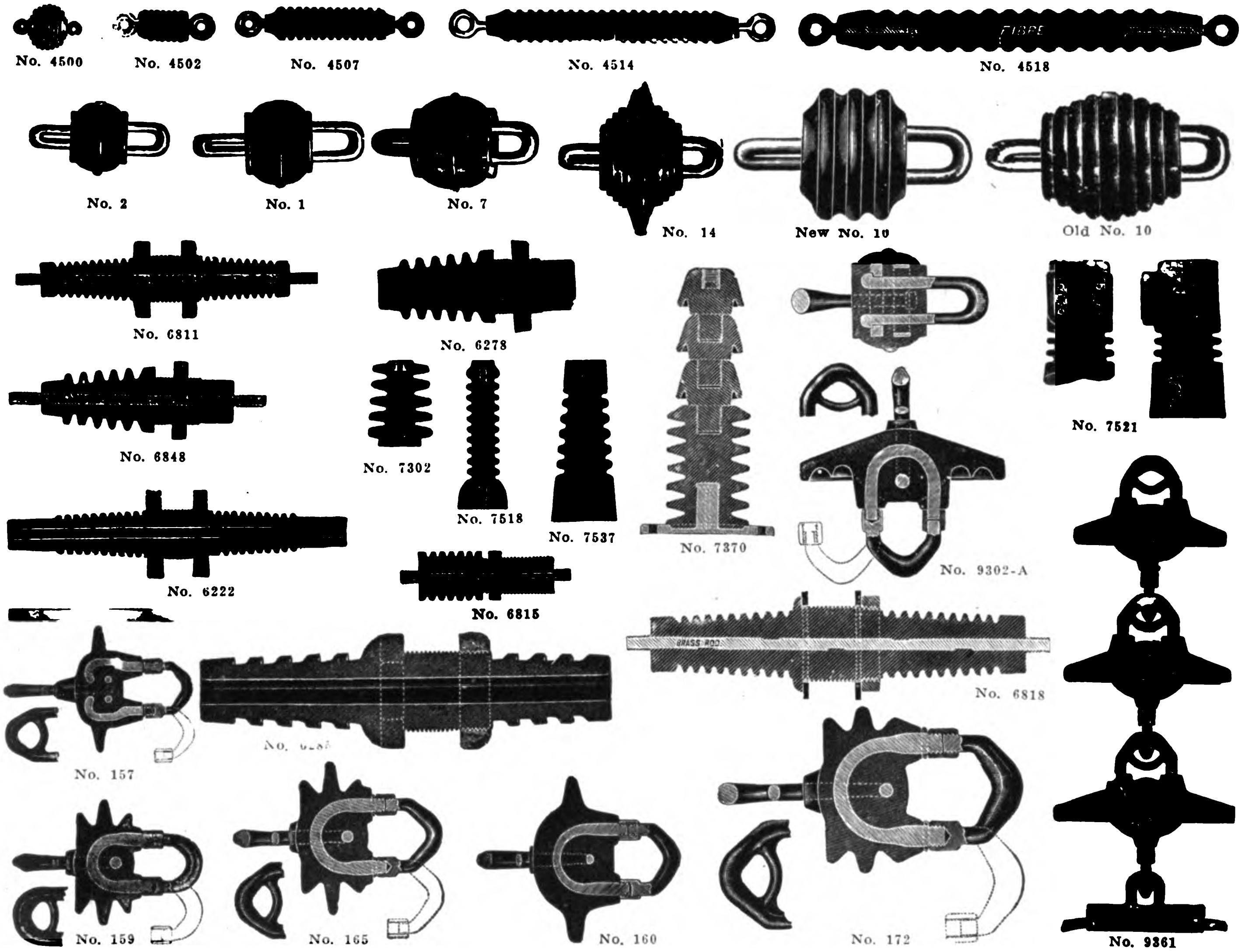
And Many Exclusive Features in This Issue

WORLD'S ONLY MAKER

Moulded High Frequency High Tension Insulators

INSULATORS 1,000 TO 1,000,000 VOLTS

TRADE ELECTROSE MARK
INSULATION
"MADE IN AMERICA"
Louis Steinberger's Patents



"ELECTROSE" Insulators are standard with UNITED STATES NAVY and ARMY and Wireless Telegraph and Telephone Companies. "Electrose" is made in a number of grades for various requirements, each grade possessing special characteristics. **"Electrose"** Insulators—Best in the World for High Frequency Currents, Power and Transmission Circuits.

ELECTROSE STANDARD PRODUCTS

"Arcover" disk strain and suspension line insulators, "Safety Strain" Insulators, Disk, Hood, Thimble and Rod type strain insulators, Spool and Bracket-Arm strain insulators, Pin-type line insulators, Insulator pins, Roof, Barrier and Wall Bushings and Insulated Connectors, single and multi-part, plain and locking, water and gas tight, Bus-bar insulators, Insulating Supports and Pedestal, Arc Lamp Insulators, Insulating Knobs and Handles, Insulating Sheets, Tubes and Rods, etc., etc.

Electrose Railway Line Material:—"Safety Strain" Insulators, Brooklyn Strain Insulators, Insulated Turn-Buckles, Caps and Cones, "Ideal" Locking Caps and Cones, Insulated Bolts, Feed Wire Insulators, Third Rail Insulators, also special forms of Trolley Wire Suspension Insulators, etc., etc. Complete line always carried in stock.

Ignition Insulating Parts:—Distributor Blocks, Disks, Switch Bases, Spools, Brush Holders, Knobs, Handles, etc., etc.

"Electrose" insulation (certain grades) is recognized as the best obtainable for use in connection with insulating parts for ignition service for Automobiles, Aeroplanes, Motor Boats, etc.

Insulators and Insulating parts and devices of special sizes and forms, designed and made to order.

SOLE MANUFACTURERS

ELECTROSE MFG. CO.

60-82 Washington Street
66-76 Front Street
27-37 York Street
1-23 Flint Street

BROOKLYN, N. Y., AMERICA

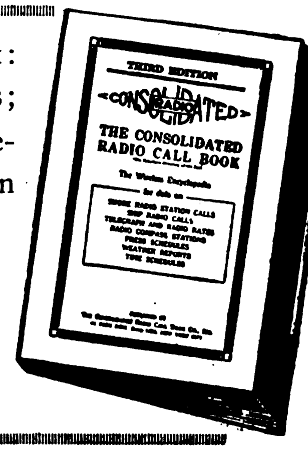
The Third Edition of the

Consolidated Radio Call Book

Very Greatly Enlarged—Will Be Ready January 20th

192 pages. (32 pages more than 2nd edition), better paper, stiff covers, etc.

Some of the special information contained in the new book: Radio rate sheet (charges to and from vessels, etc.); Cable rates; Table for finding cable charges to various points; Weather reports and hydrographic reports of the world; Time signal section of the world; American radio compass stations; French radio compass stations; British radio compass stations; Canadian radio compass stations; General information section; International abbreviations; High power radio stations of the world; Press schedules of spark stations.



The Consolidated Radio Call Book is the only book in print officially listing all the Radio calls as issued by the Bureau of Commerce. Every vessel and land station in the world is represented and listed alphabetically, according to names of vessels or land stations, and according to call letters; Revision of American coastal stations under U. S. Naval control, and their new calls.

Every New Amateur Call Is Listed

SPECIAL—Given Free with Each Copy

A Wireless Map of the World in colors is given absolutely free with each copy. This map shows the locations of all the high powered RADIO stations in the world, including the time signal stations. In addition it tells at a glance how far away any of these stations are. Of greater interest are the time zones, which enable the amateur to compute instantly the correct time for the zone in which he is located from any time signal station.

The second edition of 10,000 copies was exhausted in ten days. The book is on press now and will POSITIVELY BE READY on January 20th. Order direct or reserve your order from your favorite dealer

Price $1.50 Prepaid

Either Direct from us or for sale by the following responsible Dealers:

American Electro Tech. Appliance Co.,	New York City
American Hardware Stores,	Bridgeport, Conn.
Atlantic Radio Co.,	Boston, Mass.
Bamberger & Co., L.,	Newark, N. J.
Benwood Specialty Co.,	St. Louis, Mo.
Brode Electric Co.,	Los Angeles, Cal.
Bunnell & Co., J. H.,	New York City
California Electric Co.,	San Francisco, Cal.
Catton, Neill & Co.,	Honolulu, T. H.
Chicago Radio Apparatus Co.,	Chicago, Ill.
Continental Radio & Electric Corp.	New York City
Cutting & Washington Radio Corp.,	New York City
Detroit Radio Laboratories,	Detroit, Mich.
Dewey Sporting Goods Co.,	Milwaukee, Wis.
Doubleday-Hill Electric Co.,	Pittsburgh, Pa.
Electro Importing Co.,	New York City
Findley Electric Co.,	Minneapolis, Minn.
Fuller Co., Seth W.,	Boston, Mass.
Gurd & Co., Wm.	London, Canada
Holt Electric Utilities Co.,	Jacksonville, Fla.
Hovey, A. T.,	Boston, Mass.
Jenkins, Lester I.,	New Bedford, Mass.
Katzenbach & Co., F. S.,	Trenton, N. J.
Kendell Co., W. D.,	Worcester, Mass.
Killoch Co., David,	New York City
Kluge, Arno A.,	Los Angeles, Cal.
Krause & Co., A. F.,	Detroit, Mich.
Manhattan Electric Supply Co.,	New York, Chicago
McCarthy Bros. & Ford,	Buffalo, N. Y.
McClurg & Co., A. C.,	Chicago, Ill.
Meter Electrical Construction Co,	Oshkosh, Wis.
Meyberg Co., Leo J.,	San Francisco, Cal.
Mohawk Electrical Supply Co.,	Syracuse, N. Y.
New Era Shop,	Milwaukee, Wis.
Newman-Stern Co.,	Cleveland, Ohio
Nola Radio Co.,	New Orleans, La.
Noll & Co., E. P.,	Philadelphia, Pa.
Northwest Radio Service Co.,	Seattle, Wash.
N. S. W. Bookstall Co.,	Sydney, Australia
Paramount Radio Supply Co.,	Atlantic City, N. J.
Pacent Electric Co.,	New York City
Parks, Henry Francis,	Butte, Mont.
Pearlman's Book Shop,	Washington, D. C.
Pennsylvania Marconi Wireless School,	Philadelphia, Pa.
Penn. Radio Apparatus Co.,	Reading, Pa.
Piedmont Electric Co.,	Asheville, N. C.
Pioneer Electric Co.,	St. Paul, Minn.
Pitts Co., F. D.	Boston, Mass.
Post Office News Co.,	Chicago, Ill.
Precision Equipment Co.,	Cincinnati, Ohio
Radio Distributing Co.,	Newark, N. J.
Radio Electric Co.,	Pittsburgh, Pa.
Radio Equipment Co.,	Boston, Mass.
Radiolectric Shop,	Cleveland, Ohio
Ray-Di-Co.,	Chicago, Ill.
Reuter Electric Co.,	Cincinnati, Ohio
Riverside Laboratory,	Milwaukee, Wis.
Rose Radio Supply,	New Orleans, La.
Saunders Co., Geo. S.,	Boston, Mass.
Schmidt & Co., Rudolph,	Rochester, N. Y.
Shaffers',	Norfolk, Va.
Shotton Radio Mfg. Co.	Scranton, Pa.
Smith Novotoy Electric, Inc.,	Charlotte, N. C.
Southern Electrical Supply Co.,	San Diego, Cal.
United Radio Telegraphers' Assoc.,	Baltimore, Md.
Western Radio Electric Co.,	Los Angeles, Cal.
Whitall Electric Co,	Westerly, R. I.
White & Boyer Co.,	Washington, D. C.
Williamson Electric Co., H. E.,	Seattle, Wash.
Wilmington Electrical Specialty Co.,	Wilmington, Del.
Wireless Mfg. Co.,	Canton, Ohio
Wireless Press,	New York City
Wireless Shop,	Los Angeles, Cal.
Young & McCombs,	Rock Island, Ill.
Young Men's Christian Assoc.,	Los Angeles, Cal.
Zamoiski Co., Jos. M.,	Baltimore, Md.

Published by

Consolidated Radio Call Book Co., Inc.

41 Park Row, Box 14, New York City

Vol. 8 Contents of **The Wireless Age** for Feb. 1921 No. 5

Edited by J. ANDREW WHITE

RENEWALS—When subscription expires you will find a renewal blank enclosed. Return with remittance promptly.

CHANGE OF ADDRESS—Notify us of any change in your address, giving both the old and new location.

Published Monthly at 326 Broadway, New York

GREAT BRITAIN, 12-13 Henrietta St., London

AUSTRALIA, 97 Clarence St., Sydney, N. S. W.

Yearly Subscriptions in U. S., $2.50 Outside U. S., $3.00; Single Copies, 25 cents

Entered as second class matter Oct. 9, 1913, Post Office at New York, N. Y., under the Act of March 3, 1879.

Edward J. Nally, Pres. J. Andrew White, Vice-Pres. L. MacConnach, Sec'y. George S. De Sousa, Treas. J. D. Conmee, Business Mgr.

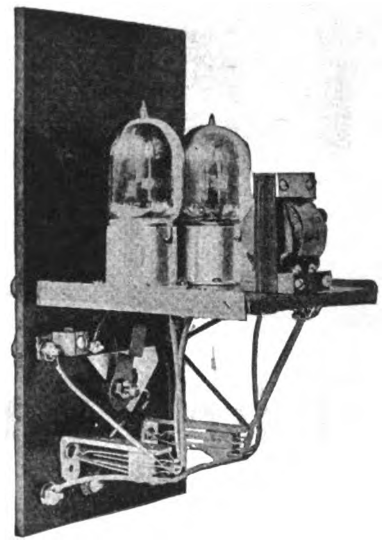
SUPERADIO

This mark of distinction on all our apparatus is the symbol of SUPREMACY.

Type D A-1, the BEST Detector and Single Stage Amplifier in the WORLD, with the new Filament Temperature Indicator, price

$45.00

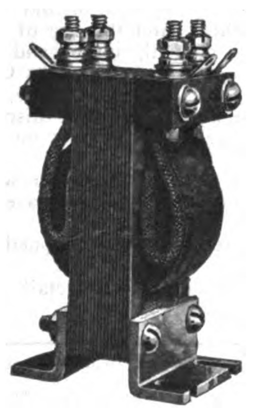
Write for Bulletin 101



Superadio Corporation

Dept. D **2674 Bailey Ave., New York**

Federal Radio Accessories and Parts

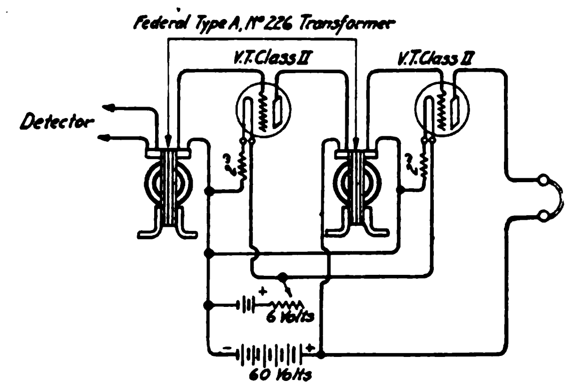


No. 226-W Type A

AUDIO FREQUENCY
Transformer
$7.50 each

Are Distinguished for Their
Reliability, Quality and Efficiency

WRITE FOR BULLETIN 101 AND 102



CIRCUIT WITH TWO STAGE AMPLIFIER

No. 52-W 2200 Ohms

LIBERTY HEAD SET
$12.50 per set

One 226-W Transformer with one Marconi V. T. gives an energy amplification of 400 times. (Audibility amplification of 20 times.)

Two 226-W Transformers with two Marconi V. T.'s give an energy amplification of 160,000 times. (Audibility amplification of 400 times.)

The 226-W Transformer is endorsed by the leading engineers and conceded to be the best transformer on the market.

Federal Telegraph and Telephone Co.

Buffalo, New York

Licensed Under Armstrong and Marconi Patents

Be Sure
it's a *real* PARAGON—
Look for the phrase,
Type R.A. TEN,
engraved in the
Bakelite panel

If it *isn't* an R.A. TEN,—
it *isn't* a PARAGON

Outstanding features of the Genuine

PARAGON R.A. TEN

(Reg. U. S. Pat. Off.)

Amplifying Short Wave Receiver

Wave length, 160 to 1000 meters.
Amplification 100 times.
No dead end losses whatever.
Vernier attachments on all controls.
Coupling has scale of 180.
Free from all body capacity effects.
Guaranteed for two years.
"The weaker the signal, the stronger the amplification."

Price Eighty-five Dollars

THIS ADVERTISEMENT is published more for your protection than ours.

Of course, we have known all along that imitators were using the PARAGON name, but only recently did we realize how Radio men were being deceived. Letters have come in, however, from a number of amateurs who bought these fake Paragons, and were tremendously disappointed.

Probably there are hundreds more who do not realize the real situation. The genuine PARAGON R. A. TEN (*use full name*), is manufactured only by Adams-Morgans Co.; and is sold exclusively by Continental and affiliated dealers. The complete name is copyrighted, and the use of the PARAGON name on other instruments is therefore not only unfair and deceptive, but also illegal. Two previous models of Adams-Morgans Co.; the PARAGON R. A. 6 and the PARAGON R. A. 200 Universal Range receiver, are, of course, genuine. However, these models are now discontinued and the PARAGON R. A. TEN is the only genuine PARAGON on the market.

Be sure to get a PARAGON,—a *real* PARAGON,—the only receiver with a wave length range up to 1,000 meters, combined with no decrease in amplification.

Send in your remittance now, and *your* PARAGON will be shipped at once.

Or let us send you our FREE bulletin, describing, in detail, the features of the PARAGON R. A. TEN.

THE SAME courtesy,—the same helpful attention that has pleased our customers here in the store, extends to our mail order department. We ship exactly what you order, the day you order it—and it's packed to arrive in perfect condition.

Our new 112-page catalogue, now out, contains probably the widest assortment of radio goods ever assembled together. The appendix contains tables for easily figuring all radio calculations, also conventional signals and abbreviations, etc. This valuable catalogue mailed anywhere in the world for 25c. Send for your copy to-day.

Partial list of our mail order specialties follows. Order direct from this ad, and then send for complete catalogue.

Radiotron Detector Tubes . . $5.00

OMNIGRAPHS
No. 313 Omnigraph Complete $20.00
No. 2 Jr., Complete... 28.00
Extra Dials each.... .20
No. 342 Practice Set with battery 4.50

BUZZERS
No. 55 Mesco 2.50
No. 251 Mesco .... .95
No. 168 Century 2.50

AMRAD GAPS
No. G-1 1 K.W. Gap.. $41.50
No. G-2 ½ K.W. Gap.. 24.50
No. G-3 ¼ K.W. Gap.. 12.00

BENWOOD GAPS
No. 1 Benwood Gap complete 30.00
No. 8 8 Stud Rotor... 8.00
No. 10 10 Stud Rotor... 8.00
No. 14 14 Stud Rotor... 8.00

LINE PROTECTORS
No. 379 Murdock Line Protector $9.00
No. AM888 Dubilier Line Protector 4.00
No. CD888 Dubilier Line Protector 6.00

TUNGAR RECTIFIERS
Two Ampere Tungar complete 18.00
Five Ampere Tungar complete 28.00
Two Ampere Extra Lamp 4.00
Five Ampere Ex. Lamp. $8.00

BURGESS "B" BATTERIES
22½ Volts Large "B" Battery 3.50
22½ Volts Small "B" Battery 2.50

PARAGON CONTROL PANEL
No. 5 Paragon Control panel 6.00

RHEOSTATS
No. 2110 Porcelain Base. 1.40
Paragon back mounted. 1.75

CONTINENTAL RADIO AND ELECTRIC CORPORATION

J. DI BLASI, Secretary Our word of honor to you is our guarantee. *Let us prove it.* **J. STANTLEY, Treasurer**

DEPT. E 51 **6 WARREN STREET** **NEW YORK**

IT MERITS YOUR INVESTIGATION

Demand

Cunningham Tubes

The name is etched on the glass

The Ideal Amateur Tube

Type C-300

$5.00

THE NEW

Cunningham AudioTron Tubes

WITH STANDARD FOUR PRONG BASE

EMBODY all the knowledge and skill of many years' research by the leading vacuum tube engineers. The New CUNNINGHAM TUBES are manufactured to rigid specifications in the world's largest vacuum tube factory. Quantity production by machinery makes possible the remarkable price.

Receiving tubes are of two general types. The high vacuum Navy type of rigid operating specifications for radio and tone frequency power amplification. Plate and filament adjustment are not critical. Detector properties are sacrificed to provide maximum amplification in multi-stage and complex circuits without distortion. An amplifying tube is necessarily an oscillator.

The gas content type designed for maximum signal audibility and sensitiveness in detector circuits.

CUNNINGHAM TYPE C-300 is of the latter class and its combination properties exceeded the expectations of its designers. The plate requires only 22½ volts—a single block cell. Maximum sensitiveness is always between 18-22½ volts. In addition to its wonderful detector properties, low B battery, quietness in operation, it functions as a tone frequency amplifier and is a free and persistent oscillator for regenerative amplification and CW reception. The pleasure and satisfaction from operating this tube cannot be described. **$5.00**

Cunningham Type C-301 High Vacuum Amplifier is the

most efficient and stable amplifier ever produced and meets the demand for the Navy type amplifier and regenerative receiver. The exhaust is carried to a high stage permitting operation at plate voltages from 40 to 100 with increasing amplification. Amplification constant 6.5-8 at 40 volts plate and 8-10 at 100 volts. Filament operates on 6 volts with rheostat. Try C-301 in your multi-stage amplifier with loud speaker. There is a surprise waiting for you. **$6.50**

SEE YOUR DEALER TODAY and get your copy of Bulletin C-300 describing these new tubes. If your dealer cannot supply you send us his name and address and we will mail you a copy without charge.

Cunningham tubes are covered by patents dated 11-7-05, 1-15-07, 2-18-08, *and others issued and pending. Licensed only for amateur or experimental uses in radio communication. Any other use will be an infringement.*

SERVICE AND QUALITY SINCE 1915

DEALERS—JOBBERS

You will be interested in my proposition on the new tubes with the standard four prong base, packed in attractive individual cartons. DELIVERIES FOR 60 DAYS NECESSARILY IN ROTATION. Write today for full details.

TRADING AS

AUDIOTRON MFG. COMPANY

35 Montgomery St. - - San Francisco

Radisco BETTER "B" BATTERIES are back--

FOR THE PAST few months, manufacturing difficulties and inferior materials made it advisable to limit the production of Radisco Better "B" Batteries.

In the meantime, however, our research work has developed new methods, better materials, and more economical manufacturing principles.

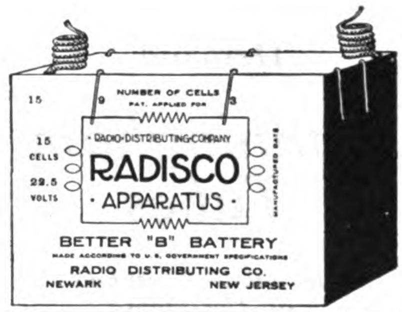
NOW, the NEW Radisco Better "B" Batteries are ready!

Powerful batteries with an operating life of 600 to 1,000 hours—sturdy and well-built thruout—no batteries at the price are as good—no batteries at any price are better.

The Radisco dealer in your district has a complete stock of the NEW Better "B" batteries. *Get your supply from him!*

No. 1	3¼"x2"x2½"	$1.50	Shipping Wt. 2 lbs.
No. 2	6½"x4"x3"	2.65	Shipping Wt. 5 lbs.

Both 15 cells, 22½ volts. Larger size has exclusive Variable Voltage feature. Ask your dealer to explain it.



Special Notice to Radio Phone Experimenters-

Do you know that Radisco Better "B" Batteries make a very reliable and satisfactory source of high voltage for Radio Phone and other CW work? A Radio Phone operating on Radisco "B" Batteries is exceptionally quiet, and free from the disagreeable hum of a motor generator or the rectified 60 cycle tone.

Radisco Coils:

The deserved popularity of these famous coils continues to increase daily, in spite of the many freakish coil windings that are now flooding the market. Most experienced Radio men are glad to recommend universal wound coils, with their minimum high frequency resistance and low distributed capacity. Users of Radisco Coils have found, without exception, that they give better service, in direct comparison with coils that cost much more.

Radisco Coils are made in 17 sizes, tapped and plain, with wave length range from 200 to 20,000 meters. Your Radisco dealer has a complete stock of all sizes, and will be glad to help you select a combination that will give good results and will work well with the rest of your equipment.

THESE PROGRESSIVE DEALERS CARRY THE ENTIRE RADISCO LINE

ALBANY, N. Y.
Shotton Radio Mfg. Co.
8 Market St.

ASHVILLE, N. C.
Hi-Grade Wireless Instrument Co.

ATLANTIC CITY, N. J.
Paramount Radio Supply
518 N. Connecticut Ave.

BALTIMORE, MD.
Radio Engineering Co.
614 No. Calvert St

BEINVILLE, QUEBEC, CAN.
Canadian Radio Mfg. Co.

BOSTON, MASS.
Atlantic Radio Co.
88 Broad St.

BROOKLYN, N. Y.
Kelly & Phillips
312 Flatbush Ave.

CHARLOTTE, N. C.
Smith Novotoy Electric

CHICAGO, ILL.
Chicago Radio Laboratories
1316 Carmen Ave.

EUREKA, ILL.
Klaus Radio Co.
Branch, Peoria, Ill.

KANSAS CITY, MO.
McCreary Radio Supply
4th and Delaware Sts.

LOS ANGELES, CALIF.
The Wireless Shop
511 W. Washington St.

MONTREAL, QUE., CANADA
J. B. Miller
136 Vendome Ave., N. D. G.

NEW BRUNSWICK, N. J.
Geo. N. DeLaplaine
306 George St. and
8th and Magnolia Sts.

NEW ORLEANS, La
Rose Radio Supply
604 Gravier St.

NEWARK, N. J.
A. H. Corwin & Co.
4 West Park St.

NEWCASTLE, PENN.
Pennsylvania Wireless Mfg. Co.
507 Florence Ave. "8HA"

OMAHA, NEBRASKA
O-B Radio Supply Co.
406 Brown Building

PHILADELPHIA, PENN
Philadelphia School of Wireless Telegraphy
Broad and Cherry Sts

PROVIDENCE, R. I.
Rhode Island Elec. Equip. Co.
45 Washington St.

PITTSBURGH, PENN.
Radio Electric Co.
3807 Fifth Ave.

PORTLAND, ME.
Atlantic Radio Co.
15 Temple St.

SEATTLE, WASH.
Northwest Radio Service Co.
609 Fourth Ave.

SCRANTON, PENN.
Shotton Radio Mfg. Co.
P. O. Box 3
Branch, 8 Kingsbury St.
Jamestown, N. Y.

ST. LOUIS, MO.
The Benwood Co., Inc.
3424 Olive St.

TORONTO, ONT., CAN.
The Vimy Supply Co.,
567 College St.

WICHITA, KAN.
The Cosradio Co.
1725 Fairmount Ave.

RADIO DISTRIBUTING CO., Newark, N. J.

This Mark RADIO DISTRIBUTING COMPANY · RADISCO · APPARATUS · *Your Guarantee*

Vol. 8. No. 5. FEBRUARY, 1921

THE WIRELESS AGE

WORLD WIDE WIRELESS

Shanghai Firemen Use Radio

WIRELESS telephony has been put into practical use in China and today every fire truck in the Shanghai International Settlement Fire Department is equipped with a radio outfit with which to communicate with the stations to which they are attached. The primary cause of the innovation is the poor local telephone service. In the Chinese districts where most of the fires take place, there are no telephones. In the foreign districts it takes from ten to fifteen minutes to put through a call at night.

As a result of this condition the community has erected "Watch Towers"—Shanghai being on level land where a blaze may be seen at a great distance. But Chief W. W. Pett found that his executive officers in the stations had difficulty in getting in touch with their men at fires and so he tried out wireless telephony.

Wireless to Broadcast Harding Inaugural Address

SPECIAL wireless telephone apparatus will transmit President-elect Harding's inaugural address to every army post, to every battleship and to halls in various cities where "inaugural parties" will be held, Edward B. McLean, chairman of the inaugural committee, has announced.

A committee on inaugural radio news has obtained the co-operation of the army and navy radio services to carry out the plans, it was said. In addition megaphones will be placed in the reviewing stand in front of the White House and will be connected by special wires to the amplifying device at the Capitol, permitting crowds unable to be at the Capitol to hear the speech.

Brazil Plans Radio Expansion

INCREASED wireless communication with neighboring South American republics and within the vast territory of Brazil itself is the aim of a bill just introduced into the Chamber of Deputies. It provides for the installation of high-power wireless stations in the Federal district and (by arrangement with Paraguay) in Asuncion, and at convenient points in the Brazilian states of Matto Grosso and Rio Grande do Sul.

The preamble of the measure refers to the wireless progress made in recent years, adding that this means of communication between Rio de Janeiro, Asuncion, Buenos Aires and Montevideo would be more economical than by present land telegraph or cable systems. It suggests the possibility of wireless communication between Brazil and the countries on the West Coast through erection of stations in the interior states of Brazil.

Wall Street Uses Radio

FOR the first time in the history of Wall Street, wireless has supplanted the ordinary telegraph lines in the carrying on of stock market operations between New York and Chicago. The wire lines were disrupted by one of the recent storms and during the final hour of trading on the New York Stock Exchange W. J. Wollman & Co. conducted business with Clement, Curtis & Co. of Chicago by wireless. The plan worked with such perfection that

International.
A portable miniature receiving set with a book-form tuner. Signals have been received in London from Paris and Berlin on it

W. J. Wollman, who instituted the new procedure, stated that it was a tremendous step forward and precluded New York being isolated from the rest of the country because of storms which would affect the telegraph lines.

Farmers' Market Reports by Radio

PLANS for sending out agricultural bulletins to farmers of the country by the use of wireless are being perfected by the Department of Agriculture. The trial service will be offered to a half dozen or more counties adjacent to the District of Columbia.

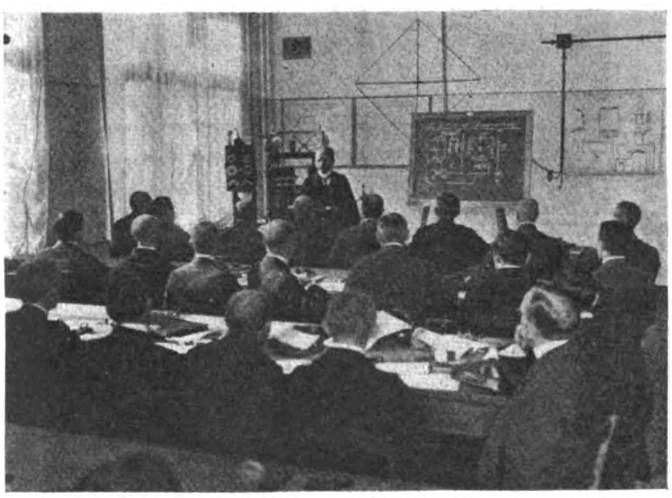
The first message will probably be sent from the Bureau of Standards station to numerous privately licensed operators who will aid in distributing the bulletin to farmers in their immediate territory.

It is planned eventually to erect seventeen wireless plants throughout the country. There would be ten 250-mile radius stations, eight in the East, where market centers are more numerous and closer together, and two in the far West; two 300-mile radius stations to reach outlying points in Maine and New York and five 500-mile radius stations west of the Mississippi.

Each of these stations will be connected with the Washington office and the other stations by leased telegraph wires, and twice a day would receive, for immediate release, a summarized report of market conditions and quotations at market centers and shipment points. Crop and weather reports and other information of value to farmers will also be sent out.

Surgeon Directs Bonesetting by Radio at Sea

HOW the chief surgeon on the Leyland liner Winifredian directed by wireless the setting of a seaman's broken bones and the care of internal injuries of others on the Belgian steamer Menapier after she had been battered by a hurricane was told when the Winifredian reached port from Liverpool. The surgeon is Dr. Patrick



A class of students in a German radio school for ex-officers in Berlin

S. Burns, of Providence, a veteran of the Medical Service in the World War.

An SOS message from the Belgian ship requesting medical aid was picked up by the Winifredian several days out. The distressed steamer, bound for Antwerp from New Orleans, was 100 miles away, but under forced draught the Winifredian got within hailing distance in a few hours.

"Hit hard by a hurricane," signaled the Belgian captain. "Several men washed overboard. Several others have broken legs and arms and some injured internally. There's no doctor aboard. Can you help us?"

Dr. Burns attempted to put out in a lifeboat, but toppling seas and a strong wind prevented the launching. He then conceived the idea of using the wireless.

Details as to the men's condition sputtered into the receiver in the Winifredian's wireless room, and carefully Dr. Burns dictated the treatment required. For three days the two vessels lay within hailing distance, unable to communicate by boat, while the surgeon's instructions were obeyed.

On the fourth day came this message from the Menapier's captain:

"All your instructions safely carried out. The men are resting comfortably and are out of danger."

San Francisco Radio Operator Sets World Receiving Record

ANTHONY E. GEARHARDT, a wireless operator of San Francisco, broke the world's speed record for receiving radiograms at the closing session of the Pacific Coast Radio convention. He took forty-nine words a minute for four consecutive minutes, without error. The champion is employed by the Radio Corporation of America at the Marshall High Power Station, California, and took all prizes at the Panama-Pacific International Exposition in 1915.

R. F. Miller, of New York, who is also employed by the same company, still holds the cup presented at the Philadelphia Electrical Show some years ago, for the world's speed record in receiving messages.

Radio Re-Unites Married Couple

A MAN and his wife were reunited in Philadelphia after a year's separation through a wireless message consisting of a telephone number. The message was sent by Mrs. Alice Lipke, a Y. W. C. A. worker, to her husband, Adam Lipke, on board the steamer Pansa, about 150 miles from shore.

Lipke, who is a wireless operator on board, received the number, "Spruce 3317," and when the vessel docked at Port Richmond, he called the number and was answered by his wife, who is residing at No. 1902 Arch street.

Lipke has just returned from Calcutta, India, following a trip around the world, and last heard from his wife when she sailed from Seward, Alaska, last July, where she had been doing Y. W. C. A. work. She kept track of the movements of his ship, and when it neared this port she sent the message. He was not aware she was in this city.

The reunion was made more enjoyable by numerous gifts he brought to his wife, including a beautiful pair of jade stones from China.

International Weather Bulletins by Radio

INTERNATIONAL agreement is being sought to extend and unify the system of collecting meteorological data by wireless from ships at sea and at the same time to organize the transmission of weather bulletins and storm warnings from a sufficient number of wireless stations to admit of ships being constantly supplied with reliable weather reports and forecasts wherever they may be.

An Admiralty notice to mariners contains complete and up-to-date lists of the wireless stations throughout the world which communicate weather bulletins and storm warnings either at fixed times or otherwise. The stations named are in the following countries: Australia, Brazil, British Columbia, Canada, China, France, Germany, Great Britain, Hawaiian Islands, Holland, India, Italy, Jamaica, Japan, Malta, Mexico, New Guinea, New Zealand, Newfoundland, Nova Scotia, Panama (Canal Zone), Philippines, Samoa, South Africa, Spain, Tonga Island and United States.

Tetrazzini Gives Concert by Radiophone

MME. LUISA TETRAZZINI, with the aid of the radio telephone, recently gave a musical evening for hundreds on board naval ships at sea and in port within a radius of 400 miles of New York City. The prima donna sang four songs into a specially equipped telephone, tuned to transpose her voice to the telephonic receiving sets with which nearly all of the navy vessels are now equipped.

Amplifiers on board the vessels had been rigged to project Tetrazzini's voice on shipboard. The crews were assembled at 9.30 in the evening, the hour set for the concert, and telephonic radio stations were ordered to suspend traffic for thirty minutes.

When the prima donna's manager received word from the radio staff in the Whitehall Building that everything was set, Mme. Tetrazzini, with three musicians, grouped themselves near the transmitter.

"We have a treat for Mme. Tetrazzini," came a voice from somewhere. "Private Fred Bennettt of Fort Wood, Staten Island, is going to sing 'A Tumble Down Shack in Athlone' for her."

The soldier's voice came clearly over the wire to Mme. Tetrazzini's room, and, although there was no amplifier, the prima donna and her friends could hear it very plainly. A chorus of "bravos" from those in the McAlpin followed the song.

Then Mme. Tetrazzini sang the "Polonaise" from "Mignon," "Rondo" from "La Sonnambula," in which she sent her high F sharp far out to sea, "Somewhere a Voice Is Calling" and "I Milioni d'Arlecchino."

After the songs Tetrazzini talked with some of the men in the Whitehall Building and on the Pennsylvania, in the Brooklyn Navy Yard.

"Fine," was the comment from the Pennsylvania.

Naval officers said that the experiment in long distance entertainment for the men on shipboard was successful, although definite reports from the ships, which would give the range of the entertainment, were not received.

British Wireless Companies Declare Dividends

MARCONI'S Wireless Telegraph Company, Limited, of London, has announced the following dividends:

A dividend of 7 per cent., less income tax, upon the 250,000 7 per cent. cumulative participating preference shares; and an interim dividend of 5 per cent., less income tax, upon the 2,016,906 ordinary shares.

These dividends are payable on February 1st.

The Marconi International Marine Communication Company, Limited, announces an interim dividend of 5 per cent., less income tax, upon the issued capital of the company.

This dividend was payable on January 17th.

Navy Stations May Handle News

PRESS Associations and important American newspapers have asked Congress to open naval wireless stations for transmission of news to and from Europe for the period of one year. A joint resolution to this effect was referred to a sub-committee of the Committee on Merchant Marine, the House of Representatives, on January 6th, following an earlier hearing at which the representatives of the press, the commercial radio companies and government officials exchanged views.

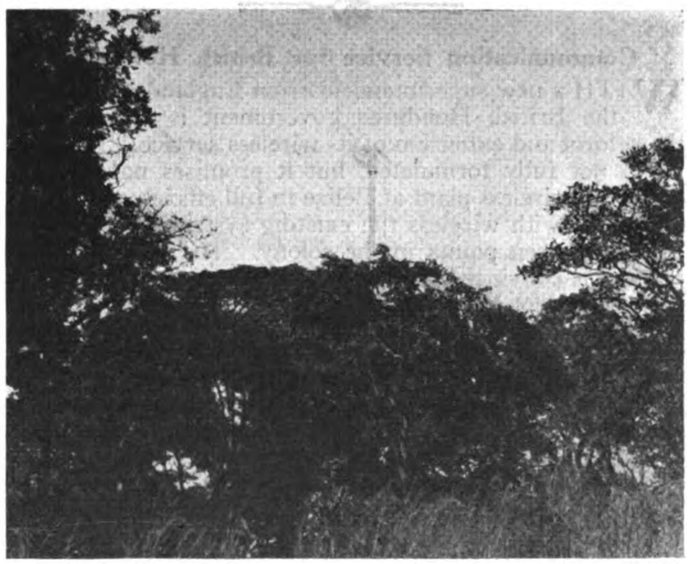
The proposed amendment to the present law would provide for a permit covering one year's use of the Navy facilities for the transmission of press matter across the ocean. The modification would affect the provision in the existing law which states that Navy Department radio stations can handle despatches only when privately owned radio systems are not adequate to handle "the normal communication requirements."

German Spark and Undamped Wave Receivers

FROM a German source it is learned that the adoption of undamped-wave transmitters in the Italian navy led to a study of receivers capable of receiving both spark and undamped-wave signals. The type of receiver adopted was the so-called "ultraudion" receiver, in which a single valve acts at the same time as oscillation generator and detector. Three types of apparatus, according to the requirements of shore and ship stations, were built, the wave lengths ranging from 300 to 15,000 meters.

A Station in the African Jungle

THE British government is now planning an all-British chain of wireless stations from Capetown to Oxford, England. The chain will include the powerful station built by the Germans at Windhuk, South-west Africa, which is reported to have sent messages directly to Berlin, a distance of more than four thousand miles. A new station is to be erected at Niarobi, British East Africa, to receive the Windhuk messages. From there they will be relayed to Cairo, and thence to Europe.



The wireless station located in the Belgian Congo at a place called Kikondji

The present transmission employs a station at Kikondji, in the Belgian Congo, two days' journey north of Bukama, head of the Cape-to-Cairo railroad.

Mrs. John M. Springer, of the Methodist mission station near Kikondji, who furnished the accompanying photograph of the station, says:

"From our place in the heart of the African jungle it is possible to send messages to our friends in New York or Oshkosh, provided we have the necessary funds and there are no local disturbances. A lion ate the predecessor of the present operator."

U. S. Post Office Finds Radio Aircraft Navigation Aid

EXPERIMENTS on the use of radio apparatus as an aid in aerial navigation are described in a publication recently completed. The experiments were conducted jointly by the Post Office Department and the Bureau of Standards and have resulted in the following conclusions:

Radio signaling is a practical aid to navigation provided certain precautions are taken, such as making the radio apparatus sufficiently rigid to stand severe vibration and the use of a special type of antenna located in the fuselage of the machine as far as possible from the engine and the wires of the ignition system. Metal sheaths must be provided to protect the radio receiving apparatus from the ignition system though the disturbances from this cause can be reduced by the use of a compensating coil in the receiving apparatus.

The use of a coil type of antenna or radio compass makes it possible not only to carry on communication but also to guide the airplane and determine its position by radio methods. By the use of special transmitting apparatus located on the landing field, the airplane is able to determine its position with respect to the field and to descend safely in darkness or fog. Two methods have been found practicable for such signaling apparatus: the use of alternating current of relative low frequency in a large coil on the landing field, and the use of radio signals transmitted from a special type of antenna on the landing field. While much has already been done, there is need for a great deal more research and development in order to perfect the use of radio on airplanes. The satisfactory solution of these problems will result in more reliable communication, decrease in the cost of apparatus, and increase in the distance over which communication can be carried out.

Communication Service for British Honduras

WITH a new superintendent from England on the job, the British Honduras government is undertaking the reform and extension of its wireless service. The policy is not fully formulated, but it promises not only to bring the wireless plant at Belize to full efficiency but also to replace with wireless the existing system of communication between points in the colony. The new superintendent is convinced that wireless affords the only means for an efficient but not unduly expensive system of communication for British Honduras.

In the original Belize installation, local static conditions were not fully appreciated and the station was underpowered. It has been much hampered. Arlington can only occasionally be read. Sometimes the Jamaica station cannot be reached, though only 600 miles away, and it is usually necessary to relay messages between the colony and the nearby United States. These conditions have militated against the revenues from the plant and have made its service far less effective than business men desire. There is especial dependence upon this wireless plant because cable messages must be transmitted via Mexico, where delays in relaying are often so serious that cables arrive long after the letters confirming them.

Poor as has been the equipment for communication with outside points, the so-called "telegraph" system of the colony has been worse. Quotation marks are used because the system is a relay of long distance telephones, and a telegraph only in name. Its revenues are far less than would be those of a dependable service, for everyone avoids its use whenever possible regardless of the low rates. It has long been a handicap rather than a help to business. This arises primarily from natural difficulties inherent to any wire system with long runs through a sparsely settled, thickly forested region of high humidity. In rainy season the lines have frequently been broken over a week before repairs could be effected. Moreover, the industries of the country are scattered, centering at camps in the interior which are usually a long distance from the nearest station.

The new superintendent proposes wireless stations at Corozal, El Cayo, Stann Creek, Monkey River and Punta Gorda in place of this expensive and unsatisfactory wire system. By such a plan the investment in the new plant for Belize will be most productive. The communication overhead for the colony will be greatly reduced and there is the probability of considerable increase in revenue when such a reliable system is in operation. Mahogany contractors, planters and others operating in the interior will be urged to buy or lease from the government small sets for private use, eliminating costly messenger service to distant stations, and making it possible for the government to give them real service.

The execution of this reform should create a growing demand for American-made equipment. The orders placed for new apparatus for the Belize plant are understood to have gone, for the most part, to American makers. Other manufacturers specialize in small plant equipment wholly suited for use in such an undeveloped region. Makers of telephone equipment may expect that urban telephone systems will be enabled to make repairs, with the burden of the long distance lines removed the replacements and extensions long desired.

London Radiophones to Geneva

A VERY successful demonstration of wireless telephony between London and Geneva was given by the Marconi Company in connection with a gathering of newspaper correspondents representing the press of the world who have been engaged in reporting the proceedings of the first conference of the League of Nations.

The event was invested with special interest owing to the fact that Dr. A. Graham Bell, the distinguished American who invented the Bell telephone nearly half a century ago, sent a wireless telephone message of greeting from London to the Geneva audience.

Lord Burnham, C. H., also spoke to Geneva from London. Both speakers used an ordinary desk telephone in a director's room at Marconi House, which instrument was connected by a post office line direct to the wireless apparatus at the Marconi Company's Chelmsford station. This apparatus automatically and instantaneously relayed the message to Geneva, so that in effect the speakers were in direct communication with Switzerland, operating the wireless plant by means of their voices.

Lord Riddell and Senatore Marconi also sent messages, which were spoken on their behalf into the transmitter at Chelmsford.

The voices of Lord Burnham and Dr. Graham Bell were reported by Geneva to be very clear, Lord Riddell's "Good luck to you all" brought forth loud expressions of "Merci" from the French journalists present. The demonstration concluded with the playing of two phonograph records.

At Geneva the messages and music were intercepted by the aerial at the Marconi receiving station and carried over several miles of land line to the conference hall of the league. The journalists there were able to hear every word by means of ordinary telephone receivers.

Chesapeake Bay Ice Boats Use Radio

BALTIMORE'S two ice boats, commissioned to fight the ice conditions in the Chesapeake Bay and its tributaries, have been fully equipped with new wireless apparatus to increase the efficiency of the work of both steamers. For more than a year Harbor Engineer Hill has been endeavoring to have this equipment installed on these steamers.

While either of them have been on duty combating ice in the bay or rivers in the past there has been no way in which he could reach them to dispatch them to a vessel in distress in the ice. With the wireless installation it will be possible to communicate with either of the steamers at any time it is desirable.

Amateur Spark and C. W. Transmission

A Comparison of the Two Methods Illustrating Their Advantages and Disadvantages

By J. O. Smith, 2 ZL.

THE transition of amateur radio transmitting stations from the spark to the continuous wave method has undoubtedly been more general than the average amateur would suppose. It is true that a great many amateur stations now using C.W. are able to cover only short distances, but this has been due more to the inability to secure proper equipment—primarily tubes—than to any lack of desire on the part of the fraternity to be able to work Mars with continuous waves.

A great many amateurs who have used the spark method of transmission for many years have been known to utterly refuse to be interested in C.W. transmission, and to give many reasons why C.W. transmission would never supplant, or even equal, the old familiar spark method. It is a notable and interesting fact also that after C.W. had been used awhile by others many of these same amateurs were the first to comment on the apparent advantages of it, especially its low decrement, or rather lack of decrement, the amazing distances it would cover on small power and its great flexibility.

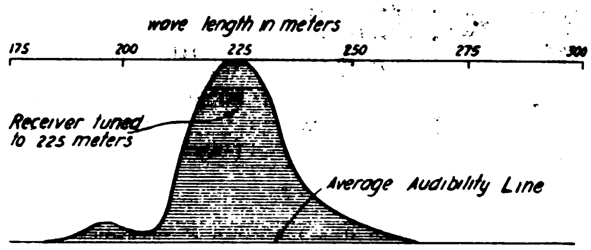


Figure 1

Diagram showing energy radiated over a large band of wave lengths

The spark transmitter, employing alternating current of some frequency, is good for one thing—telegraphing. It has frequently been stated that the only way to get anywhere with a spark set is to use power to the limit. Of course construction of the station, antenna system and a few other things are considered important incidentals, but the main thing is power. When the idea of distance gets into the station owner's head, the first thing he thinks of is power and the greatest possible antenna current. It is a common thing to see an amateur station with a one kw. transmitter that draws 1,500 actual watts working on a ¼ kw. antenna system. In fact, a canvass of amateur stations throughout the country will show such a condition much more often than it will a 1 kw. antenna system with a ¼ kw. transmitter.

It is true that while his intentions are of the best, in many cases the amateur is limited in a mechanical or financial way in the construction of his antenna and ground system. So he does the best he can. The writer has visited a great many amateur stations throughout the country and in most all of the cases noted, the antenna and ground system was entirely inadequate to properly handle the amount of energy put into it by the spark transmitter. The idea of designing a transmitter and antenna system suited to each other is an important point generally overlooked by amateurs.

If one were to attempt to use pressure, and force two gallons of liquid into a one-gallon receptacle, something would be likely to happen. In the case of the station using a 1 kw. spark transmitter on a ¼ kw. antenna, the something that happens is the emission of energy on a hundred or so wave lengths, even with a loose coupling. The effect is the same as in the case of a too closely coupled set—where energy is radiated over a large band of wave lengths. The result at the receiver is about as shown in figure 1.

About 75 per cent of the amateur QRM we hear so much about is due to the fact that energy is being radiated over a wide band of wave lengths, instead of on a narrow band as it should. Certainly the receiver can only be tuned to one wave length at a time, consequently all the energy radiated on other wave lengths is wasted energy, accomplishing nothing but interference in the case of other stations endeavoring to receive on neighboring wave lengths.

The legal decrement of a transmitting station is fixed at .2, and even where this feature of the radio law is complied with, there is interference on other wave lengths when a nearby station is endeavoring to receive signals.

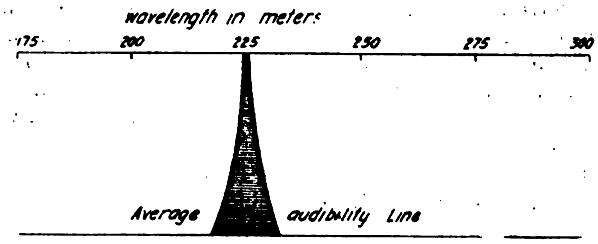


Figure 2

Diagram showing energy radiated practically on one wave length for C. W. transmission

In the case of C.W. transmission, the energy is practically all radiated on one wave length. The result at the receiver is shown in figure 2.

It will readily be seen that C.W. transmission eliminates practically all of the unnecessary QRM caused by a spark set of reasonable power. The fact that the signals from a C. W. transmitter can be heard at only one place on the receiving set is one reason why many amateurs have objected to its use as a means of communication. These objections are based on both ends of the transaction—the operator of the transmitting station experiences difficulty in "raising" a distant station, and receiving operator complains of the unusual sharpness of tuning which calls for more than ordinary care in the adjustment of circuits, etc. These objections, however, seem trivial in the face of the great advantage of C. W. transmission over the spark method, especially as they can be overcome easily.

In the matter of "raising" distant stations, a schedule should be agreed upon and once the operator of the receiving stations knows the wave length of the transmitting station there will be no further difficulty about effecting communication. As the use of increased power for C. W. transmitters develops, there will be less difficulty in "raising" practically any station within working range without resorting to previous notice and agreement.

The complaint of sharpness of tuning at the receiving end usually dissipates quicker than last week's salary once the advantages of it are experienced. Of course, the practice of closely coupling the receiving set, and lying back in a chair with a pair of cowhides decorating the operating table won't bring in C. W. signals. The operator must possess enough initiative to occasionally explore for them. Once the signals from a C. W. transmitter are located, however, the possibilities of tuning them away from QRM and QRN are there. It is up to the operator to accomplish this very desirable result. It is quite a common thing nowadays to get a card from some fellow hundreds of miles away saying that the C. W. signals were QSA and could be read through local QRM, etc., without trouble. And this is quite true even when the antenna current of the transmitting station was n the neighborhood of approximately one ampere. As was stated in the article in last month's issue, operators of stations make a great mistake in not doing more exploring for C. W. signals. On nights when the air is "dead" and no distant spark stations can be heard, there is usually some distant station using straight or modulated C. W. whose signals can be easily read.

When the output of a C. W. set is modulated with a buzzer or tone wheel, the received signal can be regenerated and amplified to a much greater extent than a spark signal, especially of the 60 cycle variety. In fact it is often found that such a signal can be regenerated and amplified to such an extent as to become objectionably loud.

Another great advantage in the use of C. W. by amateurs, for short distance work particularly, is in voice modulation. The fact that the law requires that work shall be carried on with a minimum of power necessary to effect successful communication is a point generally overlooked, intentionally or otherwise, by many operators of 1 kw. "stone crushers" and it is a frequent occurrence to hear a 1 kw. station using full power to communicate with another station on the same block. This phase of amateur radio has been repeatedly criticised. Everyone is familiar with the tales of the interfering spark coil station, whose operator is usually accused of being able to transmit, but not receive, and the misuse of power by the big station is a favorite method of counter-attack on the part of the small station operator. It is, however, quite true, that the high-powered amateur stations are frequently interrupted in relay work by small stations and spend much precious time and use many kw's of good energy trying to make the operator of the small station understand that he is interfering—at the end of which the operator of the small station often comes back and informs the operator of the high-powered station that his "signals are strong tonight."

The use of a voice modulated C. W. set obviates all such discontinuance of diplomatic relations. The operator of the small station can usually understand English, even though he never heard of Morse, and if he understands that he is creating interference, will usually "stand by" or "go to bed." Then, too, there is always the opportunity to entertain the wide world with music, providing one is so inclined. And many are so inclined, it seems, for the night air is full of all kinds of music.

With spark transmitters of high power (1 kw. or more) all sorts of mechanical and electrical difficulties are generally present. "Kickbacks" are the bugbear of an amateur's life, except in cases where proper care is used in the layout and erection of a station, and even then they happen. The matter of insulation is another matter of great importance, both in the case of interior wiring and the antenna system. It is generally possible to properly insulate interior wiring without great trouble, but where high spark voltages and heavy currents are imposed upon an antenna it is a different matter. Where more energy is impressed upon an antenna system than the system can properly take care of brush discharges occur to such an extent as to cause aerial fireworks of considerable magnitude and loss of efficiency. Frequently the antenna insulators break down under such unusual strain.

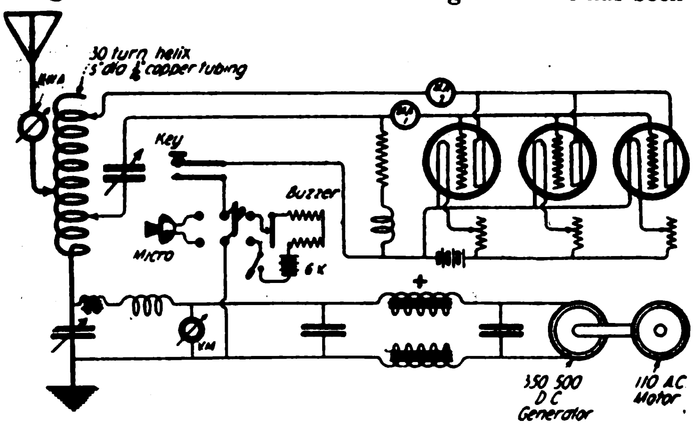
Another phase of spark transmission which has caused amateurs generally to sit up and take notice the country over is the stand the power and telephone companies have taken where high-powered amateur spark sets are operated. In many cities and towns the power companies have recently refused to allow transmitting sets to be connected to house lines, insisting that a separate service transformer and separate power line be installed. The cost of installation of the separate transformer and service asked by the power companies has been generally

(*Continued on page* 14)

Amateur C. W. Transmission

Errata Notice

CERTAIN omissions occurred in the diagrams of the article "Amateur C. W. Transmission," by J. O. Smith, which appeared on pages 14 and 15 of the January WIRELESS AGE and they are reprinted here in the completed form for the benefit of readers who may not have noticed the absence of the missing elements. In all the diagrams a variable condenser in the grid circuit has been



Fgure 1—Circuit diagram showing method of modulating the output

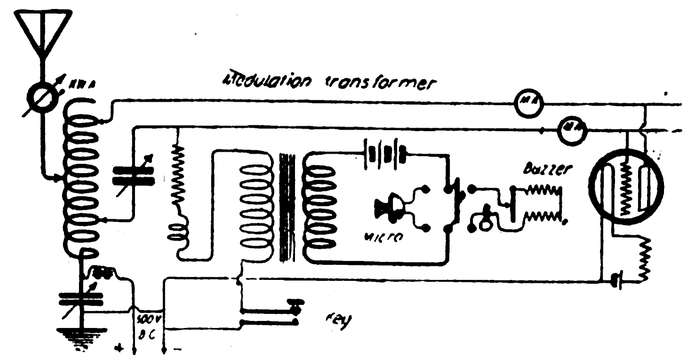


Figure 2—Circuit diagram having the secondary of a modulation transformer in the grid leak

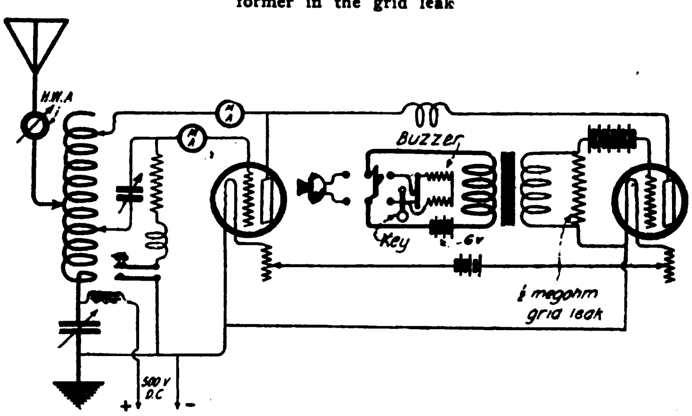


Figure 3—Diagram showing the Heising system of modulation

inserted, without which the circuit would not oscillate. An audio frequency choke coil, in series with the positive pole of the high voltage generator also is necessary for modulation purposes. In figure 2 a six-volt battery is necessary in the primary of the modulation transformer. The completed diagrams appear above and can be substituted for those appearing in the January issue.

Admiral Bullard

The Director of Naval Communications In a New Role—How He Offered the Initial Suggestion That Led to the Formation of a Great Combination of Radio Interests

William H. G. Bullard, Rear Admiral of the United States Navy

ADMIRAL Bullard, known and respected wherever radio men follow their calling, has achieved a new international stature. Under his advocacy, in a period concerned with the reconstruction of world affairs a great forward step has been accomplished, almost unnoticed; it is the securing for America of a new position in the nation's communication with the outside world. News and commercial services—so important a factor in the country's fight for trade supremacy—no longer are to be at the mercy of foreign countries. Timely intervention by William H. G. Bullard, Rear Admiral of the United States Navy, has worked to set aside the foreign hand that has long held the domination over the cables and might have secured a like hold on long distance wireless.

A leader and the guiding light since the navy became interested in wireless, Rear Admiral Bullard some time ago foresaw the danger to America's commerce should foreign interests secure a hold on two new American inventions which have done more to revolutionize the radio system of the world than anything else—the Alexanderson high frequency alternator and the Weagant Static Eliminator.

The British Marconi Company has been quick to realize the importance of these inventions. In the spring of 1919 a $5,000,000 order for Alexanderson alternators was placed with the General Electric Company, holders of the patents and manufacturers of the machine. Before closing this deal the company, realizing the seriousness of any move that might give world radio control to another nation, decided to first consult with the United States Government. The Navy then had a war control of wireless, so the situation was explained to Secretary Daniels. Rear Admiral Bullard, in company with Commander S. C. Hooper, Bureau of Engineering, went to New York to appear before a meeting of the Board of Directors of the General Electric Company. They urged the company not to sell, although they had no alternative to offer, for the Navy was no longer in the commercial field and could not buy the machine. The appeal, nevertheless, hit its mark. The British contract was set aside with the observation by Charles A. Coffin, chairman of the Board: "Now we will start afresh. We will not put this machine in the hands of foreigners without some regulation and control. But what shall we do? We have no other customers for it."

"Why don't you go in the business yourself?" asked Admiral Bullard.

This suggestion solved the problem. It opened the way for the organization of The Radio Corporation of America by General Electric and American Marconi interests, a strictly domestic concern backed by the country's strongest financial interests and possessed of the patent rights to the Alexanderson alternator.

One of the first acts of this new company was the purchase of the British holdings in the American Marconi Company. Then with the consent of the stockholders, it next absorbed the American Marconi, thus bringing radio activity in the United States under wholly American management.

This movement, of such far-reaching importance that its full significance is not yet realized, will stand as a monument to the vision of the Admiral and his eagerness to secure independence of communication for his country. The commercial advantages thus secured were recently emphasized by Gordon C. Corbaley, assistant to the President of the Seattle Chamber of Commerce, who in speaking before the National Foreign Trade Convention at San Francisco on the dire needs of better foreign communications with particular reference to deplorable conditions on the Pacific coast, said:

"This intolerable condition must be corrected. We must have adequate communication facilities with the Orient, or America and the Pacific will lose the business turned by the War.

"Wireless offers the first hope of relief. This is largely because of the basic change that is taking place in the world's wireless situation. To most of us wireless is a thing little understood. Even to experts that is largely true. In its early stages wireless made slow progress. This was largely because the Marconi Company was not adequately financed and the big problem of wireless could not command the concentrated technical attention necessary to their solution.

"In 1919 the world's wireless system was revolutionized.

"This was largely because of two inventions:

"The Alexanderson Alternator was perfected to send a continuous wave of oscillations upon which the message was imposed, thus taking the place of the intermittent sparks.

"The Weagant Static Eliminator was perfected to relieve wireless from the atmospheric disturbances that had rendered dependable service almost impossible.

"Then took place an event that should be written deeply in the history of American commerce. Due to the fine patriotism of Admiral W. H. G. Bullard, these inventions were saved for America and have been made the foundation for a world-wide American wireless service.

"Admiral Bullard is the man who has really built the communications service of the Navy. As a captain he originally organized that service and under war time strain he was returned to its command.

"Impressed with the necessity for a world-wide service owned by Americans and operated by Americans he went before the officers of the General Electric Company and pleaded with them to hold these inventions and to make the wireless of the future an American institution.

"Admiral Bullard won his point. The General Electric Company purchased the control of the American Marconi Company and it was reorganized as the Radio Corporation of America, with a provision in its laws that 80 per cent of its stock must always be owned by Americans.

"The Radio Corporation of America is preparing to cover the world with a modern, efficient wireless system. One of the first steps in this plan is to be a comprehensive solving of the communications problem of the Pacific as far as wireless can ever solve that problem. A great modern sending station is to be built on the Pacific coast of the United States, able to send messages direct to receiving stations in the principal cities of Japan, China, Philippines and the Straits Settlements.

"A concession has been secured from China to permit the erection of a similar sending station near Shanghai strong enough to talk direct to Seattle, Portland, San Francisco or Los Angeles.

"When this system is fully in operation, wireless messages can be filed at any large city in the United States or in the Orient, can be relayed by wireless to the sending station on their side of the water, and then sent direct by wireless to the city of their destination.

"All of this sounds too perfect to be true. It is probably more perfect than it will be for many months to come, but I have tried to give you the idea that has been approved by the General Electric Company and that is in process of realization by Edward J. Nally and his associates."

That he should offer the initial suggestion that set such great forces to work was probably far from the thoughts of young Bullard, when 22 years ago as a naval lieutenant, fresh from Spanish American war service, he was first attracted by wireless. During his student days at Annapolis, electricity and electrical engineering interested him. These studies he carried on further, following graduation. He soon became known as one of the "electrical sharps" of the navy.

Wireless appealed to him, both as an electrical engineer and as a military officer. With his knowledge of electricity the military possibilities that lay in radio were readily apparent. So he threw himself into the subject.

He is now Director of the Navy Communications Service, and was the first superintendent of radio service from 1912 to 1916, since enlarged to embrace all forms of communication activities. In that capacity he is head of one of the most extensive radio services in the world. More than 140 shore stations, eighty radio compass stations, five transoceanic stations and five air stations are under his administrative direction, in addition to the radio installation on all Navy department vessels.

Born in Media, Pa., December 6, 1866, he is not yet 55 years old. In 1882 he was appointed a naval cadet from the sixth Pennsylvania district. He completed his four years' course in June, 1886, and on July 1, that year, was commissioned an ensign. He returned to the Naval Academy for four different tours of duty as a member of the faculty. Physics, chemistry and electrical engineering were the subjects he taught. In 1896 he was promoted to lieutenant, junior grade; three years later he was made a lieutenant and on January 1, 1905, was appointed a lieutenant-commander. February 1, 1907, he was again promoted, this time to commander. On October 1, 1912, he was made a captain and it was then he became associated with the navy's newly organized radio communication service. In 1918 he was promoted to rear admiral, the position he still holds.

He originated and for a period of four years from 1907 to 1912 was head of the new department of electrical engineering at the Naval Academy. Scores of young naval officers owe their knowledge of electrical engineering and fondness for the science to the Bullard inspiration, and his text "The Naval Electrical Text Book" is the standard in the course of Electrical Engineering.

But in the navy, no matter what may be the scientific attainment of an officer, he has to perform the routine duties of the service. Hence, Rear Admiral Bullard has more than eighteen years of sea service to his credit, his last command before coming ashore being in the World War as commander of U. S. Naval forces in the Eastern Mediterranean and charged with accomplishing the naval terms of the armistice with Austria Hungary. Under his command certain Austria-Hungary battleships were taken over by the American forces. He further participated in the first allied commission to investigate conditions in Fiume.

In 1899, the year following the Spanish-American War, Marconi brought to this country from Italy three sets of his wonderful new wireless apparatus, the immediate purpose being to use them in reporting the International yacht races that year. The Navy Department appointed a commision to observe and report on the working of the system. Following the report of this body, the Navy placed the battleship Massachusetts, the armored cruiser New York, and the torpedo boat Porter at the disposal of Marconi for further experiments. A shore station was established near New York, the first in America. The three vessels were the first of Uncle Sam's navy so equipped. Thus began the navy radio service.

The growth and development has been remarkable. No part of the Atlantic or Pacific Ocean is too far away to be out of reach of a radiogram from an American naval shore station. In fact during the World War, it was possible for Washington to keep in constant communication with its forces abroad through radio from the powerful New Brunswick station, equipped with the new Alexanderson high frequency alternator. America's armistice terms were sent to General Pershing through this station.

The organization of naval radio records both a growth and a develoopment of a service and an executive of demonstrated achievements.

Amateur Spark and C. W. Transmission

(*Continued from page* 12)

declared exorbitant, and in many cases the situation has resulted in a deadlock, the result being that the amateur has had to be content with a spark coil, or no transmitting set at all. The other phase of the question, that of interference on neighboring telephone lines, is a common occurrence and one which has caused no end of hard words by neighbors and the telephone company concerned.

While not vital to the operation of the offending station, such occurrences certainly do not add to the peace of mind of the operator.

With a C. W. set, however, unless the set is of unusually high power, the pull on the service lines is so small as to make connection on the regular house service lines entirely feasible and safe, and consequently no separate service is necessary or required. Neither is there any danger of overloading the antenna.

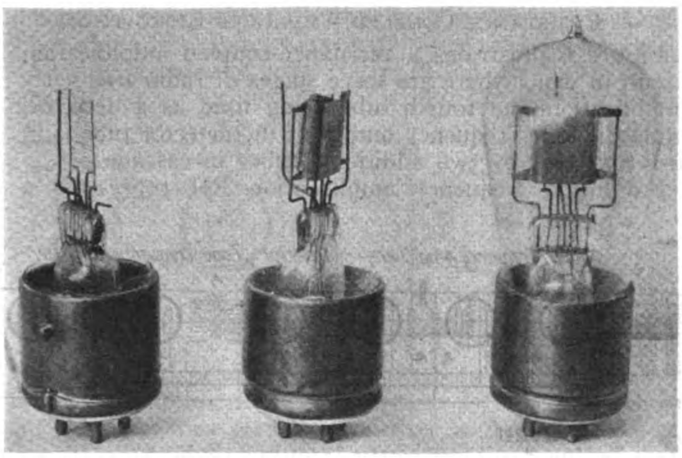
Unless the set is of very high power as amateur sets go, the difficulty is liable to be in the other direction, in that the capacity of the antenna system might be so great as to absorb energy faster than the set could supply it. The result of such condition would be that the set would not oscillate. Here, again, the rule that transmitters and antenna systems should be designed for each other still holds good. In the case of C. W. transmission, however, the matter is more favorable to the amateur field, in that a smaller antenna system, involving less expenditure of money for erection and upkeep, will answer every requirement of successful transmission.

In view of the fact that practically all of the energy of a C. W. transmitter is radiated on one wave length, a set of such characteristics of small power will usually accomplish as much at the receiver as a spark transmitter of many times the power, making a C. W. transmitter a comparatively inexpensive, safe and wonderful method of communication. And so far as interference on neighboring telephone lines by a C. W. set is concerned, it's like the case of the farmer at the circus menagerie when he first saw a giraffe—"Hec, there ain't no such animal."

Two New Vacuum Tubes

By Pierre H. Boucheron

THE vacuum tube as we know it today has rightly earned for itself the name, "An Electrical Acrobat." Indeed, speaking from a radio point of view, it has become what the Aladdin Lamp is reputed to have been to a certain mythological character. Considering the comparative short time in which it has emerged from the laboratory of scientists to its present position in the art of professional and amateur radio communication, it is hardly necessary to make further prophesies as to its future. Its past performance has already proclaimed it the modern wonder machine, and one recalls the rather startling announcement made recently of a New Jersey amateur radiophone having been heard clear across the Atlantic to Scotland.



Three views of the new tubes. To the left is shown the grid and filament set-up; in the center is the plate and its supports, while to the right is shown the actual tube. The detector and amplifier tubes are alike in appearance

With this in mind, it is, therefore, not strange that amateur radio should have been considered so important a factor in the development of the art as to set to work the brains and equipment of the greatest organization of its kind, in the task of developing two unusual tubes: one specially designed and adapted for amateur radiotelegraph signal detection, and the other to the equally important task of radio and tone frequency amplification.

The Detector Tube

The first of these tubes, which by the way travels under the rather expressive name of Radiotron, is known primarily as a detector and secondarily as an amplifier and is designated as the U.V.-200. It is a supersensitive tube having the desirable feature of operating from one standard 22-volt plate battery. Since economy is an important factor to the amateur, this single battery operation eliminates one of the most frequent objections to other types of tubes, some of which require from three to five standard plate batteries before the necessary plate voltage is attained.

Incidentally, this detector has not only been found to be an exceptional spark signal receptor, but it is also an excellent tone frequency amplifier, and therefore proves of great value for the magnification of the usual telephone current in vacuum tube receiving circuits. It has also been found to give very good results when used with any standard amateur regenerative circuit.

A Recent Test

A recent test in New York City performed by a well-known amateur furnishes some rather interesting information concerning some of the operating characteristics of this detector. The experiment was performed with a standard amateur receiving set ranging from 150 to 1000 meters in wave length.

A number of tubes were taken and tested in sequence, in order to determine their constancy of function. In this case it was very evident that all gave equal signal intensity and were better in detection than any other tubes, providing, of course, that both the filament and plate potentials were properly adjusted, that is to say in accordance with existing practice and instruction.

Although Radiotrons are much better detectors than many other types on the market today, even during the early hours of their life, it has been observed that their sensitiveness seems to increase with the operating life of the tube.

Operation as Detector

In figure 1 we are shown one form of regenerative circuit particularly adapted for amateur use. For future work it would perhaps prove a wise plan to copy or preserve this as well as the other hookups referred to in this article.

There are some experimenters who prefer a variable grid condenser, finding it advantageous in regenerative circuits. However, when the Radiotron detector tube is used for detection a fixed grid condenser of approximately .00025 mfd. should be inserted in series with the grid and the upper leg of the secondary coil L-2. Across this grid condenser a grid leak R-1 is connected as shown in figure 1.

In connection with grid leaks the following should be borne in mind. Although tests show that in most cases the proper "leak resistance" for use with the U.V.-200 type Radiotron is in the neighborhood of ½ megohm

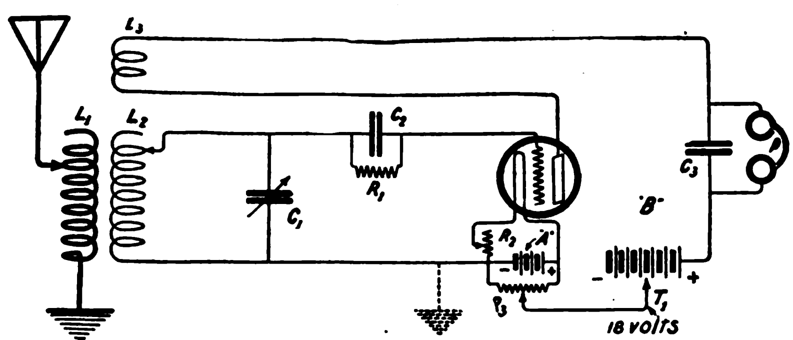


Figure 1—One form of regenerative circuit

(500,000 ohms.) this is not always the correct value for all circuits. This is due to a number of conditions met with in standard receiving circuits and these conditions govern the proper value of grid leak resistance. For instance, the leakage which may occur through the insulation of the receiving apparatus plays an important part in the choosing of grid resistances.

As a matter of fact, resistance of from ½ to 3 megohms have been found by experiment to be of advantage. Thus it will be seen that in order to secure best results with any vacuum tube detector the amateur should have a small assortment of grid leaks at his disposal ranging, let us say, from ½ to 3 megohms. Of course, these are not absolutely necessary, but for purposes of experimentation this scheme will be found useful. The proper use of these leaks gives stability to tube circuits and they often increase the signal audibility considerably. Incidentally it is well to remember that a standard grid leak of a definite and stated resistance proves most reliable in the long run and eliminates guess work.

Cascade Amplification

The detector and two-stage amplifier in radio reception has of late become very popular with amateurs and experimenters. Such amplification is, in fact, particularly suited and desirable for radiotelephony, otherwise one cannot expect long distance work.

In this type of circuit the Radiotron detector tube has given excellent results. Figure 2 shows three of these tubes in use; one as a detector and two as amplifiers. As will be seen, the circuit is a regenerative one and the two stages of amplification are at tone frequency.

Figure 2 shows an "A" battery potentiometer which is of a special type having from 50 to 200 ohms. in resistance for close variation of the plate voltage of the first or detector tube, but a tapped "B" battery will give good enough results for average working. The plate circuit of the detector tube should be tapped at some point on the "B" cell, giving a plate voltage lying between 16 and

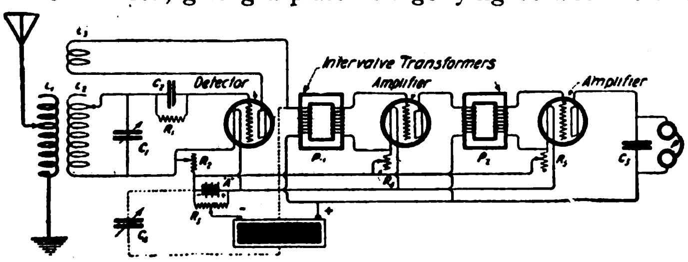


Figure 2—Detector and two-stage amplifier circuit

22½ volts. Usually the plate circuits of the two amplifying tubes can be connected to the full voltage of the "B" cell. The circuit is of unusual simplicity and is well adapted to general communication. In the event that U.V.-200 is used as a detector and several stages of Radiotron U.V.-201 as an amplifier, the whole set can be worked from two "B" batteries. The plate connection of U.V.-200 should then be tapped at 16 to 22½ volts, and the full voltage of the two batteries applied to the amplifier, U.V.-201.

The Amplifier Tube

The second tube dealt with in this article is of the pliotron type and has been designed specially for ama-

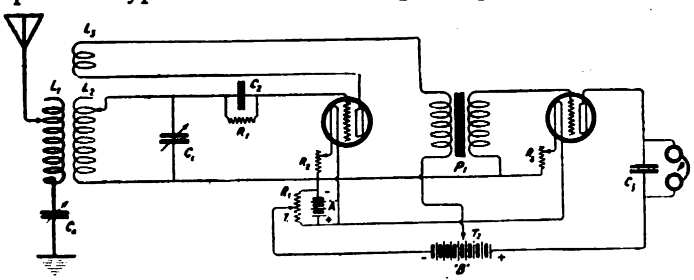


Figure 3—Detector and one-stage amplifier circuit

teur and experimental radio stations; it is designated as the U.V.-201. In the design of this unusual tube the requirements of complex amplifying circuits has been taken into account with the result that this type possesses rigid operating characteristics. It will magnify radio and tone frequency currents in radio receiving sets, and can be shifted from one socket to another in a cascade arrangement without loss of signal audibility. In cascade radio frequency amplifying circuits the U.V.-201 can be adjusted to magnify without distortion. The use of such circuits has of late been desired by amateurs seeking long distance communication on short wave lengths—that is, 200 meters or less.

Although the detector tube U.V-200 previously mentioned is in itself a good tone frequency amplifier, it does not give the "power" amplifications which may be obtained with the amplifier tube U.V.-201, therefore, for devices requiring a considerable amount of energy, such as loud speaking telephones, etc., this special amplifier tube proves of great value and is, of course, preferable.

In figure 3 we have a detector and one-stage amplifier circuit where either the gas content detector or the pliotron amplifier tube may be used for detection and where the pliotron amplifier is used for one step of tone frequency amplification.

Resistance Coupled Amplifier Circuit

Figure 4 illustrates a resistance-coupled amplification circuit in which there are three stages of radio frequency amplification, the fourth tube being used as a detector, while the tone frequency output of the detector tube is in turn amplified by two additional tubes in cascade.

For radio frequency amplification R-1 represents a

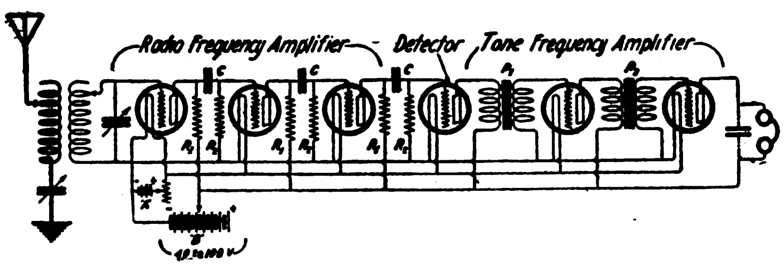


Figure 4—Diagram of a resistance-coupled amplifier circuit

coupling resistance of ½ megohm, R-2 indicates a grid leak of approximately 2 megohms. P-1 and P-2 are suitable intervalve tone frequency transformers. A is a 6-volt storage battery of suitable ampere hour capacity, and B a plate battery providing from 40 to 100 volts for the plate. If a single filament rheostat such as R-4 is employed to control the filament current of all the tubes, the precaution should be taken to secure a rheostat of suitable current carrying capacity, allowing approximately 1 ampere for each tube.

There are, of course, numerous other circuits in which these tubes may be used with marked results. The four circuits given in this article may prove suggestive and of practical value to the experimenter.

Some Interesting Operating Data

Now that the more general facts concerning these highly developed and effective tubes have been presented it is perhaps not untimely that amateurs should be interested in their operating characteristics. It is therefore, presented in an easily accessible manner in figure 5.

FIGURE 5—TECHNICAL DATA ON THE NEW AMATEUR VACUUM TUBES

Type	*Filament Current*	*Filament Voltage*	*Plate Voltage*	*Grid Leak*	*Grid Condenser*	*Impedance*	*Amplification Constant*	*Life in Hours*
Amateur Soft Detector and Amplifier Tube	1 to 1.1 amp.	5V	18 to 23.5	0.5 meg.	.0005 mfd.	3000-5000 ohms		1000 average
Amateur and Commercial Hard Detector and Amplifier	1 amp. or 6%	5V	40 V normal 100 V max.	0.5 to 2 megohm	75 to 1000 micro-mfds.	15000 to 25000 ohms at 40 volts. 10000 to 15000 ohms at 100 volts.	6.5 to 8 at 40 v. 8 to 10 at 100 v.	1000 average

Radio Telephony Systems Employing Thermionic Vacuum Tubes

By John Scott Taggart

Editor's Note: This article contains a portion of the matter embodied in a complete volume on vacuum tubes by the writer. The volume will very shortly be published.

(*Continued from January* WIRELESS AGE)

FIGURE 4 illustrates a wireless modulation system capable of giving very good results. The output circuit of the oscillator could be induced by means of the transformer L_1 L_2 into the intermediary circuit L_2 C L_3, the coil L_3 being either connected across the grid and filament of the amplifying tube or coupled loosely to a coil L_4, which represents the input circuit of the amplifier. Leakage will occur through the tube and the extent of this

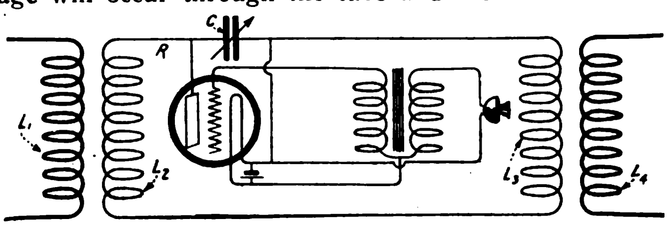


Figure 4—Circuit of a modulation system giving good results

leakage will depend upon the grid potential of the tube. If this potential be highly negative no leakage will occur, but if it becomes relatively positive a large amount of energy will be deflected by the tube and will be dissipated on the plate. A resistance may, if desired, be included in the plate circuit of the tube in the position indicated by the letter R. This resistance improves articulation and will help to dissipate the diverted current. The microphone, it will be noticed, is supplied with current from the same source that heats the filament of the absorbing vacuum tube. Instead of using one tube, two tubes may be employed, or a tube employing two plates and one filament. These modifications become very important when using later systems of modulation and will be discussed then.

A practical circuit employing the arrangement of figure 4 is shown in figure 5. The vacuum tube V_1 is used to produce oscillations in a plate oscillatory circuit L_1 C_1 in the usual manner. The inductance L_1 is coupled in a variable manner to an inductance L_3, which may, if desired, be tuned by connecting a variable condenser in parallel with it. This latter circuit constitutes the input side of the amplifier tube V_3 and energy is diverted from this imput circuit through the dissipation tube V_2, whose grid potential is varied by the microphone M through the step-up transformer. The potentials across L_3 will be modified on account of the leakage through V_2 and the modulated potentials applied to the grid of V_3 will be amplified and produce modulated oscillations in the aerial circuit. This arrangement gives good speech. As in all cases, the grid potential of V_2 may be made negative if desired. The potential of the grid of the amplifier V_3 is shown negative and is obtained by utilizing the potential drop across the grid leak of the oscillator V_1. If the grid of V_2 is to be negative a portion of the same grid leak may also be utilized in this case. Many variations of this circuit are possible and it is not proposed to give further examples. It must be understood that the system will work no matter what the source of primary oscillations. Some form of vacuum tube generating circuit is, however, to be recommended on account of the purity of the oscillations produced.

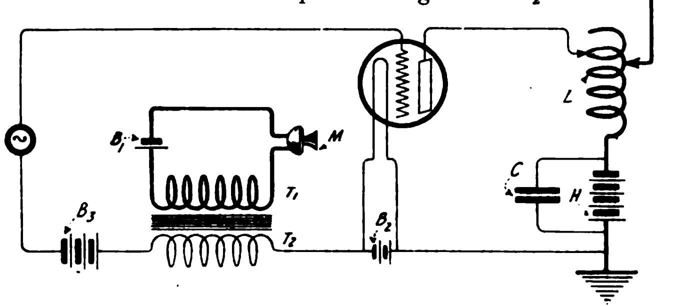


Figure 6—Fundamental circuit of a separately excited amplifier system

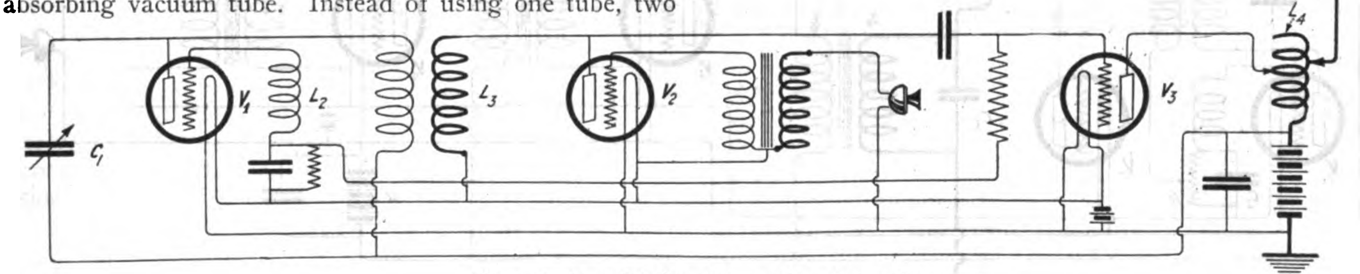


Figure 5—A modulation system using three tubes

We now come to a separately excited amplifier circuit in which the output of the amplifier tube is varied microphonically. There are various ways of doing this, one of them consists in varying the normal operating grid voltage by means of a microphone. The fundamental circuit is shown in figure 6. The source of oscillations

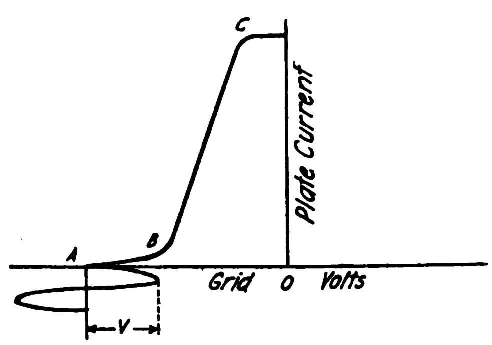


Figure 7—Graph showing the plate current curve

is in the grid circuit of an amplifying tube V_2. In the grid circuit is also included a source of electromotive force B^3 which gives the grid a high negative potential, a secondary T_2 of a microphone transformer T_1 T_2 is also included in the grid circuit. The action of this arrangement will best be understood by reference to figure 7, which shows the plate current curve of a three

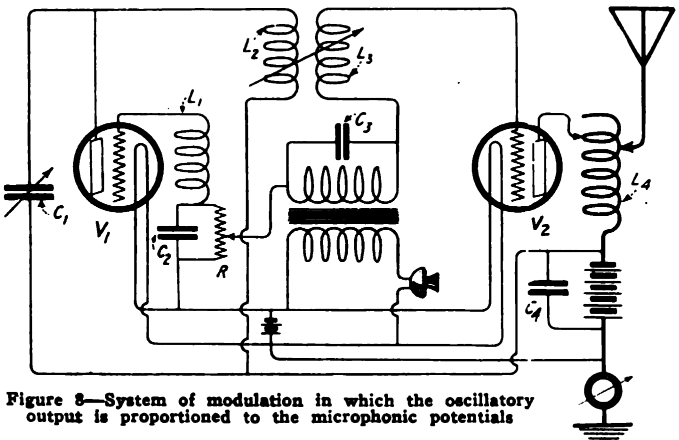


Figure 8—System of modulation in which the oscillatory output is proportioned to the microphonic potentials

electrode vacuum tube (curve ABC). This plate current curve should preferably lie completely to the left of the vertical line through zero grid volts and this will be the case when the plate voltage is high.

Let us consider that we are operating the tube at a point A on its characteristic curve; that is to say, at a negative potential well to the left of the point B. Let us consider, moreover, that the high frequency oscillations are of amplitude V and during their positive half cycles cause the grid potential to move from A to about B. Obviously under normal conditions no current will

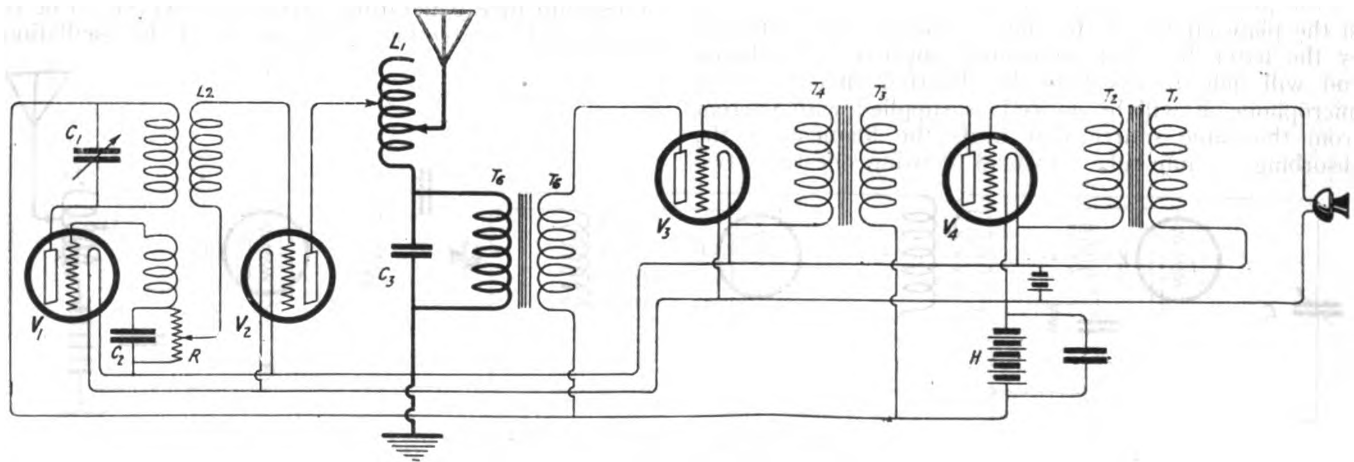


Figure 10—Circuit of system with power for long distance work

be produced in the output circuit of V, since the grid potential never reaches a sufficiently high value to produce any such current. If, however, we were to decrease the value of B_3 or in other words, move the normal operating or grid "base-line" potential, the positive half oscillations will cause the grid potentials to move up the steep portion of the characteristic curve and the oscillatory output of the tube V_2 will depend on the amount of the curve utilized. The maximum output will be attained when the high frequency oscillations vary the plate current between its minimum and saturation values. Now by utilizing the microphone potentials produced in T_2 we are able to vary the normal grid "base-line" potential and so move the operating point between A and B. The oscillatory output will consequently be proportional to the microphonic potentials. This is exactly what we desire to obtain—good articulation. This system of modulation gives very good speech in actual practice

and a practical circuit employing this arrangement is given in figure 8.

The tube V_1 is the master oscillator whose frequency is tuned by means of the condenser C_1 connected across the inductance L_2 in the plate circuit. This latter inductance is coupled to an aperiodic coil L_3 in an adjustable manner. A suitable negative potential for the grid of the amplifier tube is obtained by means of a tapping off the grid leak R in the grid circuit of the oscillating

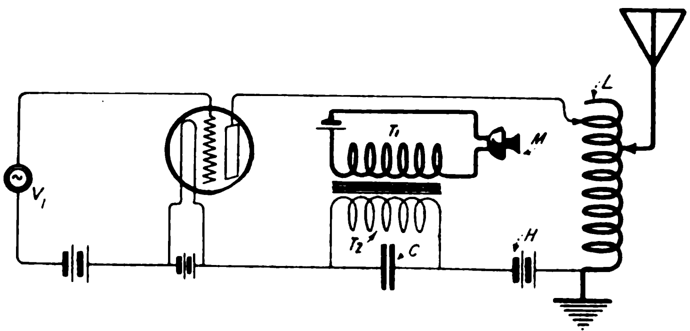


Figure 9—Diagram showing tube used as an amplifier with a separately excited grid circuit

tube V_1. The microphone and microphone transformer are also connected so as to vary the grid "base-line" of the tube V_2. A condenser C_3 may be connected across the secondary of the transformer in order to by-pass the high frequency potentials. A coupling between L_2 and L_3 is adjusted to give the best results. As shown in previous circuits the same source of plate voltage is used for both the oscillating and the amplifying vacuum tubes. The latter tube will usually be of larger dimensions than the master oscillator or if desired, several tubes may be connected in parallel to obtain the necessary

power. It is to be noted in all these separately excited amplifier circuits that the aerial circuit must be accurately tuned to the same wave length as the oscillator. This perhaps makes it a little more difficult for these circuits to be rapidly tuned to different wave lengths, but the disadvantage is of no great importance since most stations work on a fixed wave length which is rarely changed. When the master oscillator has been set to the given wave length which incidentally is independent of the aerial system, the latter circuit may be correctly tuned by altering the adjustments until the maximum antenna current is registered by the aerial ammeter. It is to be noted that this class of circuit does not radiate when not actually speaking, a very distinct advantage. The plate current of the amplifier tube is normally almost zero, but rises to high value when speaking into the microphone. By eliminating the carrier wave when not speaking less power is wasted and less interference is caused than when the ordinary arrangement is employed.

Our next type of circuit consists of a three electrode tube used as an amplifier with a separately excited grid circuit, figure 9, the exciting source being preferably a vacuum tube oscillator. The plate voltage is supplied by means of a microphone transformer T_1 T_2. When not speaking the plate voltage is zero, consequently no oscillatory current is produced in L although the grid potential of the tube V_2 is being altered at high frequency by means of the oscillator V_1. When M is spoken into however, the plate of V_2 becomes positive to an extent depending upon the potentials supplied by the transformer. Since the oscillatory current in L will be directly proportional to the voltage of the plate, we see that the waves radiated from the aerial will be modulated in accordance with the microphone potentials. It is to be noticed that the microphone transformer is now supplying all the energy for transmission as well as acting as a modulating device. No energy is thus being wasted when not speaking and no radiation occurs. Although this would appear to be a very useful circuit, the speech obtainable is not as good as in certain other systems. In the figure we have shown a source of electromotive force included in the grid circuit of V_2, this electromotive force is desirable, but not essential. We have also shown a source of electromotive force H which may be omitted altogether, but when added to give the plate a small steady potential produces better results. If H be of a high value, say, half the emf. which would produce saturation of the tube V_2, the action of the circuit becomes rather different. There will normally be a steady stream of waves radiated. When speech is being transmitted the potentials across T_2 being positive and negative will alternately add themselves to, or subtract themselves from, the battery or source H, thus the plate voltage of V_2 will be varied perhaps between zero and twice the voltage of H. The oscillatory output will consequently be modulated between zero and twice the normal value.

When H is omitted it will clearly be seen that it is only the positive half cycles produced in T_2 which supply the power. This power in the case of an average microphone transformer is in the neighborhood of 0.12 watts and is thus practically useless for ordinary work. We can, however, amplify the microphone potentials and connect the output circuit of the amplifier in place of the winding T_2, any desired power may in this way be obtained. A practical circuit carrying these ideas into effect is shown in figure 10. The tube V_1 obtains its plate voltage from the battery or dynamo H, the oscillations produced in L_1 C_1 being passed on to the grid circuit L_2 of the amplifier tube V_2. The grid potential of V_2 is maintained at a negative value in the usual manner. The main power is supplied by means of a vacuum tube V_3, which is also fed from H. The output transformer T_5 T_6 has its secondary T_6 arranged so that the potentials across it are connected to the plate of the tube V_2. If desired, the mircophone transformer could be connected across the grid circuit of V_3, but in the figure the author has shown the use of a preliminary amplifying tube V_4 also fed from the battery H. Sufficient power for long distance working could be obtained by the use of circuits of this nature.

If we are proposing to use the arrangement without the addition of a separate steady source of plate voltage for V_2 it will be desirable to give the grids of the tubes V_3 and V_4 a negative potential, otherwise half the output of T_5 T_6 will not be used since it would tend to give the plate of V_2 a negative potential. The negative potentials for the grids V_3 V_4 may be obtained by connecting the foot of T_4 and the foot of T_2 to a point on the resistance R. If we desire to have steady voltage in the plate circuit of V_2 we could either use a separate source of emf. or use the battery or dynamo H. A little consideration will show that this can be done by connecting the foot of T_6 not to the earth as shown, but to the positive terminal of H.

(To be continued in March)

Self-Cooled Quenched Gap

A QUENCHED spark gap which is light in weight and relatively cheap to manufacture has been developed by Henry E. Hallborg. This gap has no fan or blower protective devices, auxiliary leads or switches, is self-contained, and has nothing inflammable in its construction.

an insulating gasket as applied to a unit. Figure 4 is a perspective view of another of the radiating units. Figure 5 is an enlarged section of a portion of the device shown in figure 1, and figure 6 is an end view of the device.

Extending between the end supports secured to the base

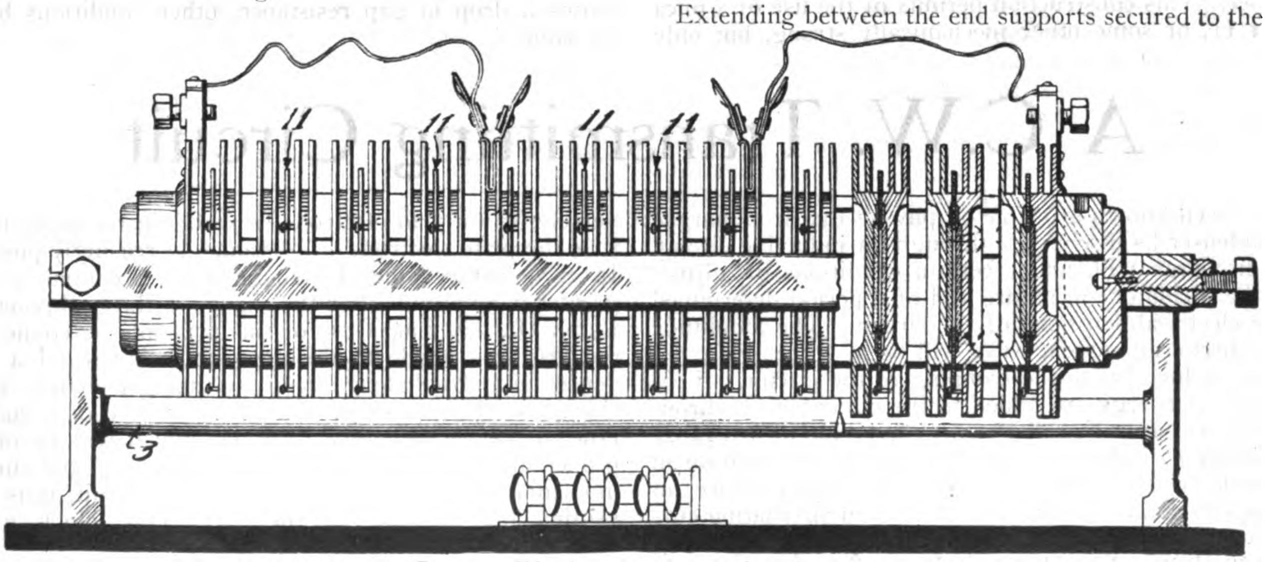
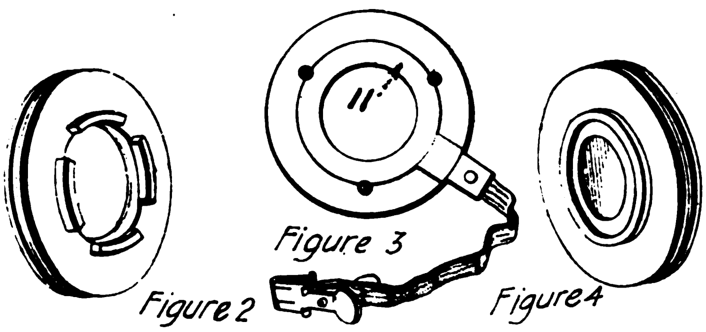


Figure 1—Side view of the quenched spark gap

Figure 1 is a side view of the device, some parts being shown in section. Figure 2 is a perspective view of one of the radiating units. Figure 3 is a face view showing

is a pair of micarta rods 3, while at the top of the uprights is a frame. In figure 5, it will be seen that the device is made up of a series of units, these units consisting of a circular copper disk 5, having a comparatively deep recess 6 on one face and a relatively shallow recess 7 on the opposite face. The face having the recess 7 is further recessed to provide room for a chemically pure silver disk whose edges are slightly machined away, as shown at 8. This silver disk is soldered to the body portion 5 with a semi-hard solder made by increasing the lead content of ordinary solder to raise its melting point. The object of this procedure is to avoid heating the silver during manufacture to a temperature at which it will absorb impurities, as would be the case with silver solder or hard solder. A further reason is to insure a melting temperature of the solder well above that resulting from heating when the spark is in actual operation. Half of the units have segmental rims. The units are assembled in pairs back to back, one without the rim and one with the rim, as shown in the drawing. When assembled the openings formed by the registering recesses 6 allow free air circulation between each pair of sparking surfaces, and make the internal walls of the air chamber thus formed effective in radiating the heat due to the spark.

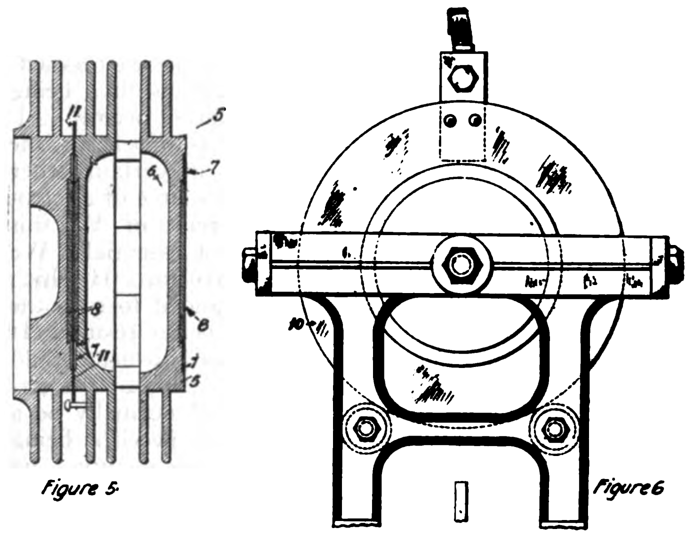


Detailed views of the radiating units

Each unit has two radiating vanes. Obviously any number of these may be provided as long as the total radiating surface provided is enough not to dissipate more than 5 watts per square inch. The object of keeping the outside diameter of the units small is to more nearly equalize the temperature between the bottoms and tops of the radiating vanes, since metal radiates heat faster at the higher temperature. This is the reason for the length of the gap and the comparatively small diameter of the units. The annular space 7 between the units is made shallow in order to inclose a minimum amount of air in the sparking chamber. This construction permits of the use of a mica gasket 11, or some other mechanically strong, but only semi-airtight gasket, without impairing the tone due to the air leakage. The air in the chamber is consumed more rapidly than it can leak in sufficient quantities to impair the tone. The gaskets 11 are retained in position and alignment by pins spaced 120 apart. This permits of rapid assembling and disassembling of the units without disturbing the individual gasket alignment.

The micarta rods support the plates and furnish temporary alignment. The plates when assembled are clamped by means of a clamping screw between the heads. This affords a construction which holds the plates securely, and yet which permits the device to be readily taken apart for inspection or repair.

The operation of the gap differs from the usual type of gap, in that the quenching of the spark is more rapid, resulting in lower current in the gap circuit and lower energy losses in this circuit. The coupling between the antenna and gap circuits can therefore be made closer with a corresponding increase in energy input to the antenna. The spark gap spacing is so chosen that the resistance of the gap is at its maximum or near this maximum. This maximum value of spark resistance had been found to vary with the diameters of the sparking surfaces and has a critical value for each. The spacing is so selected that increase or decrease of sparking distance causes a drop in gap resistance, other conditions being the same.



Sectional and end view of the spark gap

A C.W. Transmitting Circuit

It is a well-known principle of physics that if a charged condenser be discharged through an inductive circuit, such discharge will, under certain conditions of adjustment, be oscillatory in nature and of a period determined by the electrical constants of the circuit. The amplitude of the discharge current wave will be of successively decreasing value, due to the damping of the circuit. If increments of energy are added to the circuit in synchronism with its natural oscillations it is possible to neutralize the damping of the circuit or prevent the diminution in amplitude of succeeding waves. This will produce an undamped train of oscillations; that is, an alternating current of constant amplitude and a frequency depending upon the electrical constants of the oscillatory circuit will flow.

If the grid electrode be made increasingly negative, the plate electrode will become increasingly positive and conversely, if the grid electrode be made decreasingly negative, the plate electrode will become decreasingly positive. In each instance the change in anode potential will be greater in amplitude than the change in the grid potential. Ralph Hartley makes use of this principle by connecting the grid and anode to the opposite terminals of a condenser in an oscillatory circuit, so that any change in the charge on the condenser will be productive of a current flow in the vacuum tube repeater, which will be of the proper direction to increase the amplitude of the current momentarily flowing in the oscillatory circuit, thus preventing the damping of the oscillations which would otherwise occur.

A circuit arrangement for producing the result is shown in the accompanying drawing in which the condenser and inductances 1 and 2 comprise a circuit electrically tuned to give oscillations of the desired frequency. The grid is connected to one terminal of the condenser through a polarizing battery 3, while the anode is connected to the opposite terminal of the condenser through the "B" battery. The cathode is heated to incandescence by means of a battery and is connected to a point midway between the two terminals of the condenser. An inductance may, as shown, be associated with one of the inductances 1 and 2.

To understand the operation of the circuit consider the condenser to be charged in such a way that the terminal 4 is positive and the terminal 5 is negative, and that the filament battery is of such a value as to maintain the grid always negative with respect to the cathode. The presence of a positive charge, therefore, on terminal 4 will tend to decrease the normal negative charge of the grid which will have the effect of lessening the electrical obstruction which the grid charge offers to the thermionic stream flowing between cathode and anode. The reduction in this obstruction acts in effect like a lowering of the resistance of the path of the thermionic space current and decreases the positive potential of the anode with respect to the cathode. This decrease in positive potential will be greater in magnitude than the change in voltage on the grid which is due to the amplifying effect of the vacuum tube. Therefore, there will be an increase in the negative charge on the terminal 5 of the condenser, which will be in phase with the voltage of the oscillations in the oscillatory circuit and this energy will be added to the energy of the latter.

Upon the reversal of current in the oscillatory circuit the opposite action takes place, namely, the terminal 4 now being negative, the grid will become more negative, thereby raising the positive potential of the anode and adding to the energy of the current flowing from the terminal 5 to the terminal 4 through the inductances 1 and 2, thus oscillatory currents of a frequency which will be

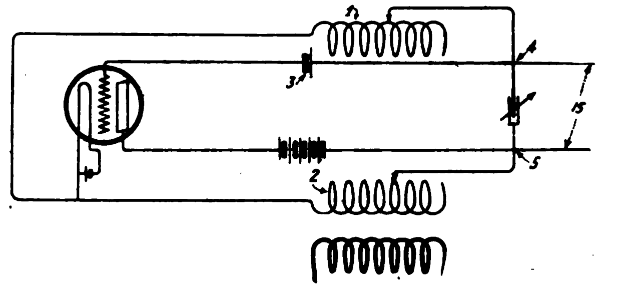


Figure 1—Diagram of the C. W. transmitting system

dependent upon the constants of the condenser and the inductances will be set up in the circuit. Such oscillations will be of constant amplitude, due to the increments of energy supplied by the vacuum tube and an undamped electro-motive force will be developed between terminals 4 and 5 which may be employed for radio telegraphic or telephonic transmission.

A Tube Transmitter Using Two Aerials

IT IS a well known fact that if oscillations of a predetermined phase are maintained in a number of transmitting aerials spaced apart at distances which are a considerable proportion of the wave length, very useful directional effects will be obtained. For instance, if oscillations of the same intensity and phase are maintained in two aerials spaced apart a half wave length, the system radiates powerfully in the direction at right angles to the line between the two aerials and not at all in the direction of this line. If, however, the oscillations maintained in the two aerials are of equal intensity and opposite in phase, then the radiation is most powerful in the direction of the line joining the aerials and zero in the direction

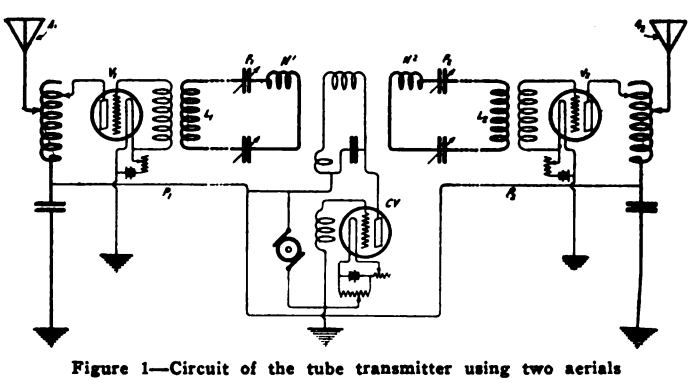


Figure 1—Circuit of the tube transmitter using two aerials

at right angles. If oscillations of equal intensity and having a phase difference of 90 degrees are maintained in two aerials spaced apart a quarter wave length, the radiation is a maximum in one direction of the line joining the two aerials and zero in the opposite direction. By combining a number of spaced aerials, which may be either of the directional or non-directional type, and controlling the oscillations in them a variety of useful effects can be obtained.

Oscillations conveyed to the spaced aerials by circuits comprised of parallel wires properly arranged can be supplied from a central oscillation generator, such as a single or multi-phase alternator, an arc or a thermionic oscillation valve. Such a system, however, is liable to be inefficient owing to the losses in the conveying circuits.

Mr. C. S. Franklin, of London, provides each of the aerials of a system with an oscillation generator of the three-element thermionic type, power being supplied to each generator from some common source. The frequency of each generator is controlled from a central independent generator, the oscillations of which are led to the grid circuits of all the generators coupled to the aerials so as to control the frequency and phase therein.

This is illustrated in the accompanying drawing as applied to two aerials A^1, A^2, at any desired fraction of a wave length apart.

The oscillations in the two aerials are generated by valves V^1, V^2, respectively, the power being supplied by a dynamo and conveyed to each valve by wires P^1, P^2. This is, however, a matter of convenience since each valve may have its own independent source of power.

CV is a control valve of relatively smaller power and situated at some convenient place, preferably equidistant from the two aerials. This control valve is arranged to generate oscillations of the desired frequency.

A coil in the anode circuit of the control valve is coupled to coils N^1, N^2, connected through tuning condensers F^1, F^2, to lines L^1, L^2, which convey the oscillations from the control valve to transformers, the secondaries of which are connected to the grids of the valves V^1, V^2, and control the frequency and phase of the oscillations generated by them.

The frequency is determined by the valve CV and the phases by the tuning of the circuits comprising the primaries of the transformers, the lines L^1, L^2, the condensers F^1, F^2, and the coils N^1, N^2, respectively. The phases may also be controlled by the tuning of the aerials A^1, A^2.

It is necessary to arrange the twin leads of L^1 and L^2 so that the waves radiated by A^1 and A^2 affect them equally and produce no reaction effect on the valves V^1, V^2 or CV.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

An Efficient Variometer for the Amateur

By A. Hazelton Rice, Jr.

I'VE built nearly everything known to the art of radio, but the thing that nearly stumped me was a variometer.

You know just about how handy they are when you wish to try out that new circuit that 2 XYZ has been hearing Mars with. . . . Well, so did I, but when I started to make it! Oh boy!!! Of course, it's a cinch, if you're not fussy, to take two short lengths of mailing tube, but I'm not that kind of a "Ham." I've built a variometer that would delight your heart if you owned it, so I say to you: "Go thou and do likewise!" for if you follow instructions closely, you will have a mighty handsome and efficient instrument.

The first requisite is the case. If you are handy with tools, build it by all means. If not, a cabinet-maker will charge you about $5 for the job. The inside dimensions are 7 inches by 7 inches. The stock should be ½ inch mahogany and, strange as it may seem, is not much more expensive than substitutes. The bottom of the case should extend about ½ inch on all sides and should be planed or rounded off. The front of the cabinet should be left open and rabbetted to receive the hard rubber face plate. The case should be finished as neatly as possible; being first stained, then varnished and rubbed down several times with pumice stone and water, and finally with rotten stone and oil. Figure 1 gives a good idea of the completed cabinet.

Variometer coils wound on sections of perfect spheres are much more efficient than those wound on flat tubes. We cannot make a section of a sphere, hollow inside and with a thin wall allowing another sphere to rotate within it, without a lathe, but the Rand-McNally Co. manufacture a beautiful little globe which rotates on a wire base for Johnny in his study of "jography" and best of all it sells for 50 cents. Purchase two of them; cut off the tops and bottoms at the third line of latitude north and south of the equator and, behold, you have two cores for the outside and inside coils.

The inside core, of course, must be smaller than the outside and this is accomplished by removing a narrow strip, after which the ends may be overlapped and the core placed within the outside coil. The core should now be spread open and the ends fastened together with adhesive paper tape. In winding the inner coil, the spool containing the wire is placed on an axle on which it may freely rotate; one end of the wire is secured at the outside end of the core which is then rotated, causing an even winding. Wind very nearly to the "equator;" fasten the wire and cut it. Then commence at the outer, opposite end and wind backwards, connecting the two windings at the center. If any other method is attempted, it will be found that the wire cannot be held in position on the core. Before attempting the winding, a "rim" must be fastened to the outside edges of both coils to hold the wire in place; this may be built up of narrow strips of paper binding tape commonly used on bundles nowadays instead of twine. Both coils should be wound with equal quantities of No. 22 double silk covered wire and care should be taken to see that they are wound in the same direction.

The next thing that requires attention is the face plate, which should be of ¼ inch, well polished, hard rubber. See figure 2 for dimensions. The hard rubber knob used for rotating the inner coil can be purchased from any radio supply house. A 3/16 inch brass rod about 8 inches long should be secured and threaded throughout its entire length. To this shaft the indicating dial and inner, rotating coil are fastened. The outer coil is secured to the face plate by a wooden bridge as shown in figure 3.

The two coils should now be connected by flexible cord or Litzendraht wire in such a manner that the winding continues throughout, in the

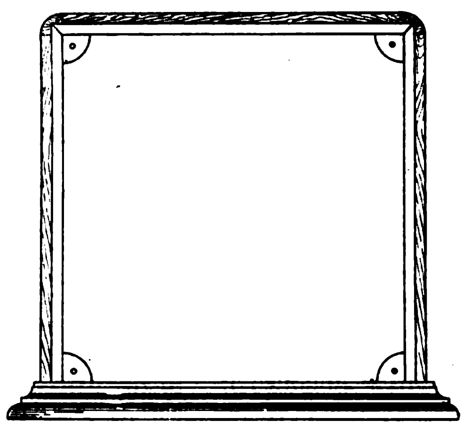


Figure 1

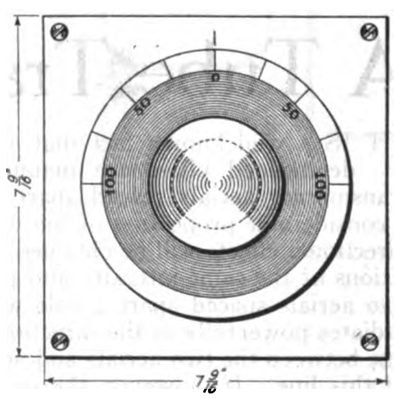


Figure 2

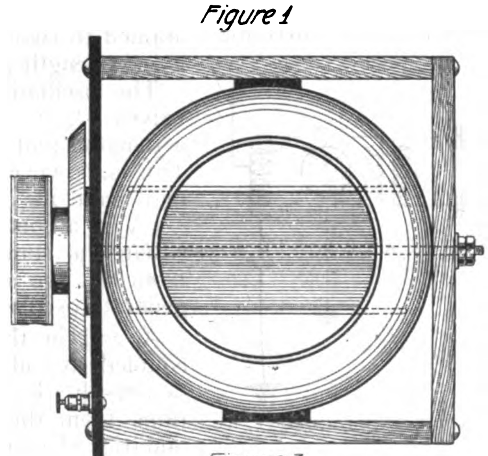


Figure 3

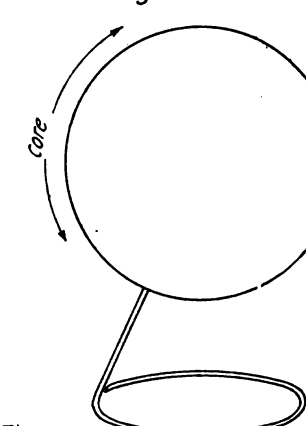


Figure 4

Detailed and assembled views of the variometer for amateur use same direction, and care should be taken that the connection is sufficiently long to allow the inner coil to rotate 180 degrees without undue strain. A strip of spring brass can be fastened to the shaft by solder in such a manner as to insure the permanency of the adjustment, or it may be fastened to a small block of wood screwed to the face plate and made to rest with sufficient tension on the shaft to accomplish this purpose.

A lead should be brought out from the left hand side of the stationary coil and from the right hand side of the movable coil and securely soldered to two large, brass or nickel binding posts on the face plate.

Some of the minor details in the construction of this instrument have been omitted, but the illustrations are so clear that no misunderstanding or confusion can arise if they are carefully examined.

A Study of Electrical Resonance in Radio Transmitters

By C. S. Perkins

IN the design of radio transmitters great care is taken to have all component parts of a circuit act with maximum efficiency towards the complete installation. It is the purpose of this article to explain mathematically the relations of inductance, capacitance and resistance to the frequency of oscillation and logarithmic decrement in spark transmitters.

In alternating current circuits, the inductive reactance $2\pi fL$ must equal the capacitive reactance $\frac{1}{2\pi fC}$ to produce a resonant condition, i. e., a circuit of unity power factor. Therefore the condition for resonance is:

$$2\pi fL = \frac{1}{2\pi fC} \qquad (1)$$

L = inductance in henries.
C = capacity in farads.
f = frequency in cycles per second.

The reactance of a circuit at any frequency is given by:

$$X = 2\pi fL - \frac{1}{2\pi fC} \qquad (2)$$

X = total reactance of the circuit in ohms.

It is evident from these formulas that an infinite number of values of L and C may be used to bring the circuit to resonance with a given frequency. For a given frequency L times C is a constant.

The total impedance offered to a current of given frequency by a circuit is:

$$Z = \sqrt{X^2 + R^2} \qquad (3)$$

Z = total impedance in ohms.
X = total reactance in ohms.
R = resistance in ohms.

At resonance Z will equal R, but at any other frequency Z is greater than R.

The true formula for frequency in radio circuits is:

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}} \qquad (4)$$

R = resistance in ohms.

In this formula if $\frac{R^2}{4L^2}$ becomes equal to or greater than $\frac{1}{LC}$, the term within the radical becomes zero or a negative quantity and cannot be solved. It has been proven that if this should take place, the circuit is aperiodic. That is, the current does not change direction and simply dies away on one pulsation. This condition is seldom found in radio circuits with the exception of the extreme case of impulse excitation which will be discussed later.

The resistance in radio circuits is usually kept so low that for all practical purposes, the formula:

$$f = \frac{1}{2\pi\sqrt{LC}} \qquad (5)$$

may be used for a simple calculation of frequency.

By the use of resonance curves, the damping and sharpness of the radiated wave can be determined. A resonance curve shows the value of current in a circuit when the frequency is varied either side of the resonance point. It may also show the current value with a change in inductance or capacitance from the resonant condition.

For example the curves in figure 1 show the variation of current squared (in the wave meter) with change in the wave-meter capacitance for two resistances.

The following tables prove that the larger the ratio $\frac{L}{C}$, the greater the reactance at a given frequency of resonance, and therefore the sharper the resonance curve. See figure 2.

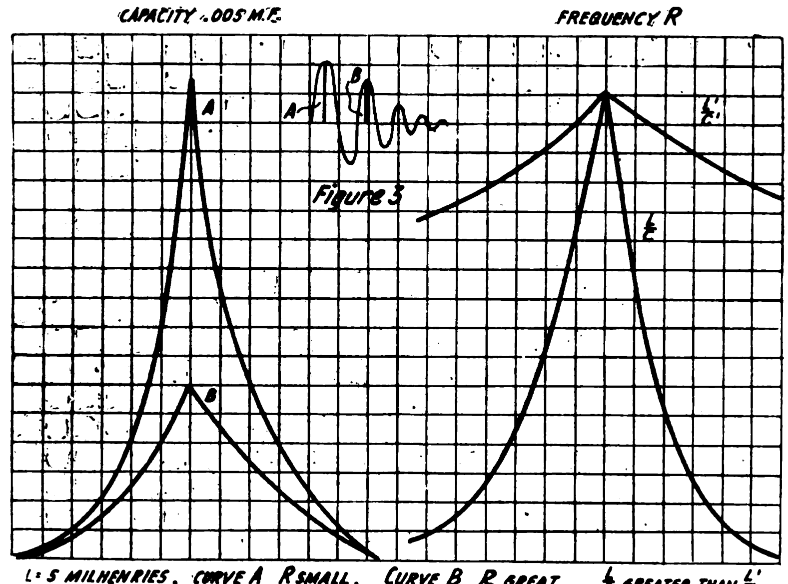


Figure 1 Figure 2

Graphs showing variation of the resonance curve according to the resistance

L=5 milhenries. C=.0005 mfd.

Frequency.	Inductive Reactance.	Capacitive Reactance.	Total Reactance.	Difference of X with change of f.
100000	3142	—3184	—42	42
100700	3162	—3162	0	

L=.5 milhenries. C=.005 mfd.

f	$2\pi fL$	$\frac{1}{2\pi fC}$	X	Difference
100000	314.2	—318.4	—4.2	4.2
100700	316.2	—316.2	0	

In the same way, the change in impedance for a given frequency of resonance becomes smaller as the resistance increases. This statement is proven by the formula (3) and is calculated in the following tables. See figure 1.

L=5 milhenries. C=.0005 mfd. R=5 ohms.

f	X (ohms)	Z (ohms)	Difference in Z with f.
100000	42	42.3	37.3
100700	0	5	

R=10 ohms.

f	X	Z	Difference in Z.
100000	42	43.2	33.2
100700	0	10	

These statements may be summed up in the expression of the factor of selectivity or sharpness of resonance. In terms of L and R it is $\frac{2\pi fL}{R}$ and in terms of C and R it is $\frac{1}{2\pi fCR}$ where L and C are the values at resonance.

The logarithmic decrement is defined as the Naperian logarithm of the ratio of two successive maxima in the same direction, such as the Naperian logarithm of the ratio $\frac{A}{B}$ in figure 4. As the logarithmic decrement increases the circuit becomes nearer the aperiodic state and the wave is not sharply defined. The law specifies that the decrement shall not exceed $\frac{2}{10}$ per complete oscillation except in case of distress where a broad interfering wave is desired. In commercial radio practice the decrement is ordinarily kept far below this value.

The logarithmic decrement in terms of resistance and inductance is:

$$\delta = \frac{\pi R}{2\pi fL} \qquad (6)$$

In terms of resistance and capacitance it is:

$$\delta = 2\pi fC \ \pi R \qquad (7)$$

In terms of resistance, inductance and capacitance it is:

$$\delta = \pi R \sqrt{\frac{C}{L}} \qquad (8)$$

Therefore the logarithmic decrement is π times the reciprocal of the sharpness of resonance.

There are many so-called methods of measuring decrement which are materially measurements of resistance from which the decrement may be calculated from the formula (8).

The method in practical use for the measurement of decrement is the reactance-variation method where the current squared is reduced to half its value at resonance and the reactance necessary to cause this decrease is calculated. This method is simplified and used in the following:

$$\delta_1 + \delta_2 = \frac{C_r - C_1}{C_r} \pi \qquad (9)$$

δ_1 = decrement of circuit under measurement.

δ_2 = decrement of decremeter.

C_r = capacity of decremeter under condenser at resonance.

C_1 = capacity of decremeter condenser below resonance where I^2 is one-half its value at resonance.

This method is used in some direct reading decremeters.

The resonance curve of a radio transmitter is not symmetrical so the results will be more accurate if a value of capacity is taken above resonance as well as below so that a mean value can be obtained as follows:

$$\delta_1 + \delta_2 = \frac{C_2 - C_1}{C_r} \frac{\pi}{2} \qquad (10)$$

C_2 = capacity of decremeter condenser above resonance where I^2 is one-half its value at resonance.

Both of these methods may be used to calculate the decrement from the resonance curve, where the latter is made from varying the capacity of the wave-meter condenser.

In the early days of radio telegraphy, the spark-gap was placed across the secondary of the transformer and in series with the antenna and ground. The transformer then charged the condenser, consisting of the distributed and lumped capacities of the antenna system, and discharged through the gap, thus forming an oscillatory circuit of the gap, antenna and ground. This method of exciting the antenna system causes a wave of high decrement to be transmitted owing to the resistance of the spark-gap.

Therefore the tuned closed circuit was adopted where the energy was transferred electro-magnetically by the oscillation transformer to the open antenna circuit. The decrement of the transmitted wave depended practically upon the inductance, capacitance and resistance of the latter circuit. But here a new obstacle was encountered. There was a re-transference of energy from the open to the closed circuit before the oscillations of the latter had died away. Since the so-called closed circuit was electrically conducting, there was mutual inductance between the primary and secondary of the oscillation transformer. Therefore the transmitted wave did not depend upon the self-inductance of the secondary and waves of two frequencies were transmitted. This method of forcing the oscillations in the antenna is being done away with at present. If, after the antenna circuit is properly excited, the closed circuit can be made non-conducting, there will be no magnetic connection and no re-transference of energy between primary and secondary and the open circuit will oscillate at its natural frequency with a decrement determined entirely by the constants of that circuit. In order to accomplish this condition, the gap must be quickly deionized, thus increasing its resistance after discharge and causing it to become non-conducting. Then the coupling may be greatly increased and more energy transferred in fewer oscillations.

The gap may be de-ionized by cooling, but this method is not entirely satisfactory in the case of the plain spark-gap. So a series or quenched gap, which is made up of a series of metal plates insulated from each other and the spaces betwen the sparking surfaces kept air-tight, is used. Owing to the large cooling surface the gap does not become very hot, but usually a blower is used to further increase its efficiency. In actual practice, the quenched-gap seldom becomes too hot to touch. By the use of the quenched-gap, the coupling may be increased, the secondary voltage of the transformer may be decreased and a large condenser may be used.

This system is called impulse excitation because the closed circuit is operative just long enough to transfer all possible energy to the antenna.

In order to obtain proper quenching the decrement may be greatly increased, but the resistance of the closed circuit before discharge should not be materialy augmented. As proven above, the decrement increases as the square root of the ratio $\frac{C}{L}$, directly as $2\pi fC$, or inversely as $2\pi fL$. As the capacity is increased, the inductance must decrease for a given frequency and the field about the coupling coil may not be great enough for a proper transference of energy. Therefore the condenser should not be too large or the voltage too small as seen by the formula:

$$C = \frac{2P}{NE^2}$$

C = capacity of secondary condenser in farads.

P = power of transformer secondary in watts.

N = condenser charges per second.

E = effective voltage of transformer secondary.

The extreme case of impulse excitation is where the closed circuit is not oscillatory and the current dies away on one alternation. That is $\frac{R^2}{4L^2}$ is slightly greater than $\frac{1}{LC}$ as discussed above. This is accomplished by using a very large capacity across the transformer with a low secondary voltage. The gap is essentially of the quenched type, but is finely adjustable in order to vary the resistance for best results.

(Continued on page 26)

Making Dry Cell Batteries Pay for Themselves

By Edward Thomas Jones, A. I. R. E.

I AM sure that a few lines of Hooverism in regards to the abuse and especially the disposition of so-called dead batteries, will prove of value to numerous readers of THE WIRELESS AGE.

Figure it out on your finger tips. You order four dry cells from your electrical shop at forty-five cents each, making the total cost exactly $1.80. Would you like to know how to reclaim from these batteries, after they are termed dead, the neat sum of $1.64? Of course you would. Well, then if you are interested follow me as I point out to you the numerous ways of saving on dead batteries.

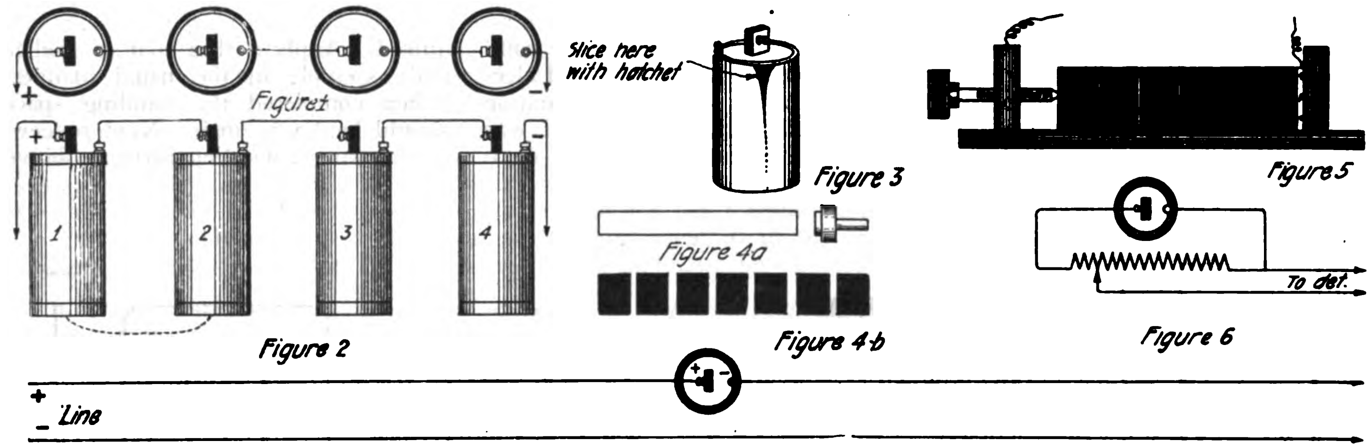
Experience proves that you can draw one ampere for thirty hours from four new dry cells. At this point it will be hardly possible to draw more than one-half ampere for a period longer than five hours. From this point the cells fall off rapidly into such ampere values that they are not suitable for the operation of an ordinary buzzer. The best connection for the use of four batteries as quoted above is to arrange the batteries in series. See figure 1.

CARE OF DRY CELLS IN USE

The batteries should be sealed in a dry wooden box so that they will not be effected by the weather or dampness. This will have a decided effect upon the life of the batteries. If it is not possible to put the batteries in such a container be careful to select a dry spot and a place where the rain will not seep in. If the batteries are permitted to stand in a wet place they will short circuit themselves when connected in series. The dotted line in figure 2 shows the path of the short circuit. Battery number 2 is shorted because the carbon or positive connection has a return to the zinc through the dotted line conductor. Do not place the batteries close together if the covers have been removed. Keep the zincs apart by cardboard spacers.

RECLAIMING DRY CELLS

In the following itemized list is given the reclaimed articles or material from four dry cells and their estimated market value.



Details of reclaiming dry cell batteries

½ lb. sealing wax compound retails at .20c per lb.	$0.10
8 Knurled Brass thumb nuts at .008c each.	.064
4 8/32x½ inch brass screws (off zincs) at .005c	.02
4 Brass cups with 8/32 screws retail at 15c each for use in connection with wireless detectors	.60
1 lb. zinc—converted into solder by dissolving same in muriatic or hydrochloric acid. About	.10
1 Variable resistance for the laboratory from carbons....	.75
	$1.64

RECLAIMING THE SEALING INSULATING COMPOUND

Hold the battery with the top down and beat around the edges with a hammer. The sealing compound will fall out, leaving a cardboard washer covering the active material. Out of four dry cells one half pound was recovered. This is similar to plumbers' cement, which retails at twenty cents a pound. This material will come in handy around the shop, especially when you desire to hermetically seal some electric windings in a small container.

REMOVING THE CARBON

As is shown in figure 3, cut a slit in the top of the zinc shell and slice it right down to the bottom. By taking hold of the battery shell with both hands it can be pried open and the carbon rod will fall out.

REMOVING THE KNURLED THUMB NUTS AND SCREWS

It is hardly necessary to mention anything about the removal of these parts. It is only necessary to remove them before releasing the sealing compound. By taking hold of the 8/32 post which forms the zinc connection with a pair of pliers, it can be twisted off from the zinc to which it is soldered—care being taken not to strip the threads.

BRASS CUPS FOR WIRELESS DETECTORS

After the carbon rods are removed cut them off as shown in figure 4a, permitting a small piece of the carbon rod to protrude above the edges of the brass cup. This makes a cup which can be employed in connection with mineral and electrolytic detectors. While you are cutting the carbon rod with a good sharp hack-saw you may as well cut the rod into pieces for the variable resistance unit. Cut the rod into ½ inch pieces as shown in figure 4b.

RESISTANCE UNIT

Make a suitable stand for the pieces of carbon to fit in. The complete instrument is clearly shown in figure 5. An 8/32 screw with hard rubber handle is brought to bear against the pieces of carbon and their resistances are changed by tightening or loosening the screw.

MAKING SOLDER FROM ZINC SHELLS

By dissolving the battery shells in either muriatic or hydrochloric acid about ten cents worth of pure solder can be obtained.

POTENTIOMETER BATTERY

When a battery is termed dead, the radio man can make use of it by connecting it to his potentiometer which is employed in connection with crystal detectors. The connection is given in figure 6. The potentiometer is of about 400 ohms. resistance and permits about 50 milliamperes to pass.

USING DEAD DRY CELL AS RESISTANCE

By connecting a dead dry cell so that it is "bucking the line" we can make use of its internal resistance. (See figure 7.) This is accomplished by connecting the positive lead of the line to the carbon element.

Resonance in Radio Transmitters

(*Continued from page 24*)

The primary of the oscillation transformer is a single turn, but the heavy current in the circuit sets up a strong enough field about the primary to efficiently transfer the energy to the open circuit. The latter is then free to oscillate at its natural frequency and the decrement depends entirely upon the constants of this circuit.

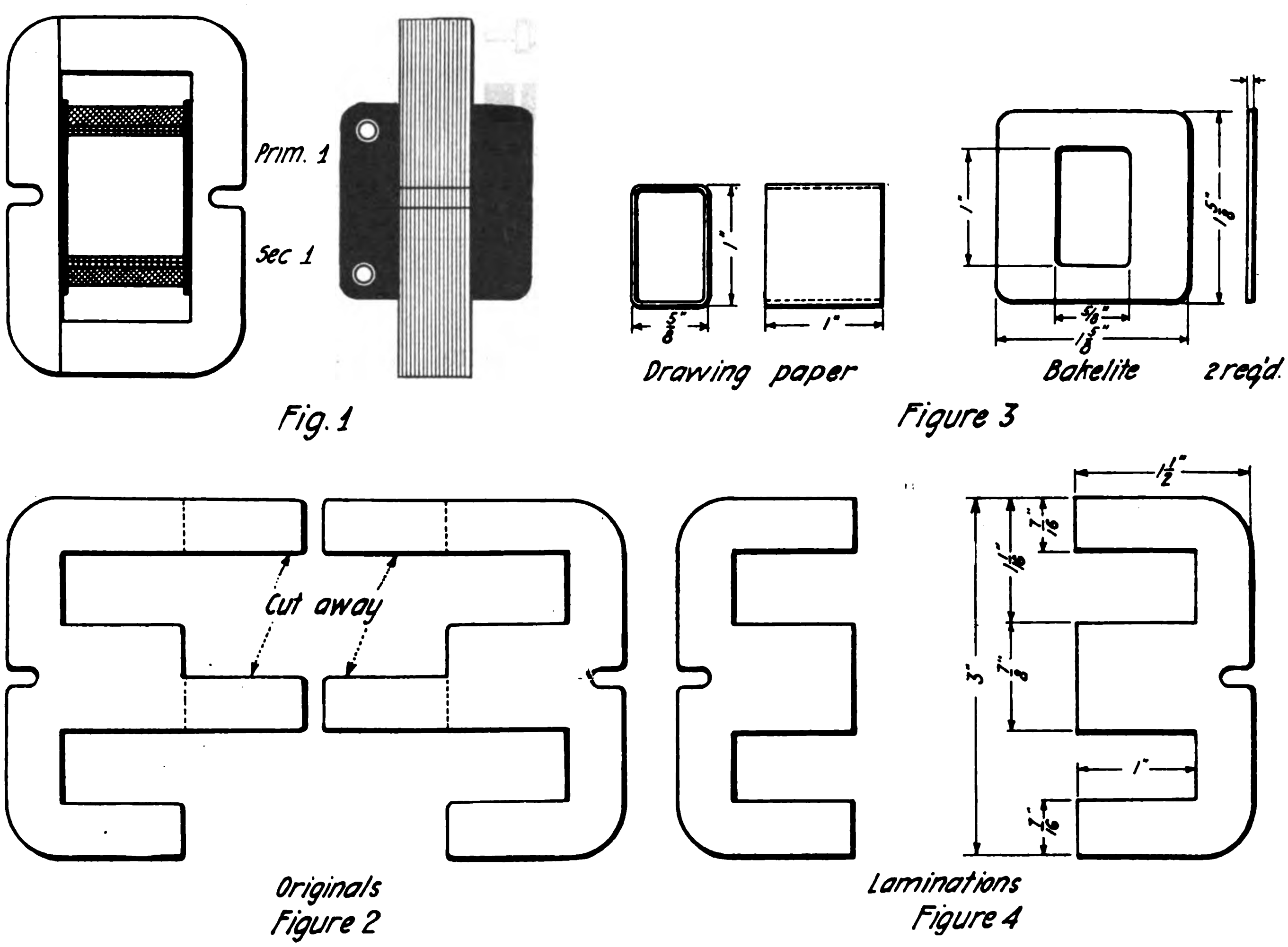
The Design and Construction of Audio Frequency Transformers

By C. M. Minnis

FIRST PRIZE, $10.00

THE high cost of multi-stage audio frequency amplifiers can be greatly reduced by constructing the intervalve type of transformers.

The accompanying drawings show how an old Westinghouse motor impedance was converted into three serviceable audio frequency transformers at a cost of two dollars—the price of an old impedance from the local power company.



Constructional details and method of assembling the audio frequency transformer

The first step was to procure an impedance from the local power company or a dealer in second-hand electrical apparatus. Upon examination it was discovered that this coil was of the steel core type and was composed of 132 laminations, .014 inches thick and shaped as shown in figure 2. A slight modification secured by cutting off parts shown in the figure renders them suitable for laminations for amplifying transformers.

For the core 38 laminations are required. Apply a thin coat of shellac and assemble in the usual manner. When completed the winding space should be 1 x 5/8 inch. Next proceed to construct a winding form as shown in figure 3, 1/16 inch thick. Bakelite is employed for the ends while thick drawing paper should be used for the tube.

For constructing the primary and secondary coils the winding of the impedance was employed, as it was found to be No. 40 B. & S. enameled, which proved entirely satisfactory. By referring to the drawings it will be seen that the actual winding space is ¾ inch wide. Winding 180 turns per layers, 20 layers or 4200 turns compose the primary. Each individual layer should be separated by oiled paper .006 thick and the entire primary separated from the secondary by a double thickness of empire cloth. The secondary is wound directly over the primary and in the same manner winding the same number turns per layer, 60 layers will be required or 12600 turns. Flexible leads are now soldered to the primary and secondary wires.

Next comes the process of impregnation to render the coil moisture-free and moisture-proof. This is accomplished by first boiling the entire coil in a compound composed of 1 part beeswax to 3 parts paraffine, until the air bubbles cease to rise to the surface.

The coil is then removed and baked for a period of four hours in an oven at a temperature of 180 degrees.

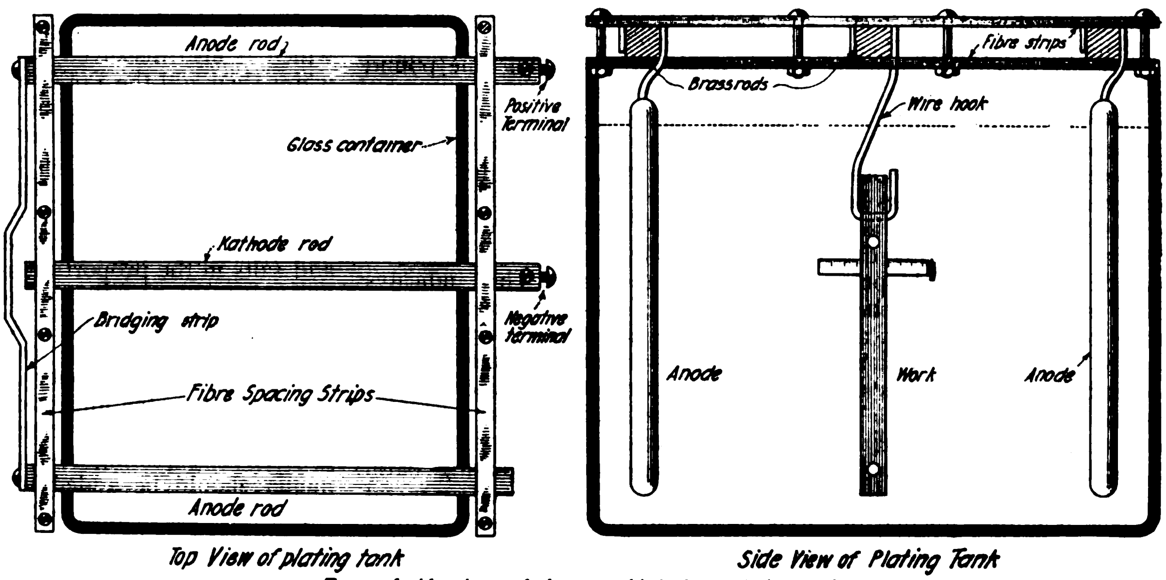
The coil is then assembled with the core which completes the transformer. No special mounting is necessary for the terminals other than small binding posts arranged on the bakelite coil heads.

NOTICE

Mr. C. M. Minnis' article on audio frequency transformers was the only one received for this prize contest, but since it is a good article and one which every amateur will read with interest. I feel that the contest was a big success. Now, Boys! There is no benefit derived from putting up simple prize article contests which have been written-to-death. What we all want is something new so get in on our Prize Contest.—EDITOR.

Electroplating for the Experimenter

AT slight expense and with but little effort the constructor or experimenter can arrange a complete electroplating outfit that will enable him to plate the various pieces of apparatus he constructs. This not only improves the appearance of the apparatus, but adds to their value and ofttimes improves their operation. With a little practice quite creditable work can be done that will easily pay one for the effort expended. The outfit can be simple or elaborate as desired. Various processes are here described separately so one can select and construct an outfit that will meet his particular needs.



Top and side views of the assembled electroplating tank

PLATING TANK

The size of the plating tank is determined by ones requirements. For small articles a wet battery jar will serve. Storage battery jars can be obtained in various sizes and one suitable for any size work can be purchased cheaply. It is preferable that the jar or tank be of glass; stoneware or porcelain can be used but the process can be watched more easily when a glass container is used. The size of the tank can be roughly approximated by allowing a gallon of solution for every twenty-four square inches of surface to be plated.

Supports must be arranged across the top of the tank from which the anode and articles to be plated are hung. These take the form of three square brass rods separated by fiber or hard rubber strips as shown in the illustration. One-quarter inch brass is heavy enough for the purpose, binding posts being soldered to the ends of the rods to facilitate the connecting of wires. The insulating strips keep the rods parallel and prevent them from slipping. This completes the plating tank.

PLATING CURRENT

The voltage between terminals and the amperage of the plating current will vary with the metal being deposited, for no two metals deposit exactly alike. The current strength is the important factor for the quantity of metal that can be properly deposited depends upon the amount of current that can flow through the plating bath. Since the density of the plating solutions and the rate of metal deposit vary, the voltage required will depend upon these factors. The following table gives the usual voltage, current strength per square foot of plating surface and the density of the solutions required for the more common metals.

	Amps per sq. ft.	Voltage	Density
Nickel	4	4	5 to 8° B.
Silver	2	2-4	14 to 20° B.
Copper (Cyanide)	6-8	4	17 to 18° B.
Copper (Sulphate)	10-12	4	15 to 20° B.

It will be seen that the voltage does not exceed four volts hence primary or storage batteries can be used for plating work. Where the amount of work being done is small bichromate cells are entirely practical. For larger work a storage battery is preferable.

Where D. C. lighting mains are available the current can be passed through a lamp bank of a suitable size to reduce it to a strength low enough for plating purposes. A low voltage generator is the best source of plating current and becomes a necessity when large quantities of work are being done. The average experimenter can usually do all his work with a few batteries and with this in mind the description of a simple bichromate cell will not be out of place.

A bichromate cell can be made from

an ordinary sal-ammoniac battery in the following manner. Amalgamate the zinc rod by cleansing it with dilute sulphuric acid and then rub mercury over the surface of the zinc. This will result in a shiny surface. The solution for the battery consists of the following:

Water	13	parts
Sulphuric Acid	5	"
Bichromate of Potash. .	2	"

The acid is first poured into the water and when thoroughly stirred the bichromate is added. This solution after cooling is poured into the jars and the battery assembled. This battery will give two volts per cell, two cells being sufficient for most work. The zincs must be removed from the solution and washed off with water after using.

A four or six-volt storage battery can be used for plating purposes with excellent results and wherever attainable is to be preferred.

The wires connecting the battery to the plating tank should be of large cross section to reduce the resistance as much as possible. Two or three lengths of flexible lamp cord connected in parallel is perhaps the best arrangement. Connections should be well made and all bare metal parts kept clean to assure best results.

Preparation of the Work

Before an article can be plated it must be perfectly clean and smooth. All traces of grease and dirt must be removed or the plating will not adhere and where a high polish is desired the surface must be highly polished first, for plating reveals rather than covers any blemishes. This is an important point and should not be overlooked if satisfactory work is to be accomplished.

Before a casting can be plated it must be pickled to remove all traces of sand and scale. When the article is of steel or iron it is first pickled in a sulphuric acid bath containing one part of acid to four of water. The solution is placed in an earthenware or glass jar and the article hung from the edge with a wire. The work is left in this pickle till the scale can be brushed off readily with a stiff wire brush, it usually requires a half hour or more for this. Do not leave it in too long or the surface will become porous. When all the scale is removed the article is ready for polishing.

Castings of copper, brass or bronze are pickled in a bath consisting of 15 parts of water to one of muriatic acid. After the scale is brushed off the casting is dipped in a solution of fifty parts of sulphuric acid to one hundred parts of nitric acid. The article is left in the dip for a few seconds and when bright, washed off in hot water. It is then ready to be polished.

When the part to be plated is machined the pickling process is not necessary, but when it is of copper or brass it should be dipped in the acid bath mentioned above to remove all scale. Zinc can be cleaned in a 10 per cent solution of sulphuric acid in water. Silver in a 10 per cent solution of nitric acid in water. For tin, lead and pewter a strong solution of caustic soda is used.

Those possessing a speed lathe will have no difficulty in polishing the work, but hand polishing is very satisfactory. The work is first gone over with pumice stone dipped in water till all scratches are removed and a uniform surface is obtained. Rinse and dry the work and go over it with fine emery cloth till the pumice stone scratches are removed. Remove all traces of the emery with water and then go over the article again with rotten stone to remove all scratches left by the emery. When the surface is quite smooth the final polish can be given with a piece of buff leather smeared with fine cut crocus or tripoli.

The above process will give a good polish but the article must be cleansed of all grease before it can be plated. The grease is removed by hanging the article in a boiling solution of caustic potash made by dissolving one pound of potash in one gallon of water. When the work has been in this solution 10 minutes rinse it in clear water and scour with whiting and a stiff bristle brush, rinsing again in water to remove the whiting, note if the water runs smoothly over the whole surface of the work. This indicates that all grease has been removed.

Should the article be iron or steel dip it for a moment in a bath consisting of one part of muriatic acid to eight parts of water, rinse in clean water to remove all traces of acid and transfer at once to the plating bath. When the work is of any other metal it is dipped in a solution of one-half pound chemically pure cyanide of potash to a gallon of water, used cold. The article is then rinsed and transferred to the plating bath.

Plating Preliminaries

Copper, nickel and silver plating are the most used finishes for amateur work so they will be considered in detail. Gold plating hardly comes, within the scope of this treatise. Anodes for the plating tank are made of the same metal that is being deposited and can be purchased from dealers in plating supplies. They come in various sizes already fitted with hooks for hanging on the anode rods. The area of the anodes should be equal to that of the surface being plated. The anodes being hung on the outside rods with the article to be plated hung from the center rod by means of copper wire bent into the form of S hooks. The distance between the anodes and work should be at least three inches so that the deposit will be even over the entire surface. When too close the deposit has a tendency to be thicker at the points nearest the anodes.

To properly make up plating solutions a book of litmus paper and a hydrometer having a Beaumé scale are necessary. The litmus paper is used to test the solutions, a strip of it will turn red if dipped in an acid solution and blue if in an alkaline one. The hydrometer is used to test the density of the solutions, the proper density for each solution being previously given.

Copper Plating

For plating with copper there are two solutions in common use, the cyanide and the sulphate. It should be noted that the cyanide solution must be used with iron or steel, either solution may be used with other metals.

The cyanide solution is prepared in the following manner.

Weight for each gallon of water:

Copper Carbonate	5	ozs.
Potassium Carbonate . . .	2	"
Potassium Cyanide C.P. . .	10	"

Dissolve the cyanide in a portion of the water, stir in the copper carbonate which is also dissolved in part of the water then add the Potassium Carbonate also previously dissolved. The rest of the water is then added and the solution stirred till all the salts are thoroughly dissolved. This solution should have a density of 5° to 8° Beaumé, if greater add water, if below add salts in the proportion above mentioned till it is of the proper density.

The sulphate solution is somewhat cheaper and is made by dissolving twelve ounces of copper sulphate in a gallon of water and adding a little sulphuric acid. Too much acid will give streaky plating and a little ammonia should be added to neutralize a portion of the acid, but not enough to give an alkaline reaction with litmus paper. The solution should test between 17° and 18° Beaumé, adding sulphate or water if necessary to get the proper density. When correct it can be tested on a small piece of metal. a good deposit resulting with the evolution of some gas.

Brass Plating

Brass plating is closely allied to copper, brass being an alloy of copper and zinc. The solution is the regular copper cyanide solution with the addition of five ounces of carbonate of zinc to each gallon of solution. Brass anodes must be used with this solution. A little carbonate of ammonia added to the solution will give a lighter color and more carbonate of copper a darker color. The color can be determined by means of the article being plated, altering the solution till the proper color is obtained. Varying the current will also alter the color, a stronger current, depositing more zinc giving a lighter color.

Nickel Plating

There is but one satisfactory nickel plating solution. It is made by dissolving 15 ounces of sulphate of nickel and ammonia, in a clean jar containing a gallon of water. Specify the double salt of nickel when purchasing. When thoroughly dissolved and cool the solution should test between 5° and 8° Beaumé on the hydrometer and should be slightly acid. If it turns the litmus paper blue indicating an alkali add just sufficient acid to tinge the paper red, if too acid, add a little ammonia.

On immersing the article in the nickel bath with the current turned on, a thin white coat of nickel should be deposited within three or four minutes with bubbles rising slowly from the work. A thick white deposit that turns grey or black and excessive gas indicates too strong a current burning the work. The current may be decreased by reducing the voltage or adding more work to the tank. Should no deposit occur within three minutes and the work turn black the current is too weak, the voltage must be raised or some work removed from the tank.

A good deposit should be obtained in twenty minutes on brass. When iron is to be nickeled it should first be copper plated in a cyanide bath for about five minutes and after rinsing put into the nickel bath. The softer metals such as lead and pewter should be first copper plated to form a good base for the nickel. It is advisable to plate the soft metal rather heavy with copper and then polish them before nickeling.

Silver Plating

For plating with silver the chloride solution is usually employed and gives good results. For each gallon of water the following are required:

Silver Chloride . . . . 2 Oz.
Potassium Cyanide C.P. . . 12 Oz.

The chloride is rubbed up into a paste with a little water and after dissolving the cyanide in the rest of the water stir in the paste till it is thoroughly dissolved. It is advisable to filter this bath before using and to keep it away from bright light since light decomposes the silver salts. The solution should test between 15° and 18° Beaumé on the hydrometer, adding salts or water to get proper density.

Silver plating requires some judgment on the part of the operator to get satisfactory results and a little experimenting may be necessary before one becomes perfect. The appearance of the work is the best way to judge the solution. Should the work become coated with a dark slimy deposit, bluish in color rather than a dull white there is not sufficient cyanide. On the other hand an excess of cyanide will give the work a frosty white color. When the solution is correct the work will be dull white or grey. The best method of regulating the solution is to have on hand solutions of cyanide and of silver chloride of a density of about 15° Beaumé. Thus an excess of either can be readily compensated for without altering the density of the plating solution. An excess of cyanide can be counterbalanced by reducing the current through the bath.

Silver deposits best on copper or nickel and the best results are obtained by first plating the article with one of these metals.

Stripping

At times it is necessary to strip old plating, it is necessary to remove all traces of old plating and refinish the article as if it had never been plated when good results are desired.

To strip nickel plate attach the article to a length of heavy wire and dip it in a solution consisting of the following:

Sulphuric Acid . . . . 4 parts
Nitric Acid . . . . .1 "
Water . . . . .1 "

The article is kept in motion in the solution and as soon as the plating is removed it is rinsed off in clear water. If some of the plate still adheres dry the article before it is replaced in the stripping bath.

For stripping silver plate a mixture of one part of Nitric Acid to ten parts of Sulphuric Acid is employed, the process being as above described.

Finishing

After the plating is complete slightly swish the article in the solution and rinse off in hot water and place it in sawdust. The sawdust should be of some hard wood and kept warm if possible to drive out moisture. Brush the sawdust off and buff the article. If a buffing wheel is not available take a canvas bag and place the articles in it with good, dry, boxwood sawdust. Attach one end of the bag to a solid support and shake the bag vigorously. This will give a good polish, the finishing touches being given with a reliable metal polish or with a chamois and rouge.

The above instructions are sufficient to enable anyone to do good plating, but a few hints to protect the experimenter will not be out of place.

Potassium cyanide is a deadly poison and should be handled with care. The various dips are poisonous and corrosive. They should be handled carefully, and kept closely covered when not in use. Mix plating solutions hot because the salts dissolve more readily in hot water. The temperature of plating solutions should never drop below 60° F. Always dissolve any salts before adding them to the bath. Use only chemically pure salts and distilled or rain water for mixing solutions.

Wireless "Earths" on Aircraft

By Lieut. H. Daly, D. S. M.

On board ship and on the wireless land station good earthing arrangements are essential for the efficiency of the wireless set. The same statement applies to aircraft.

The flying machine has a very limited space for earthing, or balance capacity, as it is sometimes called, and as the capacity of a system depends largely upon its geometrical dimensions, it can well be imagined that the aircraft radio engineer had a great many difficulties to overcome. Besides the lack of space, another and more important disadvantage cropped up, this time from the point of view of the flying man, and that was the risk of fire likely to occur through the wireless earth, or ground connection.

Many cases of fire on aircraft have been caused by the bad earthing arrangements of the wireless set, for should there be any sparking between the earth wire or wires and the machine, any gasoline vapor which might escape in the vicinity would immediately ignite. This is especially so in the case of the flying boat, where the gas tanks are carried in the body. Should the mechanic when filling the tanks allow them to overflow, as often happens, the gasoline runs to the bottom of the boat, and as there is no means of egress the fuel stays there, emitting vapor. Perhaps more conflagrations have been caused through this happening than in any other way.

Airships, however, have an added danger to guard against. Besides the gasoline vapor there is the hydrogen gas used, which is highly inflammable. With aeroplanes and seaplanes the chance of fire is only likely when there is a defective fuel pipe or tank.

In the early days of the war, and before that period, when wireless was in its infancy, mechanics when fitting the machine took a lead from the earth terminals on the set to some convenient part of the engine, taking care to make

Some of the 580 Delegates Who Attended the First Pacific Coast Radio Convention, Held in the Month of November, 1920

a good electrical connection. This arrangement worked very satisfactorily with small induction coil sets of which the British Sterling transmitter is a notable example; but when larger power rotary disc sets were introduced on seaplanes the "engine earth," as it was called, was found to be inadequate as well as dangerous, two or three cases of fire occurring on 150 H.P. Short seaplanes.

The trouble was overcome in the following manner: Two lengths of insulated 6/11 wire were run out through the two lower wings, passing through a small piece of ebonite tube fitted in each rib of the two lower wings, thus further insulating the wire from the wing itself. An insulated lead was then taken from these wing wires to a terminal fitted just under the observer's seat, and this terminal was connected with the wireless set by means of a much heavier insulated cable. It can be seen, therefore, that this earthing was entirely insulated from any part of the machine. This scheme was extensively used with the Rouzet, a small rotary disc set driven off the main shaft of the engine and the type 53a, a ¼ kw. Marconi rotary disc set. Both of these sets were capable of a range of 90 miles or more when used in conjunction with this type of earth.

With the introduction of wireless telephony on aircraft this type of earth was found to be insufficient, especially for transmitting, so a new specification was brought out.

It was decided that if all the metal parts of the machine were electrically connected together the conducting surfaces would be greatly increased and consequently the electrical capacity of the wireless set would be increased. The aeroplane engine was the first item to be dealt with. All water, oil, and fuel pipes which were connected by India rubber joints or other insulating material were electrically connected by a flexible lead; thus none of the engine parts were insulated one from the other. By doing this, it was found that very little sparking took place anywhere on the engine, so the danger of fire was also minimized. In addition, a strip of brass ¼ of an inch wide and 1/32 of an inch thick was run from the port and starboard sides of the engine along the outer surface of the longerons (i.e. the main longitudinal wooden members of the aeroplane body). When these strips passed any metal parts of the aeroplane, such as petrol tanks, gun mountings, metal cowling, fuselage (body) clips, etc., a good flexible lead connection was made, and when the brass strip passed the wireless compartment a lead was taken from both of the top longeron strips to the earth terminal of the wireless set. In a flying boat the brass strip passes along the inside of the hull in a position similar to the strip on the top longerons of seaplanes and airplanes. Now for the wings of the airplanes. Four feed wires were run from the body end of the wings to the wing tips, and all metal parts were electrically connected to these four wires, such as cross bracing wires, metal spar fittings, etc. The controlling wires which are used by the pilot for turning or banking the plane were not connected, however.

It will be seen from the above description that all metal parts of the machine were connected. Therefore the maximum capacity is obtained. When this earth system has been completed it is tested for continuity and low resistance of all metal parts of the machine by a 2-volt lamp and battery. The introduction of an all metal aeroplane by the Germans (the 200 horse power Junker machine) has greatly increased the capacity for earthing. In fact, when the Telefunken system was installed, the range of the set was increased 20 per cent over what it had been when installed in the wooden machines, and the Huth transmitter was found to go one better than that, having its range increased 22 per cent.

As all metal aeroplanes are bullet proof, fireproof, and are not so liable to distortion under bad weather conditions, it is possible that the metal plane will play a big part in the future of aviation. If this is so, aircraft wireless efficiency is likely to greatly increase through the "earthing" alone.

Tapped Inductances

FEW experimenters who practice all the proper methods of hoarding energy by soldering all the connections, running leads at right angles, carefully insulating the aerial leads, etc., will give a thought to the design and computation of their inductance coils. It is well known that a circuit embodying one or several vacuum tubes will function at highest efficiency if inductance predominates in the tuner. In a regenerative or other oscillating circuit the movement of the switch-lever over the points produces noise in the phones which is extremely disagreeable, and this has led to the practice of doing all the fine tuning by condensers, and tapping the inductances to a very few points, if tapped at all.

There are four means of tapping an inductance: (1) the old and time-honored method of dividing the coil so that each tap would encompass the same number of turns; (2) dividing it so that an equal inductance will be covered by each tap; (3) dividing the turns so that each section will cover an equal range of wavelength—as shown by Mr. Batcher in the May,

There Were Twenty-six Organizations Represented at the Pacific Coast Radio Convention, Some of Which Can Be Noted in This View of the Delegates

1919, issue of WIRELESS AGE—and (4) the means shown in this paper, that of tapping so that every wave throughout the entire range of the coil may be covered with the smallest possible capacity in the shunt condenser. It is very evident from the discussion in the first paragraph that such a method will make for higher efficiency, for if the inductance is tapped so that an often-used wave (such as 600 meters) can only be tuned in by using 75° or 90° of condenser, signals will be weaker than if 600 meters can be tuned in by using 15° or 20°.

Therefore the problem resolves itself into tapping the coil so that every wavelength may be handled with the smallest possible capacity of condenser. We must decide first, the wavelength range desired, the number of taps, and the inductance to be covered by the first tap. We will see later why this is necessary. As an example, let us say that the coil we wish to design shall tune to 4,000 meters with .001 mfd. in shunt. This will require a total inductance of 4.5 millihenries and since we wish to tune to 200 meters with the first tap, we must choose an inductance for this tap which will enable us to do so efficiently. De Forest and others have chosen .04 millihenry for the value of inductance which will tune to this wave, and it will probably be wise to follow this example.

From these assumptions, we may proceed to the formula used for the purpose of finding that value by which each inductance is to be multiplied in order to find the succeeding inductance. Locating inductance values by this method will give us (as can be proved, although the proof is not within the scope of this paper) every wave-length with a maximum inductance and a minimum capacity.

The formula reads:

$$X = \sqrt[t-1]{\frac{L_t}{L_1}}$$

Where

X —the value as explained above.
t —the number of taps.
L_t—the total inductance of the coil.
L_1—the inductance of the first tap.

For example, if we have the coil suggested, with a total inductance of 4.5 millihenries, seven taps, and a first inductance (L_1) of .04 millihenries, the formula reads:

$$X = \sqrt[7-1]{\frac{4.5}{.04}}$$

$$= \sqrt[6]{112.5} = 2.197 \text{ or approximately } 2.2$$

Multiplying the first inductance by this value,

$.04 \times 2.2 = .09$ millihenries
$.09 \times 2.2 = .19$ millihenries
$.19 \times 2.2 = .42$ millihenries
$.42 \times 2.2 = .93$ millihenries
$.93 \times 2.2 = 2.0$ millihenries
$2.0 \times 2.2 = 4.5$ millihenries

the inductance of the last tap, or total inductance of the coil.

The range of wave-length for each of these values, using a condenser of only .0004 mfd. (or using only .4 of the total value available in the average variable), follows:

	Capacity .0001	Capacity .0004
.04 M.H.	120 Meters	238 Meters
.09 "	168 "	336 "
.19 "	252 "	500 "
.42 "	380 "	750 "
.93 "	570 "	1140 "
2.0 "	850 "	1700 "
4.5 "	1325 "	2650 "

In the above example, every wave from 120 meters to 1500 meters can be covered using a capacity of not over .00022 mfd. All waves from 1500 meters to 4000 meters can be tuned by the condenser alone, using the seventh tap.

The computations involved in this formula are not difficult, the only tedious part of the entire process of designing the coil being the figuring of the number of turns required for each inductance value, but if the experimenter is familiar with logarithms he will find this work considerably simplified. The results obtained with coils which have been scientifically designed will considerably repay the effort involved in the calculations. The primary coil may be designed in the same manner, if the experimenter remembers that he must figure the total effective capacity in shunt with the coil. Since the antenna will have some capacity, the inductance of the primary coil for a given wavelength will be somewhat less than that required for the secondary coil.

Wireless Phone for Autos

WILBUR R. CRAMER and Fred W. Swain, of Omaha, Neb., have a workable radiophone installed in their automobile.

Wilbur R. Cramer and His Radiophone Set

The installation made by this pair of amateur radio men is shown in the

Small Ads of Big Interest

A Meeting Place for Buyers and Sellers

Space in this department costs only 25c a line. Minimum space 8 lines. Payable in advance.

accompanying photographs. Tests of the telephone and telegraph instruments which they have attached to their automobile have proved successful, according to the experimenters, who joined the amateur ranks four years ago while they were attending the Omaha High School of Commerce. Following completion of their courses there, both young men have continued their intensive study, Cramer being

Wilbur R. Cramer on the left; Fred W. Swain on the right: two amateurs who installed a radiophone set in an auto

credited with the invention of a standard recording dial with which, during the war, all United States navy wireless sets were equipped. One of these dials was used by the crew of the NC-4.

While experimenting with their wireless telephone apparatus for automobiles, these experimenters have

View of automobile with radiophone installed and showing method of rigging the aerial

been testing out a device to control the operation of any standard make automobile by wireless. Another channel for their wireless efforts will be the conveying of orchestra music from one Omaha motion picture theatre to another and the transmitting of a speech by a nationally known suffrage worker while in Chicago to one of these theatres in Omaha.

Radio Apparatus

Distributors of Reliable Radio Apparatus to Schools, Colleges and Experimenters All Over the World!

"PITTSCO"
THE SIGN OF SERVICE
AND PROMPT DELIVERY
ALL WE ASK IS A TRIAL!

PITTSCO

"REMEMBER"
WHEN YOU SAY
"PITTSCO" YOU THINK
OF EVERYTHING IN RADIO!

Amplifying Transformers

No. A-2 Acme mounted $7.00
No. A-2 Acme semi-mounted 5.00
No. A-2 Acme unmounted 4.50
No. 166A General Radio mounted 7.00
No. 166A General Radio semi-mounted.. 5.25
No. 166A General Radio unmounted.... 4.50
No. Z-73 Clapp Eastham mounted 6.50
No. Z-73A Clapp Eastham unmounted.. 4.00
No. 226-W Federal 7.50
F. D. Pitts Co., Boston, Mass.

De Forest Unit Panel Units

No. US-100 Pri. Condenser switch $2.50
No. US-200 Anti-capacity switch 4.40
No. U-200 "A" Bat. Switch & Tel. Jack. 3.25
No. U-300 "A" Bat. Switch & Tel. Binding Posts 2.20
No. UD-100 Crystal Detector 4.30
No. UR-100 Audion Tube Receptacle.... 2.95
No. US-400 Three point switch 2.25
No. UF-200 Filament Bat. Rheostat..... 3.80
No. UCV-500 .0005 MF. Var. Condenser.. 7.75
No. U-100 .0005 MF. Var. Condenser and grid leak 8.50
No. UCS-1500 Bridging or Stopping Cond. 6.25
F. D. Pitts Co., Boston, Mass.

"B" Batteries

No. 766 Everready 22.5V large $3.50
No. 763 Everready 22.5V small 2.25
No. 7623 Standard 22.5V large 2.65
No. 7625 Standard 22.5V small 1.50
No. 7650 Standard 22.5V variable 3.50
No. P-3 Everready flashlight batteries set of ten 45V 3.50
F. D. Pitts Co., Boston, Mass.

Coils (De Forest Duo-lateral)

DL-25 .... $1.65
DL-35 .... 1.70
DL-50 .... 1.75
DL-75 .... 1.85
DL-100 .... 1.95
DL-150 .... 2.10
DL-200 .... 2.20
DL-250 .... 2.30
DL-300 .... 2.45
DL-400 .... 2.60
DL-500 .... 2.75
DL-600 .... 3.05
DL-750 .... 3.30
DL-1000 .... 3.55
DL-1250 .... 3.85
DL-1500 .... 4.10
F. D. Pitts Co., Boston, Mass.

Coils Mountings (De Forest)

No. LC-100 with gears unmounted $10.00
No. LC-101 with gears mounted with base 13.00
No. LC-201 with base and Pri. switch.. 15.00
No. ULC-200 Single coil mounting 2.00
No. ULC-300 Double coil mounting.... 4.80
No. ULC-400 Triple coil mounting 5.60
No. ULC-100 Same as LC-100 but on panel 10.75
F. D. Pitts Co., Boston, Mass.

Variable Air Condensers

No. 1 Chelsea .0012 MF. mounted $5.00
No. 2 Chelsea .0006 MF. mounted 4.50
No. 3 Chelsea .0012 MF. unmounted 4.50
No. 4 Chelsea .0006 MF. unmounted 4.00
No. Y-800 Clapp-Eastham .0006 MF Balanced type 7.50
No. Y-800A Clapp-Eastham .001 MF 9.50
No. Y-800B Clapp-Eastham .0015 MF ... 11.50
F. D. Pitts Co., Boston, Mass.

Loose Couplers

No. A.-1 Arnold 3500 Meters $22.00
No. Y-673 Clapp-Eastham 2500 Meters. 14.00
No. 344 Murdock 1500 Meters 9.00
F. D. Pitts Co., Boston, Mass.

Antenna Wire

No. F-1 7 strand No. 22 tinned copper per ft. $0.01¼
1000 ft. or over per ft 0.01
No. F-2 No. 14 Hard drawn copper per lb. 0.70
(50 ft. per lb.)
No. F-3 7 strand No. 20 Phosphor-bronze ft. 0.02½
500 ft. or over per ft 0.02
F. D. Pitts Co., Boston, Mass.

Insulators

No. O-2 4" strain type $0.50
No. O-3 10½" strain type 1.00
No. O-4 16" strain type 1.50
F. D. Pitts Co., Boston, Mass.

Ground Equipment

No. G-100 100 Amp. 600V. ground switch. $4.50
No. G-2 Weather-proof No. 4 ground wire ft. 0.10
No. G-3 Heavy porcelain cleats with screws for wire, complete 0.12
F. D. Pitts Co., Boston, Mass.

Rheostats

No. R-2 Remler back mounting $1.75
No. R-3 Paragon back mounting 1.75
No. R-4 General Radio back mounting 2.50
F. D. Pitts Co., Boston, Mass.

Jacks

No. 1423-W Federal N. P. 2 circuit.... $1.00
No. 1422-W Federal N. P. closed circuit 0.85
No. 1421-W Federal N. P. open circuit.. 0.70
No. WE-1 Western Elec. 2 circuit 0.95
No. WE-2 Western Elec. open circuit.. 0.55
F. D. Pitts Co., Boston, Mass.

Plugs

No. 1428-W Federal Brass $2.00
No. 1428-W Federal silver plated 2.50
No. WE-1 Western Elec. Brass 1.20
F. D. Pitts Co., Boston, Mass.

Transmitting Condensers (Dubilier)

Type No.	Watts	Voltage	Cap.	Price
D-100	250	10000	.007	$19.00
D-101	500	14000	.007	30.00
D-102	1000	21000	.007	45.00

F. D. Pitts Co., Boston, Mass.

Vacuum Tubes

Audiotron Det. Amp. Osc $6.00
F. D. Pitts Co., Boston, Mass.

Tube Sockets

No. GR-1 General Radio $1.75
No. R-300 De Forest 1.50
No. R-400 De Forest Inverted type.... 2.75
No. MW-1 Marconi 1.50
No. 550 Murdock 1.00
F. D. Pitts Co., Boston, Mass.

Rotary Spark Gaps

No. 443 Murdock $12.50
No. 124 Klitzen latest model 26.00
No. P-1 Benwood sound proof 30.00
Benwood Rotors 8, 10, or 14 point... 8.00
F. D. Pitts Co., Boston, Mass.

Regenerative Receivers "Grebe"

No. CR-1 170-600 meters with tube control self contained $90.00
No. CR-2 170-600 meters 51.00
No. CR-3 "Special" for relay work. 170-600 meters 65.00
No. CR-3A 170-375 meters. The latest Grebe short wave receiver 45.50
No. CR-4 170-600 meters with series condenser 65.00
No. CR-6 170-600 meters. Receiver, detector and two step amplifier self contained. A complete set 200.00
No. CR-7 500-20000 meters. Long wave, with tube control. A complete receiver 210.00
(Give him that Grebe set. An incomparable Christmas gift.)
F. D. Pitts Co., Boston, Mass.

Oscillation Transformers

No. 424 Murdock .... $ 5.00
No. P-1 Thordarson 12.00
No. TXL-100A International 16.75
No. Z-652 Clapp-Eastham 1 KW. size.. 30.00
F. D. Pitts Co., Boston, Mass.

Audion Control Panels

No. RORA Grebe with cabinet $12.50
No. RORH Grebe with tick. connections 17.00
No. P-401 De Forest in cabinet 14.25
No. P-500 De Forest in cabinet with 45 volts "B" battery 25.00
F. D. Pitts Co., Boston, Mass.

Telephones (Pair)

No. 1 Type C Baldwins Navy Standard. $16.50
No. 2 Type E Baldwin's latest super-sensitive 20.00
Brandes Superior 2000 ohms 7.00
Brandes Transatlantic 2800 ohms 12.00
Brandes Navy Type 3200 ohms 14.00
No. 55 Murdock 2000 ohms 4.50
No. 55 Murdock 3000 ohms 5.50
No. 52-W Century 3200 ohms Govt. standard 14.00
No. 53-W Century 2200 ohms Govt. standard 12.50
F. D. Pitts Co., Boston, Mass.

IMPORTANT! Every article listed sent to any part of the United States Postage or express prepaid!

We want your business!

"Let 'PITTSCO' products, service and delivery solve your Xmas problems"

SEND US YOUR ORDERS TODAY!

Manual No. 22 just out, sent upon receipt of ten cents in stamps

"PITTSCO" SERVICE REACHES ALL OVER THE WORLD! WHY NOT LET IT REACH YOU!

F. D. Pitts Co., Inc.

12 Park Square **Dept. B** **Boston, Mass, U. S. A.**

The Monthly Service Bulletin of the

National Amateur Wireless Association

Founded to promote the best interests of radio communication among wireless amateurs in America

Guglielmo Marconi, *President* — J. Andrew White, *Acting President* — H. L. Welker, *Secretary*

NATIONAL ADVISORY BOARD OF VICE-PRESIDENTS

Prof. A. E. Kennelly, *Harvard University.*
Maj. Gen. George O. Squier, *Chief Signal Officer, U. S. Army.*
Captain D. W. Todd, *U. S. N., Director Naval Communications.*
Rear Admiral W. H. G. Bullard, *U. S. N.*
Prof. Alfred N. Goldsmith, *College of the City of New York.*
Major William H. Elliott, *American Guard.*
E. E. Bucher, *Instructing Engineer.*
Prof. Samuel Sheldon, *Brooklyn Polytechnic Institute.*
Colonel Samuel Reber, *Signal Corps, U. S. Army.*
Prof. Charles R. Cross, *Massachusetts Institute of Technology.*

Headquarters, 326 Broadway, New York

Amateurs Relay Hoover Plea

HERBERT HOOVER has sent a message to the American people from his New York, Detroit and Chicago offices by means of 5,000 amateur wireless operators. Mail planes en route and vessels at sea are expected to forward the message, which reads:

"America, facing a new year that finds its population warmly housed and clothed, and possessing a great food surplus that can find no market at home, must decide within the next few weeks whether part of that surplus is to be bought for export for relief, or whether it is to remain on the farms and in the warehouses, while hundreds of thousands of helpless children in Eastern and Central Europe starve.

"Less than half of the $33,000,000 required by the European Relief Council to conduct its child care program until next harvest is now in hand. It is unthinkable that any of the 3,500,000 charges on our charity should be turned into the streets. Every American who has not yet taken an invisible guest into his home can with $10 put into effect a resolution that cannot be broken—a resolution to save a child's life. A check to Franklin K. Lane, or your local committee, will be a truly American gift."

Nassau Radio League Election

AT a meeting of the Nassau Radio League, of Freeport, L. I., the following officers were elected for the first half of the new year: Robert Johnston, president; Sinclair Raynor, vice-president; Fred Porter, secretary-treasurer; Donald Wallace, chief operator; the above with Lester Hardy, Henry Opperman and Thomas O'Brien, constitute the board of directors; Fred Combs, chairman library committee; Barrington Carman, Sinclair Raynor and Huyler Ellison, meetings and papers committee; Joseph Joyce, Sinclair Raynor, Vincent Leibler and Robert Johnston, electrical committee. The league desires to secure as members Nassau county radio amateurs.

Springfield High School Radio Club

The Springfield High School Radio Club, Springfield, Mo., organized last November, is holding meetings every other Tuesday at 7:30 P. M. A library has been started for the use of members, and code practice equipment has been installed, and the club's station will soon be completed. Amateurs going through that town are invited to drop in.

Pacific Coast Convention

AN attendance of 580 radio men testified to the success of the Pacific Coast Radio Convention, held in San Francisco, November 25th to 27th.

Major J. F. Dillon, U. S. Radio Inspector, was the honorary chairman of the Convention. He was elected chairman for the next year and a resolution was passed to make the Convention an annual affair. This action followed a series of interesting talks given by the Convention officials and other prominent radio men, among whom were: C. I. Hoppough, radio engineer for the Signal Corps, U. S. Army; B. Wolf, Pacific Coast radio supervisor for the United States Shipping Board; C. Langevin, Pacific Coast representative for the United Radio Telegraphers' Association; L. Malarin, of the Radio Corporation of America; Leo M. Meyberg; Collin B. Kennedy; A. E. Bessey, one of California's most prominent and enthusiastic amateurs: Mr. Pray, of the North Dakota Radio Association; Mr. Blake, of the Federal Telegraph Company; Mr. Kuhn, of the Ship Owners' Radio Service; Lieutenant Twist, of the Naval Radio Service, and many other prominent radio men.

A resolution to send a protest to the Congressman of California on a new proposed radio act was unanimously adopted, and many signatures were secured. It was also resolved that the figure "4" should precede the transmission of messages in order to ascertain if other stations were listening for a message. A committee of six was also appointed as advisory council on any radio questions which may be brought before it at quarterly meetings to be held in San Francisco.

On the evening of November 27th a radio ball was held at the Century Club, and those attending danced to music transmitted by radio from the St. Francis Hotel. One hundred members also attended a banquet which was included in the program.

The organizations which were represented at the Convention were the following:

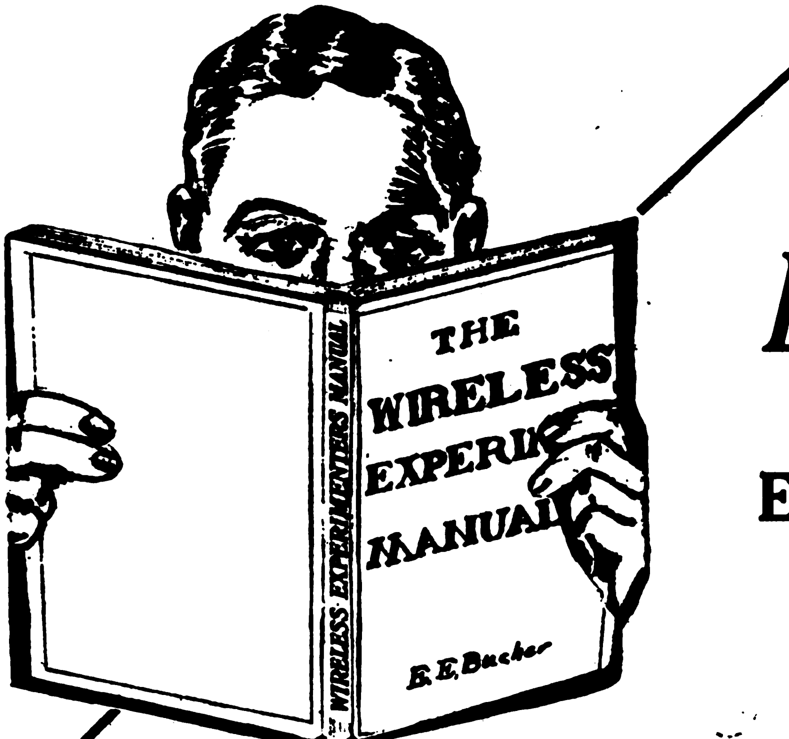
San Francisco Radio Club, Inc.
Bay Counties Radio Club.
Polytechnic Radio Club.
Reno, Nevada, Radio Club.
University of California Radio Club.
North Dakota Radio Association.
Santa Cruz Radio Club.
Lowell High Radio Club.
American Radio Relay League.
Monterey Radio Association.
Technical Radio Club, Oakland.
Stockton Radio Club.
Pomona Radio Association.
Sacramento Radio Club.
Napa Radio Club.
Federated Malay States Government.
Evening High School Radio Club of San Francisco.
"Pacific Radio News."
Leo J. Meyberg Company.
The United States Army.
The United States Navy.
The United States Shipping Board.
Department of Commerce.
United Radio Telegraphers' Association.
Knights of Columbus Radio Club.
Pacific Radio Supplies Company.

On November 28th a contest was held in which the world's record for fast radio reception was broken. Details of this contest are given on page 8 of this issue.

A Department Store Demonstration

A CHRISTMAS demonstration of wireless at the Filene Store in Boston attracted a lot of attention among holiday shoppers.

The two wireless towers on the roof were used to support a single wire aerial 250 feet above the street; from this a lead was carried to the boys' de-



You Will Like It Too!

The WIRELESS EXPERIMENTERS' MANUAL

will meet all your expectations

AS WILL

Any of these "Laboratory Tested" Books

WIRELESS PRESS BOOKS MAKE GOOD OR WE WILL

(Your Money Back If You Are Not Satisfied)

PRACTICAL WIRELESS TELEGRAPHY — By Elmer E. Bucher

PRACTICAL WIRELESS TELEGRAPHY is the recognized standard wireless text book. It is the first wireless text book to treat each topic separately and completely, furnishing a progressive study from first principles to expert practice. Starting with elementary data, it progresses, chapter by chapter, over the entire field of wireless—fundamentals, construction and practical operation.

352 pages, 340 illustrations, handsomely bound in full cloth. Price **$2.25**

THE WIRELESS EXPERIMENTERS' MANUAL — By Elmer E. Bucher

The only book published that comprehensively covers the theory and design of amateur wireless transmitters and receivers. Construction of transformers, high voltage condensers, spark gaps, aerials, masts, receiving sets for long and short wave length reception are described in great detail. Construction and operation of regenerative receivers, cascade amplifiers, preferred circuits for long and short wave receivers, direction finders, underground aerials and the use of Weagant's static eliminator for amateurs—all these are covered.

Cloth bound. 340 pages. Fully illustrated. Price **$2.25**

VACUUM TUBES IN WIRELESS COMMUNICATION By Elmer E. Bucher

An elementary text book for students, operators, experimenters and engineers. Tells in understandable language the fundamental operating principle of the vacuum tube. Shows over 100 different circuits for the practical use of the Vacuum Tube as a Detector, Radio or Audio Frequency Amplifier, Regenerative Receiver, Beat Receiver and Generator of Radio Frequency Currents.

Cloth. 184 pages, 130 diagrams and illustrations. Price **$2.25**

RADIO TELEPHONY — By Alfred N. Goldsmith, Ph.D.

It is the only book treating the subject of Radio Telephony in all its aspects.

This complete text on radio telephony is intended for radio engineers, operators and experimenters, also radio electricians in the Navy, men in the Signal Corps, and especially men in the Aviation Service who handle radio equipments. Presupposes very little knowledge of radio. Fully illustrated with wiring diagrams and previously unpublished photographs of "wireless telephone" apparatus.

256 pages, 226 illustrations. Full cloth. Price **$2.50**

WIRELESS TELEGRAPHY AND TELEPHONY

First Principles, Present Practice, and Testing, By H. M. Dowsett, M.I.E.E.

A new book intended to fit in between the elementary text book of the beginner and the highly specialized treatise of the advanced engineer and experimenter.

Cloth, 323 pages. Fully illustrated. Price **$3.50**

TELEPHONY WITHOUT WIRES — By Philip R. Coursey

Following a brief treatment of the early attempts at telephony by electro-magnetic waves, the volume takes up the various problems of speech transmission, describes advanced forms of spark and continuous wave production, arc generators and vacuum tubes as producers of oscillations, alternators and the various forms of frequency raisers and gives a broad discussion of the modulation of the transmitted energy. Receiving apparatus and amplifiers are also discussed, together with descriptions of the methods and operation of apparatus and circuits designed for interference prevention.

Cloth, 396 pages. Fully illustrated. Price **$5.00**

AND DON'T FORGET TO INCLUDE A YEAR'S SUBSCRIPTION TO THE WIRELESS AGE WITH YOUR ORDER. REGULAR PRICE, $2.50 A YEAR. WITH BOOK ORDER, ONLY $2.00. (POSTAGE OUTSIDE U. S. 50c EXTRA.)

PRACTICAL AMATEUR WIRELESS STATIONS

An "Experience" Book

Containing the best suggestions of thirty-three experimenters on Building, Installing and Operating Experimental Stations for Radio Communication. Compiled by J. Andrew White, Editor, "The Wireless Age."

Paper, 6x9 in. 136 pages. Profusely illustrated. Price, **75c**

HOW TO PASS U. S. GOV'T WIRELESS EXAMINATIONS — By E. E. Bucher

New edition revised and extended. 142 questions and answers. An ideal review quiz book when used with PRACTICAL WIRELESS TELEGRAPHY.

Size 6½x9¾ inches. Fully illustrated. Price **75c**

HOW TO CONDUCT A RADIO CLUB — By E. E. Bucher

Covers parliamentary procedure, indoor and outdoor experiments, 5,000-mile receiving sets, vacuum tube amplifiers and detectors and many other subjects.

Paper Cover. 148 pages. Fully illustrated. Price **75c**

ORDER BLANK

Wireless Press, Inc.,
326-28 Broadway,
New York.

Date ....

Please send me at once the books checked below, I enclose $ ....

......Practical Wireless Telegraphy	$2.25
......Wireless Experimenters' Manual	2.25
......Vacuum Tubes in Wireless Communication	2.25
......Radio Telephony	2.50
......Wireless Telegraphy and Telephony	3.50
......Telephony Without Wires	5.00
......Thermionic Valve, J. A. Fleming	5.00
......Oscillation Valve, R. D. Bangay	2.75
......Practical Amateur Wireless Stations	.75
......How To Pass U. S. Govt. Wireless Examinations	.75
......How To Conduct a Radio Club	.75
......*Wireless Age (with book order)	2.00
......*Wireless Age (without book order)	2.50

***Outside U. S. 50c Extra.**

Name ....

Street ....

City .... State ....

2-21

WIRELESS PRESS, Inc., 326-28 BROADWAY NEW YORK partment on the second floor, where a Navy 250 to 7500 meter receiving set was used with three Amrad amplifiers and a Magnavox loud speaker. The Arlington weather report and time were easily read all over the crowded floor of the department store, other stations as far away as Sable Island coming in so loud that it was necessary to cut down amplification, as it interfered with clerks and customers understanding each other.

A Workable Indoor Aerial

F. CLIFFORD ESTEY (1FAV), of Salem, Mass., reports that on New Year's evening at home he put up an indoor aerial, never thinking that he would get the results that followed.

He ran nine wires across the attic about fifteen feet long and connected them all together on one end and dropped a lead down between the partition and fished it out on the second floor where the steam pipe goes through the wall.

For apparatus he had an Amrad short wave coupler, two variometers and a detector amplifier (one step), using a Radiotron and one Moorehead class two, and a borrowed storage battery from an automobile. Signals from 1GBT came in like a ton of bricks on the regenerative receiver, and he got the surprise of his life to hear 8GW very clear and no QSS; at 10.35 he heard the following: 8RG, 3EN, 3VV, 3WY, 3ABC, 8ACT, 3DV, 8HG, 8XK, 8MZ, 3CO and 8SP, all QSA through QRM from first and second district stations.

With an indoor aerial and steam radiator for ground this is FB.

Radio Research Association

THE Radio Research Association has been formed by the former members of the Scientific Research Club, a pre-war organization of New York.

The club is installing a short and long wave receiver, a spark transmitter and a C.W. set. A technical committee has been appointed composed of experienced radio men and a junior class has been formed for amateurs who are not of the age to make them eligible to enter the senior organization; instruction will be given in both code and theory.

It is the purpose of the club to experiment in the field of radio and to affiliate with the National Amateur Wireless Association in the near future.

Meetings are held every Saturday at 303 Henry street, New York City.

All communications should be addressed to B. Hoffman, the secretary, at 233 South Third street, Brooklyn, N. Y.

Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

MECHANICAL INTERRUPTER FOR D. C.
TRANSMITTERS

Closing date, March 1, 1921.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the May Issue.

Some of the amateurs living in big cities are supplied with direct current and have to find a means for breaking it up before they are able to do any transmitting. One of the young men so handicapped has put it up to me and I am going to "pass the buck" to you. Show us how to make a mechanical interrupter capable of handling a one-half K. W. Transmitter.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

Radio Engineers Wanted

THE United States Civil Service Commission announces open competitive examinations for the positions of radio engineer, $3,000 to $4,800 a year; assistant radio engineer, $2,000 to $3,000 a year; radio laboratory assistant, grade 1, $800 to $1,200 a year; grade 2, $1,200 to $2,000 a year. Applications will be rated as received until April 5, 1921. Vacancies in the Signal Service at Large, War Department, for duty at Camp Alfred Vail, N. J.; Signal Corps Laboratory, Bureau of Standards, Washington, D. C.; and Signal Corps Radio Laboratory, McCook Field, Dayton, Ohio, at the salaries indicated, and vacancies occurring in position requiring similar qualifications, at these or higher or lower salaries, will be filled from these examinations.

For any of these positions the entrance salary within the range stated will depend upon the qualifications of the appointee as shown in the examination and the duty to which assigned.

After six months' satisfactory service appointees at annual compensation of $2,500 or less may be allowed the increase granted by Congress of $20 a month. All citizens of the United States who meet the requirements, both men and women, may enter these examinations; appointing officers, however, have the legal right to specify the sex desired in requesting certification of eligibles. For these positions in the Signal Service men are desired.

On account of the needs of the service, papers will be rated as received and certification made as the needs of the service require. In the absence of further notice, applications for these examinations will be received by the commision at Washington, D. C., until the hour of closing business on April 5, 1921. If sufficient eligibles are obtained the receipt of applications may be closed before that date, of which due notice will be given.

The duties of appointees to the positions of radio engineer and assistant radio engineer will be to conduct or superintend the development, design, and construction of practical and special apparatus and methods of radio signaling suited to special conditions and of standardizing such apparatus for the Signals Corps, such apparatus to include sets for land use for more or less permanent stations, also for portable land stations, and for airplane and ship sets to carry out advanced technical work in radio research; to analyze the data which may accrue from observations of the operation of various radio apparatus and installations; and to plan and execute experimental investigations as indicated. Ability as an operator is not essential but is very desirable.

The duties of radio laboratory assistants will be to assist in radio work to be conducted in Signal Corps laboratories.

For all of the above positions except laboratory assistant, Grade 1, it is desired to obtain men who have received a bachelor's degree or equivalent, so that they will be eligible for promotion in time up to the highest position, according as they obtain additional experience and demonstrate their fitness, and as vacancies may occur. It is not the intent, however, to bar applicants for lack of a degree if they possess the equivalent as specified hereafter and if their education and experience are such that they give promise of developing into capable engineers.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects.	Weights
1. Education and preliminary experience..	30
2. Special experience and fitness..........	40
3. Publications, reports, or thesis (to be filed with application)................	30
Total	100

Under the first two subjects competitors will be rated upon the sworn statements in their applications and upon corroborative evidence.

The requirements for eligibility for appointment to these positions are as follows:

Applicants must attain an eligible rating in the third subject and must meet the following requirements—

Radio Engineer.—Except as modified below, applicants must show that they have graduated with a bachelor's degree, with major work in physics or electrical engineering, from a college or university of recognized standing, and, in addition (1) have had at least three years' experience in the design, manufacture, or installation of radio apparatus for the Government or for a contractor who has supplied satisfactory radio apparatus for the Government, or (2) have been engaged for at least three years in research work of an acceptable character dealing with radio problems.

Assistant radio engineer.—Except as modified below, applicants must show that they have graduated with a bachelor's degree, with major work in physics or electrical engineering from a college or university of recognized standing, and, in addition (1) have had at least one year's experience in the design, manufacture, or installation of radio apparatus for the Government or for a contractor who has supplied satisfactory radio apparatus for the Government, or (2) have been engaged for at least one year in research work of an acceptable character dealing with radio problems.

Substitution of experience for college education.—If the competitor has not had the required education for radio engineer or assistant radio engineer, he may offer in lieu thereof additional experience in engineering or research work on radio, telegraph, telephone, or high tension electrical work of a character acceptable to the Commission. Applicants for radio engineer may offer two years, and for assistant radio engineer one year, of such experience as a substitute for each scholastic year of the required education. In any case at least half of the experience presented for this purpose must have been on radio work.

Radio laboratory assistant, Grade 1.—Applicants must show that they have graduated from a four-years' high-school course or have completed at least fourteen units of study acceptable for college entrance. In addition, they must either possess a first-grade amateur license as radio operator or submit evidence that they have had at least six months' experience on radio work tending to familiarize them with radio transmitting and receiving sets.

Radio laboratory assistant, Grade 2.—Applicants must show that they they have had the education and experience specified in one of the following groups:

(a) Graduation with a bachelor's degree, with major work in physics or electrical engineering, from a college or university of recognized standing.

(b) Graduation from a four-years' high-school course or the completion of at least fourteen units of study acceptable for college entrance, and, in addition, at least two years' experience as laboratory assistant in radio or electrical work or allied work of equivalent character.

Under the third subject applicants must submit with their applications an original publication, report, or thesis. If prepared specially for this examination, it should be not less than 1,000 words in length. For the positions of radio engineer and assistant radio engineer such publication, report, or thesis should represent the result of original investigation or research on radio problems. For the positions of radio laboratory assistant, Grades 1 and 2, it may be an original discussion on a technical phase of radio work.

Age on date of making oath to application:

Radio engineer, 25 to 50 years.

Assistant radio engineer, 22 to 40 years.

Radio laboratory assistant, Grades 1 and 2, 18 to 30 years.

Age limits do not apply to persons entitled to preference because of military or naval service.

Applicants will be admitted to these examinations regardless of their residence and domicile; but only those who have been actually domiciled in the State or Territory in which they reside for at least one year previous to the examination, and who have the county officer's certificate in the application form executed, may become eligible for permanent appointment to the apportioned service in Washington, D. C.

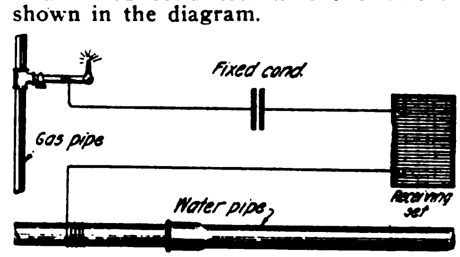
Applicants should at once apply for Form 2118, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed. Positively no Questions Answered by Mail.

S. L. G.., New York City:

Indoor aerials in the form of loops, or wire run around the room in the picture moulding, usually receive very little energy so that a vacuum tube and amplifier set are required in order to receive signals any great distance.. Try using the gas and water pipe with a small fixed condenser in the circuit as shown in the diagram.



E. H. B., Midville, Ga.:

It seems to us that your filament or plate batteries fail to supply sufficient current after using them for awhile. Try other vacuum tubes against your present detector. Possibly NAA does fade due to power output actually decreasing. Suggest you add a one or two step amplifier to your station if unsuccessful in any other way.

* * *

J. W. T., Jr., Shelby, Miss.:

The grid leak on the second bulb should be removed. Use a lower voltage, preferably variable plate circuit of the detector tube and a separate battery of 40-60 volts on the amplifiers. The tickler coil is necessary in this circuit for best results. Connecting another audio frequency transformer instead of the radio frequency connection you are now using, should give better results. In this case a grid condenser is needed in the grid circuit of the detector tube. Be sure the high voltage end of your audio frequency transformer is connected to the grid as this is the chief cause of poor amplification. The free end is the connection on the outside or top of the secondary coil.

HERE'S A *SURE* WINNER

For long distance work you can find nothing to beat the

GREBE RADIO

Type CR 3A
Short Wave Regenerative Receiver and Vacuum Tube Unit

Compact, complete, dependable, with a wave-length range running up to 375 meters, it fills the need for a moderate-priced regenerative receiver. Built in every way up to the Grebe standard.

The CR-3A includes a variable antenna circuit, continuously variable grid and plate circuits, a specially designed coupling circuit and a standard vacuum-tube mounting with a grid condenser and leakage element.

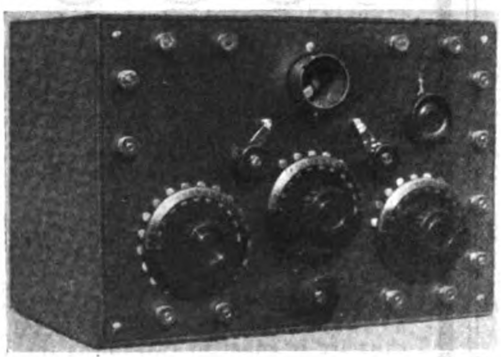
All binding posts are conveniently located on the front of the panel. The price $45.50 is within the reach of all. Be sure to ask your dealer about the CR-3A.

GREBE Radio Apparatus is Licensed Under the Original Armstrong and Marconi Patents

Central Radio Institute, Independence, Mo.
Continental Radio and Electric Corp., New York.
Detroit Electrical Co., Detroit, Mich.
Doubleday-Hill Electric Co., Pittsburgh, Pa.
Electrical Specialty Co., Columbus, Ohio.
Holt Electric Utilities Co., Jacksonville, Fla.
Hurlburt-Still Electrical Co., Houston, Texas.
Kelly & Phillips, Brooklyn, N. Y.
Klaus Radio Company, Eureka, Ill.
Manhattan Electrical Supply Co., New York, Chicago, St. Louis.
Leo J. Meyberg Co., San Francisco, Cal.
Pacent Electric Co., Inc., New York City.
F. D. Pitts Co., Inc., Boston, Mass.
Philadelphia School of Wireless Telegraphy, Phila., Pa.
Western Radio Electric Co., Los Angeles, Cal.

A. H. GREBE & CO., Inc. 74 Van Wyck Blvd., Richmond Hill, N. Y.

A NEW MODEL, JONES SHORT WAVE REGENERATIVE RECEIVER, IN CABINET FORM, FOR - $29.00



Model "H" 200-2500 Meters. Licensed under Marconi and Armstrong Patents

A superlative Cabinet Receiver, built with the same technical skill and care that characterizes our higher priced sets. Model "H" will hold its own against the best in the market. NO SEALS, NO SECRETS—Just standard, approved circuits arranged intelligently in compact manner that materially reduces the cost. Bulletins on request.

Manufactured by the JONES RADIO COMPANY, 384 Monroe Street, Brooklyn, N. Y.

OUR GRADUATES ARE SAILING THE SEVEN SEAS

RADIO OPERATORS

$100 to $125 Per Month Upward, Plus All Expenses

Call or Write for Illustrated Booklet

Y.M.C.A. RADIO SCHOOL

149 East 86th St. New York, N. Y.

The Radio Operator aboard American vessels is paid One Hundred and Twenty-five Dollars ($125.00) per month. Aside from this, he is also furnished food and quarters. He is an officer of the ship and consequently enjoys the privileges that go with such a position.

"Best Radio School in the East"

H. C. T., Brooklyn, N. Y.:

The panel type of loose coupler you desire is not being made for amateur sale. Some commercial types contain a loose coupler with taps on the panel front and some mechanical arrangement to change the coupling between primary and secondary coils. The nearest approach to this type is manufactured by J. F. Arnold, 2082 Lexington Avenue, New York City, and is listed in his catalogue at twenty dollars.

* * *

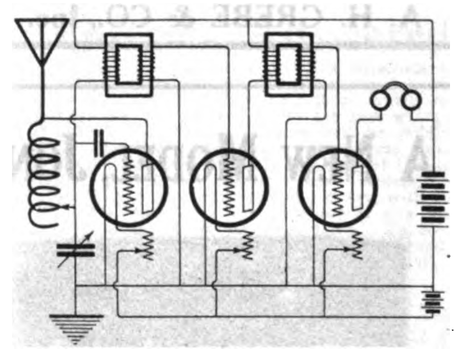
P. G., Marshall, Mich.:

Wind the primary with a few feet of number twenty and the secondary with approximately one-half pound of number forty enameled wire.

* * *

B. H. C., Brooklyn, N. Y.:

Your circuit will work fairly well as a plain detector but not as an oscillator. The accompanying diagram is an oscillating circuit and will cover any range of wave lengths by inserting a suitable inductance coil.



N. R. H., Casper, Wyo.:

The condenser connected as stated should stand 25,000 volts provided the glass has sufficient dielectric strength. When three equal sections are connected in series the capacity is one-third the capacity of one section. When in parallel simply add their values. Connnected as stated in your question the result and capacity is equal to two-thirds the value of one section. Kindly send us a sketch showing construction of one section as this is important in order to mathematically arrive at the value of capacity.

* * *

F. E. C.., Portland, Oregon.:

The natural wave length of your aerial is about 400 meters so that when connected to your set without a ground connection, except the capacity of the set to the ground, you are able to receive on six hundred meters by loading the circuits. When you connected a ground we presume that you varied your capacity. Have you tried a ground connection when using smaller coils for this wave length? We would like to hear what the results are.

Book Review

Henley's Twentieth Century Book of Formulas, Recipes and Processes. Edited by Gardner D. Hiscox. Cloth binding, 786 pages. Henley.

Revised and enlarged for the 1920 edition, this familiar work makes a renewed appeal to the man who finds joy in the things he creates with his own hands. Countless hours of fascinating and perhaps profitable spare time activity with chemicals are contained within the thousands of recipes, each one to be regarded as a basis of experiment with such departures or modifications as may suggest themselves to the home worker.