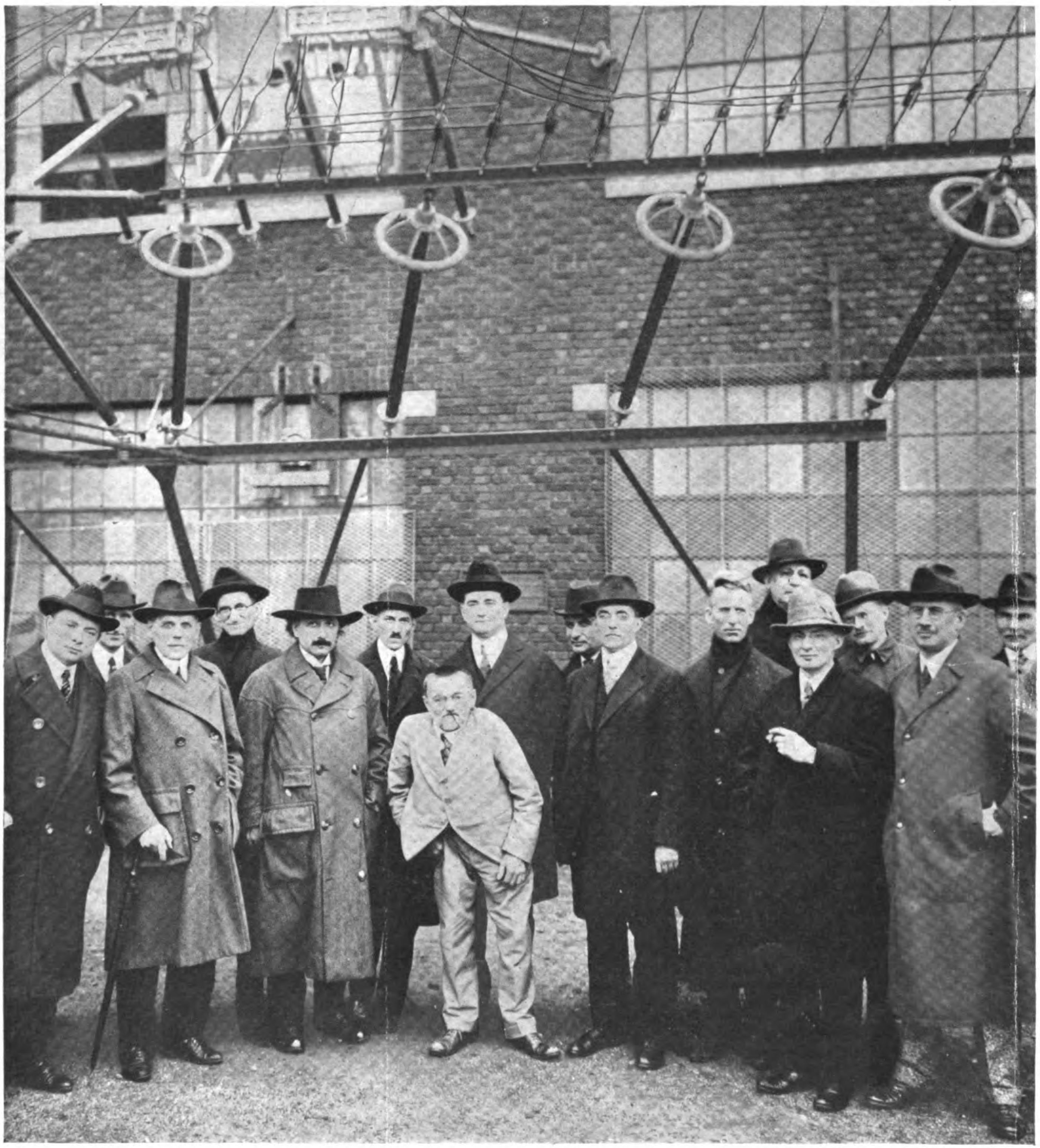
June, 1921

25 Cents

The WIRELESS AGE

Volume 8

Number 9



Professor Albert Einstein, proponent of tne world famous relativity theory with leading radio and electrical men at New Brunswick

Reading from left to right: David Sarnoff. Thomas J. Hayden. Dr. E. J. Berg, S. Benedict, Professor Albert Einstein, John Carson, Dr. C. P. Steinmetz, Dr. A. N. Goldsmith, A. Malsin, Dr. Irving Langmuir, Dr. Albert W. Hull, E. B. Pillsbury, Dr. Saul Dushman, R. H. Ranger, Dr. G. H. Campbell and C. H. Taylor.

The New Poland Radio Circuit

And Many Exclusive Features in This Issue

WORLD'S ONLY MAKER

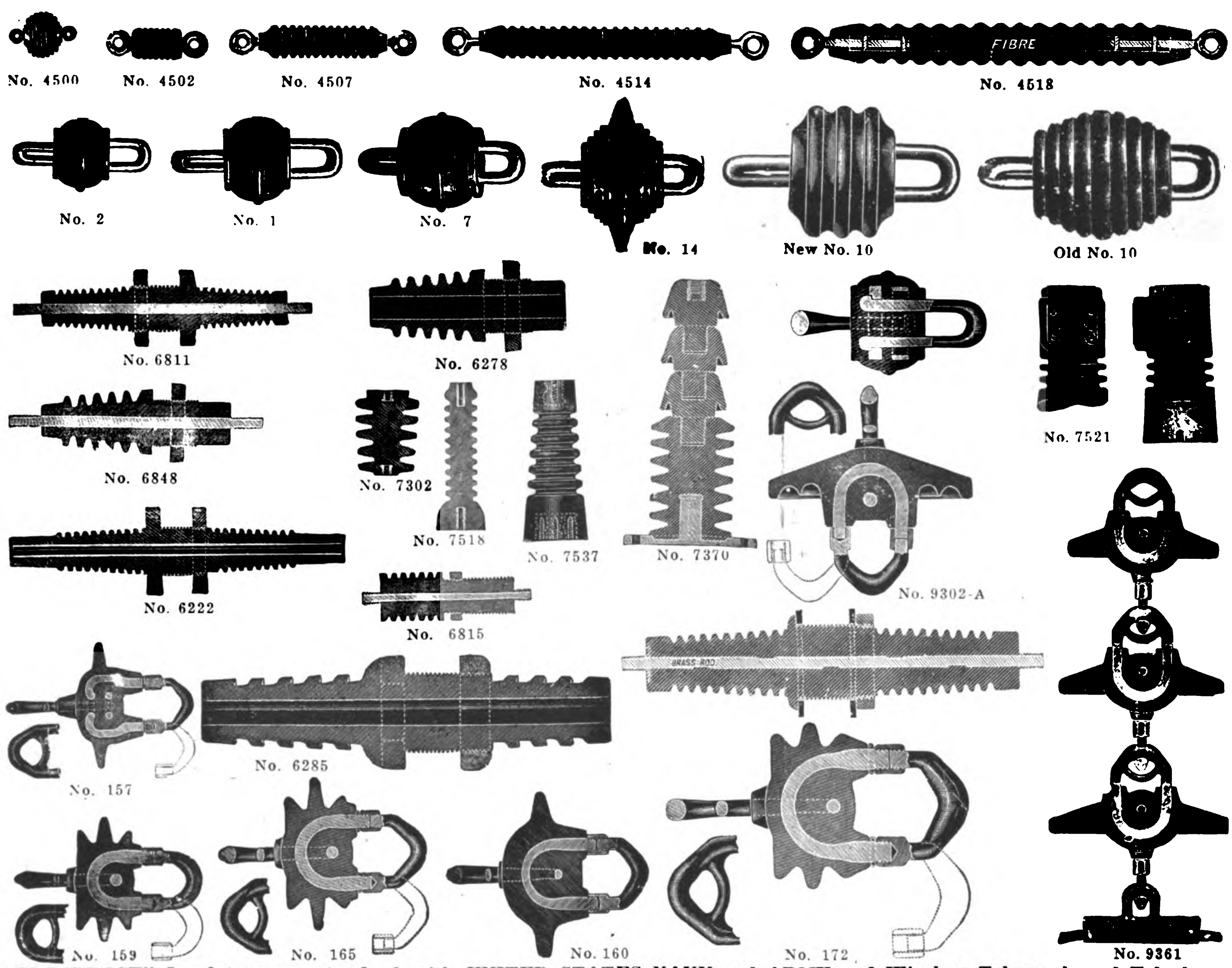
Moulded High Frequency High Tension Insulators

INSULATORS 1,000 TO 1,000,000 VOLTS

Medal and Diploma received at World's Columbian Exposition, Chicago, 1893.

TRADE ELECTROSE MARK
REG. U.S. PAT. OFF. & FOREIGN COUNTRIES.
INSULATION
"MADE IN AMERICA"
Louis Steinberger's Patents

Medal and Diploma received at World's Fair, St. Louis, 1904



"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

Superlatives

No wonder you, Mr. Radio Man, are confused by the extraordinary descriptives such as best, most efficient and all the others you know so well. Do you ever stop to think that any one who can pay for an advertisement can make these claims? Fraternize with the old-time radio men and find out their opinion of Clapp-Eastham apparatus, of Clapp-Eastham service which goes with every sale and their reputation for fair dealing.

No one need experiment with unknown products unless he wants to. Your dealer will sell you our products if you insist but he is only human and is often tempted by a greater profit on an inferior product. Remember you pay this greater profit. Our apparatus will give you the greatest possible bargain, YOUR MONEY'S WORTH—you cannot hope for more. And with every purchase goes the guarantee of the oldest manufacturer of Radio Apparatus in the United States.

Z. R. F. D. A. Receiving Set.
Licensed under Armstrong U. S. Patents

Type Z. R. F. D. A. Regenerative receiving set is designed exclusively for those who require the very utmost in long distance short wave reception. It comprises two of our Z. R. V. Variometers, one Z. R. C. Variocoupler with switch, one of our famous balanced condensers and a detector and two stage amplifier.

All are mounted on a highly finished formica panel in heavy oak case with hinged cover.

Price complete except bulbs, batteries and telephones	$140.00
Same set without amplifiers, Type Z. R. F. D.	85.00
Same set without detector, amplifier, variable condenser or cabinet, Type Z. R. F.	38.00
Detector panel only, Type Z. R. D.	12.00
One stage amplifier panel, Z. R. A.	18.00
Variometer, Type Z. R. V. With dial and knob	6.50
Variocoupler Type Z. R. C., with dial and knob	7.50
Variocoupler, Type Z. R. C. with dial and knob switch and points	9.00
Balanced Variable Condenser, Type F800 with dial and knob	7.00
Two stage amplifier, Type O. Z. in cabinet	40.00

Amplifying coil, semi-mounted, Type Q. O.	$4.00
Unmounted Filament Rheostat, Type Z. R. R.	1.20
Knob and dial, 3 inch, heavy brass, black finish, composition knob	.75
Graphite Potentiometer, 5000 ohms	3.00

The Hytone Panel Transmitter

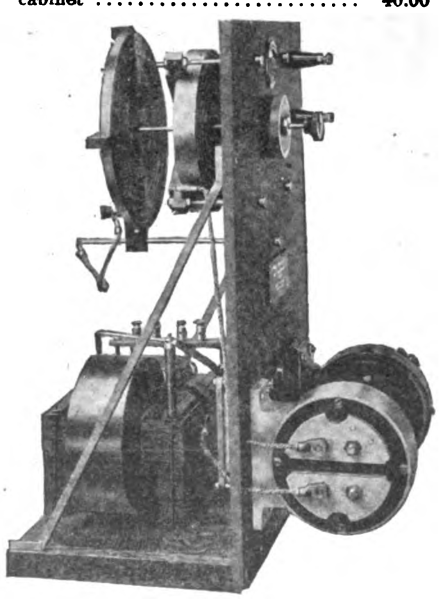
All the advantages of 500 cycle transmitters are combined in this set without the use of cumbersome and expensive motor generator sets as it operates directly on 60 cycle current. It produces a clear high pitched note which is variable at will. This set is highly efficient, with low decrement and gives sharp tuning and minimum of interference with maximum radius of communication. The set includes the following instruments all mounted on a formica panel ½ inch thick: Transformer, special low voltage type, Hytone rotary spark gap entirely enclosed in aluminum housing, Variable speed motor direct connected through flexible coupling, Mica condenser, Oscillation transformer, Thermo couple ammeter, main line switch and key.

Complete ½ K W Transmitting set as above	$250.00
Similar Transmitter 1 K W capacity	$500.00

These sets are also supplied in ratings of 2-3-5 and 10 K. W. Prices on application.

We also supply the following transmitting apparatus as shown in our complete catalogue:

Transformers, Type Z. R. L. 400 watts, especially for rotary spark gaps	$15.00
Transformers, Type L 500 watts, mounted $28.00, unmounted	22.00
Transformers, Type L 1000 watts, mounted $40.00, unmounted	34.00
Cambridge Rotary Spark Gap for use up to 1 K W including variable speed motor	50.00
Improved antenna switch	12.50
Boston Key on engraved Formica base, 10 amperes $7.50, 20 amperes	8.00
Oscillation Transformers, Type Z651	16.00



COMPLETE CATALOGUES SENT FOR 6c STAMPS. Patronize your local dealer. If he won't supply our material your order will receive immediate factory attention.

CLAPP-EASTHAM COMPANY

161 MAIN STREET CAMBRIDGE, MASS.

HEADQUARTERS FOR RADIOTRON TUBES — All Types in Stock

Vol. 8 Contents of The Wireless Age for June 1921 No. 9

Edited by J. ANDREW WHITE

FEATURE ARTICLE
The New Poland Radio Circuit.... 11
New Legislation 21

WORLD WIDE WIRELESS....... 7

RADIO SCIENCE
Measurements on Audio-Frequency Amplifiers, by L. M. Hull 12
Signal Distortion Prevented 16
A Complete Radio Set Cabinet 19
A Novel Power V-T, by H. J. Round of London 20
Two New Coastal Stations Use Tube Transmitters for First Time in Ship-to-Shore Work 20

EXPERIMENTERS' WORLD
A Quick and Accurate Relay Key, by Aubrey Whitney (First Prize) 22
Relay Key Used With a Vibroplex, by Maurice B. O'Neill (Second Prize) 23
A Relay Key for a 1 K.W. Set, by F. J. Froxler, Jr. (Third Prize).. 24
New Transcontinental Amateur Record 27

N. A. W. A. BULLETIN 29

QUERIES ANSWERED 38

ADVERTISEMENTS

MISCELLANEOUS
Omnigraph Mfg. Co............... 2

BOOKS
Branch Pub. Co., The Joseph G... 44
Q.S.T.,American Radio Relay League 29
Wireless Press, Inc. 3,4

ELECTRICAL EQUIPMENT
Ace Battery Mfg. Corp............ 34
Acme Apparatus Co.............. 3
American Electro Technical Appliance Co. 42
American Eveready Works.......... 33
American Radio and Research Corp. 30
American Radio Sales & Service Co., The 47
Atlantic Radio Co., The.......... 32
Atlantic Radio Supplies Co......... 5
Brandes, C. 40
Bunnell & Co., J. H............... 39
Clapp-Eastham Co. 1
Continental Fibre Co., The..Third Cover
Continental Radio and Electric Co. Fourth Cover
Corwin & Co., A. H............... 42
Diamond State Fibre Co.......... 43
Doolittle Co., F. M.............. 46
Doubleday-Hill Electric Co........ 36
Dreyfuss Sales Corp............. 4[illegible]
Electric Specialty Co............. 4[illegible]
Electrose Mfg. Co.........Second Cover
Federal Telegraph & Telephone Co. 46
Firth & Co., John................ 41
France Mfg. Co., The............ 36
General Apparatus Co............ 44
General Radio Co................ 37
Grebe & Co., A. H................ 46
Johnston, Chas. H................ 43
Jones Radio Co., The............
Kennedy Co., The Colin B........ 30
Laing, A. K...................... 46
Magnavox Co., The............... 35
Manhattan Electrical Supply Co.... 44
Mutual Purchasers Association.... 29
Newman-Stern Co., The........... 45
Novo Mfg. Co..................... 44
Pacent Electric Co............... 38
Pitts Co., F. D................... 39
Precision Equipment Co........... 29
Radio Corp. of America..........44-48
Radio Distributing Co............
Radio Electric Co., The 36
Radiolectric Shop 42
Remler Radio Mfg. Co............ 43
Somerville Radio Corp............ 40
Superadio Corporation 41
Thordarson Electric Mfg. Co...... 42
Tuska, The C. D.................. 43
Tresco 38
Vitalis Himmer Mfg. Co.......... 29
Western Radio Electric Co........ 30
Weston Electric Instrument Co.... 5
Whitall Electric Co............... 32

INSTRUCTION
Chambers Institute of Wireless Telegraphy 32
East Side Y. M. C. A............ 45
Eastern Radio Institute........... 34
Mass. Radio and Telegraph School 45
New York Wireless Institute...... 35
Radio Institute of America.......31-47
Uttmark's Nautical Academy...... 37
Y. M. C. A. Radio School 37

SMALL ADS OF BIG INTEREST... 42

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

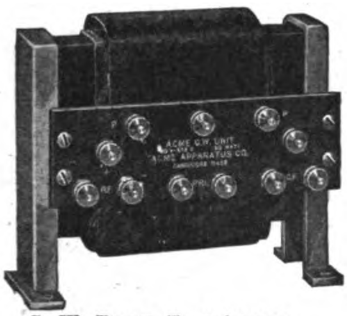
AUSTRALIA, 97 Clarence St., Sydney, N. S. W.

Yearly Subscriptions in U. S., $2.50

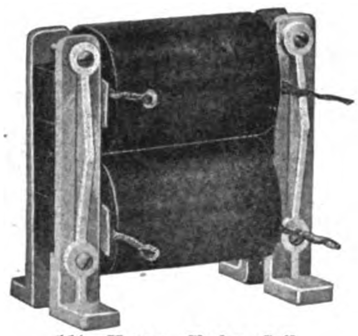
Outside U. S., $3.00; Single Copies, 25 cents

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

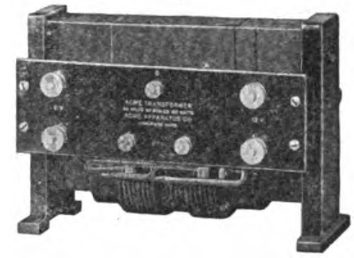
ACME C. W. APPARATUS



C. W. Power Transformer



1½ Henry Choke Coil



Filament Heating Transformer

C. W. POWER TRANSFORMERS

For use with rectifying devices or for A. C. directly on the plates of power tubes.

SPECIFICATIONS 110 volts, 60 cycles

Output	Filament voltage	Filament current	Plate voltage	Plate current	
50	10	2.5	350-	100	Two filament windings
200	12	5	250-550	200	Two filament windings
500	0	0	1000-1500	400	No. filament windings

1 1/2 HENRY CHOKE COILS

For use in ironing out pulsations and for modulating single and double 150 MA and 500 MA capacity.

FILAMENT HEATING TRANSFORMERS

allow the use of A. C. for power tube filament heating.

SPECIFICATIONS 110 volts, 60 cycles

Output	Secondary voltage	Secondary current
75	8-10	7
150	10-12	13

MODULATION TRANSFORMERS

give maximum modulation without distortion.

The Apparatus with a Guarantee

Your Dealer Will Be Glad to Show These. Ask for Bulletins

ACME APPARATUS COMPANY 190 MASSACHUSETTS AVENUE CAMBRIDGE 39, MASS.

Transformer and Radio Engineers and Manufacturers

The Sound-Method for Memorizing the Code

For success in telegraphing the letters must be learned by their *sound.*

Each letter has a distinctive cadence or rhythm which is easily memorized by a few hours' practice.

Charts which show the telegraph alphabet in dots and dashes greatly handicap the beginner. A mental picture of the dots and dashes of each letter forms in the mind, and when a signal is heard, the beginner naturally tries to call up the *picture* of the letter. In practical telegraphy there is not time to do this, and the next signal is lost.

The charts attached give the key to the rhythm of each letter of the telegraph alphabets. It forms no picture in the student mind but, instead, a sound is memorized, like a bar of music.

The chart is particularly valuable in learning to *receive* which is many times more difficult than learning to send. An hour a day devoted to memorizing the distinctive *rhythm* of each letter will enable the student to send or receive a message in a few weeks.

The beginner is strongly advised not to practice with charts or books which show the actual dots and dashes. Once a *picture* of each letter is formed in memory it will be found difficult to send or receive in the telegraph alphabet properly—by *sound.*

WIRELESS PRESS, INC.
326-28 Broadway, New York

←THIS NEW WAY OF LEARNING THE CODE

is the easiest, quickest and most thorough ever devised for learning without instruments

If you want to learn the code—

If you want to "cinch" the signals you can't remember easily—

If you want to help some one else learn the code—

GET ONE OF THESE CARDS.

Don't try to teach the Ears through the Eyes

This system teaches the signals as they come through the Head Phones

Contain both Continental and American Morse—Printed on Celluloid Fit Your Pocket.

Price 50c

WIRELESS PRESS, Inc., 326-28 B'dway, N. Y.

Vol. 8. No. 9. JUNE, 1921

THE WIRELESS AGE

WORLD WIDE WIRELESS

Annual Report of the Radio Corporation of America

AT the annual meeting of the Radio Corporation of America, stockholders re-elected the following directors for a term of three years: Owen D. Young and Albert G. Davis, vice-presidents of the General Electric Co., and Walter S. Gifford, vice-president of the American Telegraph and Telephone Co.

Edward J. Nally, president, in his remarks to shareholders covering the year ended December 31, 1920, said:

The United States is today the only country in the world carrying on direct commercial communications by wireless with five other countries. The Radio Corporation of America is the only company in this country operating high power radio stations communicating with other countries. This service has been developed within the year.

The corporation recently acquired a large tract of land (nearly 10 square miles) near Port Jefferson, Long Island, where a multiple station of five units is being constructed which will communicate with countries other than those already provided for. One unit is expected to be put into operation during 1921. This station will be known as Radio Central and is designed to be the largest and most powerful radio station in the world.

The American Marconi Company was, by reason of its arrangements with the British Company, restricted in its activities to United States territory, and because it was important that an American company should be free to extend to all countries and in all directions, an arrangement was entered into with the British Company through which the latter sold its stock in the American company to the General Electric Company, which had developed certain long distance and other devices of great value in transoceanic radio communication. Their interest resulted in the formation of the Radio Company of America and, among other things, brought to the new company the exclusive control of the Alexanderson high frequency alternator and accessories.

Later an arrangement was entered into with the American Telephone and Telegraph Company, which company acquired use of many important inventions. Both the American Telephone and Telegraph Company and the United Fruit Company have become substantial shareholders in the Radio Corporation of America.

By reason of its enlarged organization new fields of operation have been opened and the corporation has become an important factor in world-wide communication.

These enlarged opportunities have brought increased responsibilities. Large sums of money must be expended in rehabilitating stations with the latest, best and most economical equipment. It has also become expedient to effect traffic arrangements with foreign governments and foreign companies.

The preliminary contract with the Government of Poland for a station to be erected at Warsaw has been closed and a substantial cash payment has been made on account. Active negotiations with other countries are under way.

The company has no bonded debt or other liabilities except current operating liabilities. The balance sheet shows: Assets—Cash and receivables, $881,507; merchandise inventories, $689,517; investments in government and industrial bonds, $3,375,210; stocks of associated companies, $550,385; plant and equipment, after depreciation, $8,901,675; deferred charges, $606,669; patents, good will, contracts and franchises, $10,107,982; total, $25,112,945.

Dr. Albert Einstein and other noted scientists watching a demonstration of automatic high speed transoceanic radio communication at the New York office of the Radio Corporation of America. Left to right: Dr. G. H. Campbell, Dr. A. N. Goldsmith, W. A. Winterbottom, Dr. A. Einstein and Dr. C. P. Steinmetz.

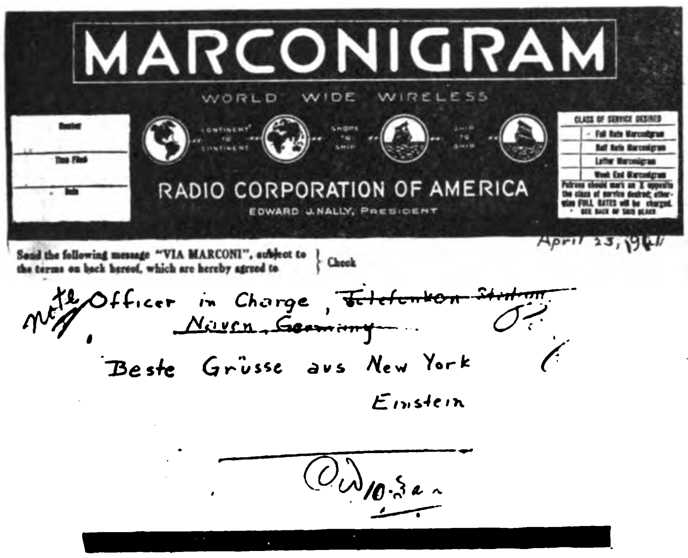
Liabilities: Preferred stock, $13,525,870; common stock, $9,611,392; current liabilities, $1,883,227; reserves, $92,456; total, $25,112,945.

At a special meeting the stockholders voted to amend the certificate of incorporation so as to increase the non-par common stock of the corporation from 5,000,000 to 7,000,000 shares. No change was made in the authorized preferred stock of the corporation, which is 5,000,000 shares at the par value of $5 per share.

Professor Einstein Looks Into Radio

PROFESSOR Albert Einstein, the world-famous discoverer of the theory of relativity, was entertained as the guest of the Radio Corporation of America, on April 23rd. At 9:30 in the morning he visited the company's New York office at 64 Broad Street, where trans-Atlantic message traffic is centered, and was received by a distinguished committee, including Professor Steinmetz, Dr. Langmuir, Dr. Dushman and Dr. Hull, of the General Electric Co.; Dr. Campbell, Dr. Carson and Dr. Wilson, of the Western Electric Co.; Mr. Sarnoff, Mr. Winterbottom, Mr. Graham and Dr. Goldsmith, of the Radio Corporation of America.

Professor Einstein expressed great pleasure in having the opportunity of witnessing a demonstration of the effectiveness of the system of radio communication established by the Radio Corporation of America, and paid special attention to the operation of the duplex circuit to England. On this circuit, the transmitting and receiving operators satside by side, one controlling with his key the New Brunswick transmitting station and the other receiving the signal from England, via Long Island, with transfer of the received signals over wire lines, direct to the office in the heart of New York's financial district. He wrote out a message to the officer in charge at Nauen. This was sent to Nauen, via the Radio Corporation sta-



Facsimile of radiogram sent by Dr. Albert Einstein to Nauen, Germany

tion at Marion, Mass., and an answer was received at Chatham and relayed to the New York office.

The typewritten answer was handed to Professor Einstein in a little over five minutes after he had written the original message; and all this was done with such facility and freedom from excitement that the distinguished guest, in his pleasantly humorous way, remarked that he could scarcely believe that the message had actually been sent and a bonafide answer received.

Professor Einstein was then taken to the New Brunswick Station and entertained at luncheon, after which short complimentary speeches were made by Professor Steinmetz, Dr. Langmuir and Dr. Goldsmith. The guest was then shown the New Brunswick transmitting station in operation and he made a careful study of the circuits and antenna arrangements, displaying an amazing grasp of the function of every portion of the equipment. The self-centering system for holding centered the huge masses of the spinning rotors of the alternators interested him greatly, as did also the delicate speed control which holds the Alexanderson alternator accurate in speed to better than 1/20th per cent.

During the walk under the multiple tuned antenna, Professor Einstein showed considerable interest in the intense electric fields in the neighborhood of the lead-in. He was amused at the fact that persons in this neighborhood could draw sparks from each other, indicating clearly the tremendous amount of energy available, and he reserved a few special humorous remarks for the struggles of a photographer whose camera sparked in his fingers every time he tried to make an exposure.

Indo-China and U. S. Connected by Radio

COMMERCIAL radio communication between the United States and Indo-China via Hawaiian Islands and the Philippines has been inaugurated.

Plans have been completed whereby commercial messages will be sent from San Francisco by naval radio to Hanoi or Saigon at the rate of 96 cents per word, with additional charge of 5 cents per word for messages for interior points in French Indo-China.

The provisional agreement arranged between the Government of French Indo-China and the Naval Communication Service provides that the new commercial service will consist of the radio communication across the Pacific via the United States Naval Radio Stations at San Francisco, Pearl Harbor, Hawaiian Islands, Guam and Cavite, and the French Radio Stations at Saigon and Hanoi, in Indo-China—Cavite communicating with the French stations named.

Tests have been carried out by the stations and the results of these tests indicate that the service should prove satisfactory.

Italian Radio Service to America

WORK will soon be begun on a powerful wireless station to be constructed near Pisa for regular communication with the United States. This announcement was made in a lecture by Marquis di Solari, who collaborated with Marconi in his wireless experiments before the Italo-American Association here. The Marquis said it was hoped to begin the operation of the plant in 1922.

The Creed Wireless Receiver and Printer

A RECENT development in wireless telegraphy is the automatic printing of messages in Roman type. A demonstration given recently by A. A. Campbell Swinton to the Royal Society of Arts in London showed that it will soon be practical to operate "wirelessly" the telegraph-printing machines which for years have been familiar in clubs and hotels. It is clear that if this could be done there would be a great saving not only in first cost and in expense of upkeep, but also because there would be no practical limit to the number of stations that could receive signals simultaneously from a single sending-station, so that it would cost no more to send to a thousand stations than to one.

"It is well known that instruments connected to telegraph-wires for printing messages are in daily use in newspaper offices and elsewhere. It is also well known that wireless messages can be recorded in various optical and mechanical ways, and even by an instrument analogous to a phonograph, but the ingenious method designed by F. G. Creed is the first to be adopted to printing wireless messages.

"Suppose a message be telegraphed from London to a newspaper office in Sheffield. It is sent out of course in the ordinary Morse code of dots and dashes; these dots and dashes may be recorded by an instrument (the receiver) at Sheffield, which receives them by punching small holes in a moving strip of paper, this being simply one of several ways in which telegraphic messages are received. The strip of paper may next be passed through a second machine (the printer), which is really a typewriter controlled in an ingenious way entirely by the position of the holes in the perforated strip. In this machine the holes in the paper constituting the dots and dashes operate a lever which causes the letter of the typewriter to fall on a second strip of paper so that the letter is printed in Roman type. In this way all the letters and spacings in their Morse code form are translated into letters and spacings in Roman type.

Frieda Hempel Sings to Radio Audience

AN unseen audience, scattered over a 500-mile radius from Denver, heard Frieda Hempel of the Chicago Opera Association recently sing through the wireless telephone.

Miss Hempel, often called "the Jenny Lind of today," sang an old familiar waltz, with Frank St. Leger playing the accompaniment. The singer also sweetly gave "Home, Sweet Home." Phonograph records reproducing her voice and records by other artists also were played, and picked up by wireless.

Scores of telephone calls after the concert expressed the gratitude of listeners who had heard the program. More than 350 persons heard it at the Fitzsimmons General Hospital, and large audiences "listened in" also at the University of Colorado at Boulder and the University of Denver.

Radio Used in Locating Lost Balloon

WIRELESS was used recently in recovering a lost balloon which broke away from the radio station of the United States Air Service at Lee Hall, Virginia. The Langley field radio station was requested to broadcast news of the escape to all vessels and radio stations.

Within 45 minutes after word of the escaping balloon had gone forth, a telephone message from the Naval Wireless Station at Norfolk, Va., was received that it had located the errant balloon 10 miles northeast of Cape Henry. The engineering department of Langley field forthwith dispatched the Air Service boat "Langley" to the point designated. In advance of its arrival, however, the balloon had drifted ashore, was deflated and packed for shipment by the Coast Artillery located at Cape Henry.

President Harding Hears Voice by Radio 5,700 Miles

A NOTABLE radio incident occurred when President Harding formally opened the direct telephonic communication service from the United States with the island of Cuba. To signal the event, a conversation took place via wireless telephone and land and sea telephone cables from Catalina Islands, off the California coast, to Cuba, a distance of 5,700 miles, or farther than from London to Peking.

In addition to the greeting between President Harding and the Cuban chief executive, the guests "listening in" at both ends, heard distinctly every word of the message from Catalina Island, in the Pacific. The messages from Catalina were heard as distinctly as if they had originated locally.

Amateurs Aid Metropolitan Police

THE New York City Police Radio, at Headquarters, call letters KUVS, has begun the daily broadcasting of descriptions of stolen automobiles. These broadcasts are sent at 7:30 and 11:30 each night and arrangements have been made with a number of amateurs in several surrounding cities to copy the descriptions and give the information to their local police departments.

The service is being extended as rapidly as arrangements can be made with additional amateurs. Sergeant Charles E. Pearce, who has charge of police radio, expects to have within a short time a dependable system whereby police news of importance may be quickly communicated to all territory surrounding New York.

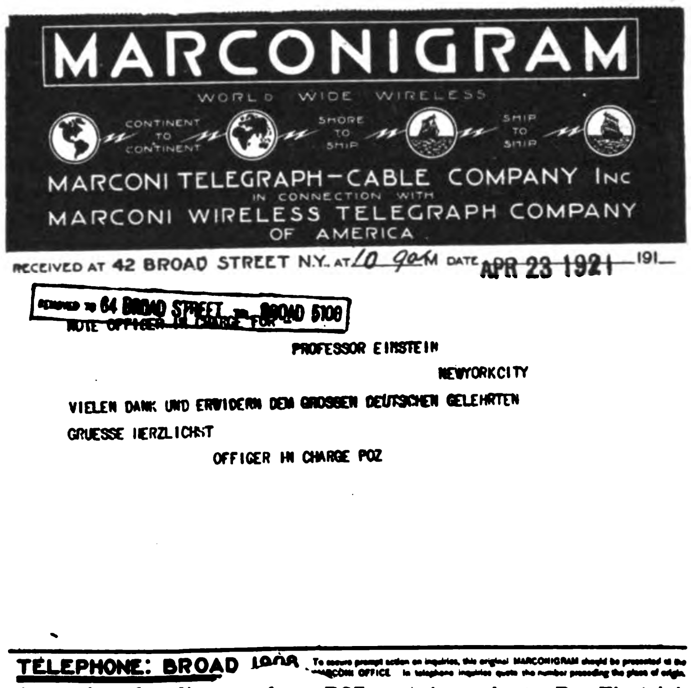
This is the first time that radio has been put to such use and it should prove of considerable benefit in apprehending auto thieves operating in the metropolitan district.

Spanish-German Radiophone Service Opened

REGULAR wireless telephonic communication has been opened between the military station at Carabanchel, Spain, just south of Madrid, and Nauen, Germany, a distance of approximately 1,175 miles. The authorities declare voices in Germany were plainly audible in Carabanchel.

Marconi Gives Radio Set to Newsboys' Home

GUGLIELMO MARCONI has presented a wireless outfit for the use of the Newsboys Home in New York. King Cole, the American stunt newsboy visiting London to show the "newsies" how to sell papers, caught the wireless inventor on the steps of Marconi House one afternoon, and after selling a paper to him got to chatting with the inventor. He found that they had a mutual acquaintance, a youth who sells papers outside of the Waldorf-Astoria Hotel, New York City, and Mr. Marconi volunteered to give the wireless instruments to the Newsboys Home when told of that institution.


MARCONIGRAM
WORLD WIDE WIRELESS
CONTINENT TO CONTINENT — SHORE TO SHIP — SHIP TO SHIP
MARCONI TELEGRAPH-CABLE COMPANY INC
IN CONNECTION WITH
MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA
RECEIVED AT 42 BROAD STREET N.Y. AT 10 9AM DATE APR 23 1921 191—

PROFESSOR EINSTEIN
NEWYORKCITY
VIELEN DANK UND ERWIDERN DEM GROSSEN DEUTSCHEN GELEHRTEN
GRUESSE HERZLICHST
OFFICER IN CHARGE POZ

TELEPHONE: BROAD 1000

Facsimile of radiogram from POZ sent in reply to Dr. Einstein's message, communication being completed in about five minutes

L. & N. R. R. Uses Radio

TRANSACTION of railroad business by wireless soon will be a reality in the south, according to an announcement by Telegraph Superintendent R. R. Hobbs of the Louisville & Nashville Railroad. The company has purchased wireless outfits and will install them at Louisville, New Orleans, Pensacola and Mobile for the general message service of the company.

The wireless will be supplementary to the regular wires.

Radio Manufacturers Organize

THE manufacturers of radio apparatus who had exhibits at the recent New York Radio Convention held at the Pennsylvania Hotel, have formed a radio section of the Associated Manufacturers of Electrical Supplies. All of the members are well known manufacturers of radio apparatus, who are interested in extending the development of radio. The organizing committee consisted of Messrs. Murdock, E. J. Eltz and L. G. Pacent.

Texas Universities Communicate by Wireless

GETTING news over wireless is a new "wrinkle" in the annals of Texas journalism. It was left to the collegiate press of the State to inaugurate this innovation in furnishing its readers with the latest news via the aerial route.

Recently the Daily Texan of the University added an intercollegiate press wire service to its other regular features, and readers of the University paper now receive daily reports of the most important happenings of Texas colleges. At present the service is practically limited to exchange of news between the University of Texas and the Texas A. & M. College as these two institutions are the only ones having wireless stations powerful enough to pick up news being sent out.

The wireless station at the University has received messages from steamers in the Pacific Ocean, and the government station at Arlington has often been heard distinctly. It is planned later to receive news from Harvard, Yale and other institutions in the North and East for publication in the Texan.

Norwegian Automatic Sending and Receiving Apparatus

THE Petersen copying telegraph, which is being tested in Norway, is said to be cheaper than ordinary telegraphing. Regular telegraphers are not necessary, only a few persons to serve the apparatus. The telegrams appear as photographic pictures of the sender's writing.

When the customer has filled out his blank, this is placed with the written side against a metal cylinder, prepared with something like a photographic film. The cylinder is then exposed to a strong light, penetrating the paper and pressing the writing on the cylinder. This is then treated with developer and the writing appears in green on the cylinders, which are brass.

After drying the cylinder is put on another piece of apparatus like a phonograph cylinder and the writing is transmitted to the receiving apparatus, on which is a similar photographic paper which shows an exact picture of the writing.

In actual operation the apparatus will be still more simple, the cylinders being displaced by plates. The copying telegraph can be used over ordinary telegraphy wires and in wireless.

German South American Radio Development

PLANS of German commercial interests to link South and Central America by a chain of wireless stations powerful enough to work direct with Nauen are likely to run into a snag, in the opinion of British officialdom, which is watching the efforts of any country to extend its trade influence in that part of the world. Two more stations are needed—one in Brazil and another on the Peruvian islands, either the Galapagos or Chincha group. Information reaching London is that the Brazilian Government is not enthusiastic over the proposal to organize a company in Brazil controlled by German capital to operate a wireless under German supervision and by German operators. It is understood France is using her influence with Brazil in an attempt to thwart such a plan.

The Germans hope to start operations in Brazil at the same time as in Argentina, but the situation in Peru is not quite so clear.

David Sarnoff Given Important Post by Radio Corporation

ILLUSTRATIVE of the unusual opportunities which prevail in the radio field today, is the appointment of David Sarnoff as General Manager of the Radio Corporation of America. This appointment was announced on April 29th by Edward J. Nally, the company's president, who arranged an informal reception at the executive offices, where he made a brief address, calling attention to the fact that Mr. Sarnoff had started his career at the very bottom of the ladder and had worked himself successively through the various stages, up to the post of great responsibility which the Board of Directors had designated for him.

Mr. Sarnoff received his honors with becoming and customary modesty, and attributed his success principally to the cooperation of his co-workers in the organization. The elevation of this young man—he is only thirty years old—to the general management of Radio Corporation business, serves to emphasize the point this magazine has continually stressed, that thorough training in the technical phases of the radio art is essential to success in the field.

Mr. Sarnoff began as an office employee at the very bottom of the ladder; he learned the business of radio communication by unremitting study and practical experience, taking successively the positions of ship operator, coastal station operator, assistant to the traffic manager, and commercial manager, before attaining his present high position, which is second only in importance and authority to that of president of the company.

The duties of the new general manager give him supervision and control of the Radio Corporation's plant and the conduct of its business under direction of the Board, the Executive Committee, and the president; it also gives him general charge of the high power stations, the coastal and ship stations and their operation and general responsibility for up-keep and maintenance of the service. He is also given the responsibility in all matters connected with the development of message traffic for the transoceanic communication system, sale and rental of apparatus, solicitation and negotiation of contracts.

The Radio Woman

WHEN she talks too long (Interrupter). If she argues incorrectly (Converter). If she is willing to come your way (Meter). If she wants to see your set (Conductor.) If she wants to be a nangel (Transformer). When she is sulky (Exciter). If she gets too excited (Controller). If she proves your circuit is wrong (Compensator). If she is wrong (Rectifier). If she goes up in the air (Condenser). If she wants chocolates (Feeder) If she sings false (Tuner). If she is a poor companion (Discharger). If she gossips too much (Regulator). If she fumes and sputters (Insulator). If she fancies some one else (Reverser).

Radio Felicitations to Venezuela

ON April 19th, the Simon Bolivar Statue in Central Park, New York City, was unveiled. President Harding and other notables attended the ceremonies, part of which consisted of the transmission of a radiogram of felicitation from an official of the Venezuelan delegation to the President of Venezuela. The message was sent direct from the officials' stand at the monument through a circuit connecting the Broad Street office of the Radio Corporation of America and thence to the control circuit utilizing the Tuckerton high power station, to the receiving station HRE in Venezuela.

The New Poland Radio Circuit

Some Interesting Facts Concerning the Latest Extension of World Wide Wireless. By Edward J. Nally, President, Radio Corporation of America

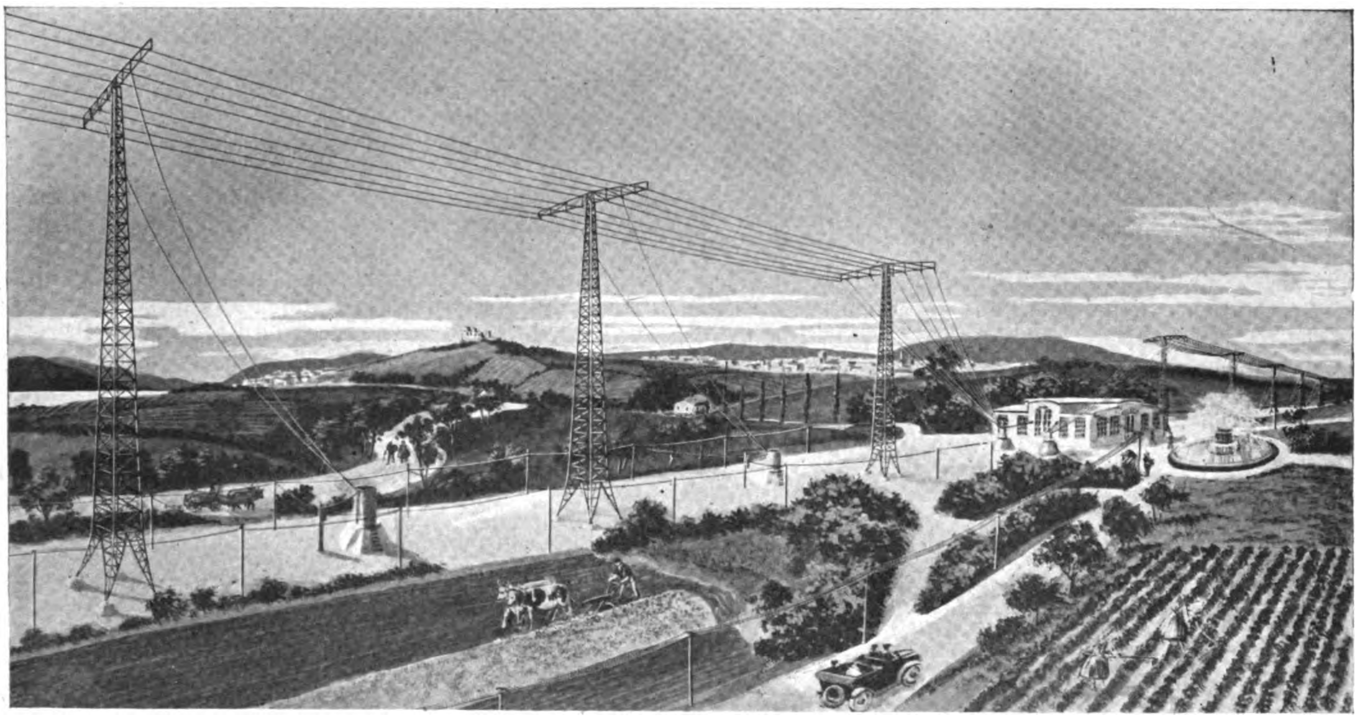
THE long looked-for link of international communication between the United States and Poland is about to become a reality. At the moment of writing negotiations have been concluded between the Poland Ministry of Posts and Telegraph and the Radio Corporation of America which will insure the rapid erection of a wireless plant of the most modern and effective type. The system adopted is known as a high power transoceanic station and is to cost the Polish government a sum between $2,000,000 and $3,000,000. This plant will be situated not far from Warsaw, Poland.

Perhaps one of the most important factors connected with this radio station is the great part it is destined to play in the future development and expansion of Poland. Here will be an instant and highly effective means of communication between the business men of Poland and the great commercial centers of industrial America.

In the past, of course, there have been other means of communication between these two great nations, but owing to their indirect route delays have resulted and mutilations in messages have often hindered and curtailed full trade expansion. The new radio circuit is unique in this respect, in that it is a direct one. There will be no intervening mediums once a message is started on either the American or the Polish side. Delivery of dispatches will thus be rapid and, owing to non-repetition of messages through relaying points, accuracy will be assured. Incidentally, this direct service makes possible a lower word rate, which means economy in addition to accuracy.

Without burdening the general reader with an array of technical data, the fundamental requirements of a modern high-power wireless station may be outlined in a few brief statements, which will explain just how international radio is made possible.

One appliance which has done much for the present day success of long distance radio communication is the Alexanderson high frequency alternator, used to generate the continuous waves which make the bridging of great distances possible. This apparatus incorporates the most modern and advanced ideas in radio design. The Alexanderson alternator is a special high frequency generating unit which has been developed at the great manufacturing plant of the General Electric Company at Schenectady. Two of these machines are to be installed in the Polish station, each one having an output of 200 kilowatts (270 horsepower). One of these is to be in constant operation and the other is to be maintained as a spare or auxiliary unit.



A general view of the proposed oceanic high power radio station designed for direct communication with the United States and which is shortly to be erected near Warsaw, Poland, by the Radio Corporation of America

Briefly, the function of these highly specialized alternators is to generate a radio current of sufficient strength to push its way clear across the Atlantic to the receiving side. This powerful current, which is known in the parlance of radio men as a radio frequency current—that is, a current of very high frequency (as distinguished from the very low commercial frequencies employed in ordinary power and electric lighting circuits)—is in turn controlled and regulated by the transmitting operator through the intermediary of the magnetic amplifier, which is an important feature of the Alexanderson system.

These high frequency signaling impulses are properly tuned to a definite wave length by means of electrical inductance and then are impressed upon the antenna system, from whence the waves are sped on their way through space to one or more receivers located many thousand miles distant. The antenna system in this case consists of a series of wires supported by twelve towers, each 123 meters in height; the towers being set upon concrete foundations.

An interesting feature of modern high power radio antenna is the sleet and ice melting equipment. An electrical current is impressed upon the exposed antenna wires of such electrical power as to cause the wires to become heated and thus readily melt any sleet or ice which may collect during the severe winter weather. Were it not for this precaution it would be extremely difficult to maintain an aerial system throughout the winter months.

In modern high power radio work it is impracticable to have the receiving equipment located in the same building as the transmitter. For this reason in the case of the Poland-to-United States radio circuit the receiving station will be located not far from Danzig, or about 15 kilometers from the transmitting station near Warsaw.

Special receiving apparatus of unusual effectiveness is to be installed in connection with this equipment. This is highly essential, for we have had in radio communication a negative factor which heretofore has given radio engineers much trouble. This undesirable condition is known as "static" or atmospheric disturbances which tend to blurr or otherwise render unreadable the characters of the Morse code representing the message.

Mr. Roy A. Weagant, a radio engineer of international reputation has after many years of research and experimentation discovered certain principles and perfected receiving equipment to such a point that the undesirable "static" is considered no longer a menace to long distance radio reception. And thus it is that the new station will be equipped with highly efficient receivers insuring uninterrupted and speedy service at all times.

The receiving equipment will make use of vacuum tubes to detect and amplify the radio signals that will come from a remarkably long distance in such manner that they will be heard and understood by the receiving operator and exceptional speed and accuracy.

Then too, high speed recording apparatus will be supplied for installation and operation at the receiving station in Poland. This will permit a rapid and most economical exchange of radio traffic between Poland and distant nations.

The average operating speed of a transoceanic station when transmitting is done by hand is 140 letters per minute. With automatic transmission and reception an average speed of 400 letters (approximately four average messages) per minute, can be readily maintained.

The subject of high speed automatic transmission and reception is one which has engaged the attention of radio engineers for many months, and owing to their highly satisfactory results recently obtained in this direction by the Radio Corporation, the new Polish government radio station will find these operating improvements of great advantage in its future traffic.

It was recently stated by investigators that approximately 20 per cent of Polish nationals are located in the United States, which is by far a much greater proportion than the people of any other foreign country. This fact immediately suggests the possibility of extensive message exchange which could be very well cultivated between the commercial and social interests of the people of Poland and of the United States. In fact, there is no doubt that this Poland-United States radio circuit will find great favor with the Polish people for they will then be able to communicate with America without having their messages subjected to undesirable censoring that in the past has caused delay and general dissatisfaction.

While the new Poland to United States radio circuit means another link to the World Wide Wireless chain of the Radio Corporation of America, there is now in process of planning and construction extensive radio circuits to other parts of the world, and notably to South American nations, all of which will ultimately result in greater foreign trade expansion of American commerce. At present this Corporation has in daily operation direct and highly effective radio communication services from the United States to France, Great Britain, Norway, Sweden, Denmark, Finland and Germany, as well as between San Francisco and Honolulu and Japan. These circuits fill a distinct need of international commerce and are prophetic of future activities of an art which having passed through the necessary period of experimentation and development is now on its way to become an indispensable and highly essential service to mankind.

Measurements on Audio-Frequency Amplifiers

By L. M. Hull

Associate Physicist Radio Laboratory, Bureau of Standards.

Published by permission of the Director, Bureau of Standards

IN the following paper is presented, briefly, the result of a series of measurements of the voltage amplification of audio-frequency amplifiers of various types. It is not purposed to discuss the theoretical principles of amplifier design, but only to present a few experimental results which may suggest additions to the present unsatisfactory theory of amplifier construction and which will, at any rate, be of interest to those who have had practical experience with the audio-frequency amplifiers in question.

The method of measuring the voltage amplification is a simple one which has been variously employed by other investigators, for this purpose, and for the purpose of measuring signal intensity by audible comparison of the received signal with a source of sound of the same pitch and of known and adjustable intensity. A schematic diagram of the measuring circuit is shown in figure 1, A is an alternator, of which the frequency can be varied over a wide range. An electron-tube generator may be used at A, but if a variable-speed machine is available it is preferable to a tube generator, because the supply voltage from a machine furnishing the extremely minute current utilized in this system will be much more nearly sinusoidal than the voltage from an audio-frequency electron tube generator. The output from a source of the latter sort is always heavily loaded with harmonics, and it is difficult to generalize concerning the behavior of amplifiers from data taken when the wave form of the supply voltage is an uncertain matter.

The step-down transformer T furnishes current to the circuit at about 5 volts. V is a thermal voltmeter. R and R_1 and R_2 are variable resistances and W is a calibrated slide-wire resistance. When the double-throw double-pole switch S is at the right, the amplified voltage (supplied to the amplifier by the potential drop across the section r of the slide wire) is connected across the telephone receiver. When the switch is at the left, the telephones are connected across the resistance R. The resistance R and the slide wire resistance r are adjusted until the sound in the telephones when the switch is at the right is just equal in intensity to the sound when the switch is at the left. Since the same current passes through r and R (assuming the telephone impedance and amplifier input impedance to be large compared with these resistances) the ratio of these voltages giving equal sounds in the receivers is $\frac{R}{r}$, which is the voltage amplification of the amplifier. The sound heard when the switch is at the right is slightly different in quality from the pure note produced by the sinusoidal voltage, since the amplifier introduces harmonics. However, at the lower values of input voltage, the region of weak signals at the output side, where the behavior of the amplifier is of particular importance, the tone given by the amplifier becomes fairly pure. In any case, with practice, settings of the slide-wire can be made and reproduced at a different time with an accuracy of about 2 per cent.

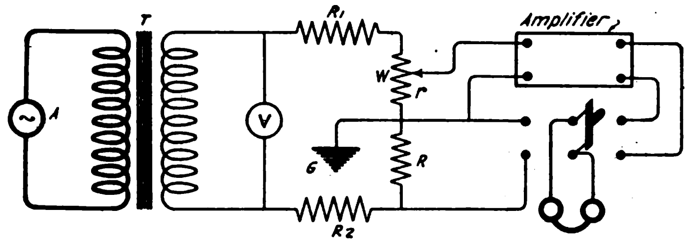


Figure 1. Diagram of the measuring circuit.

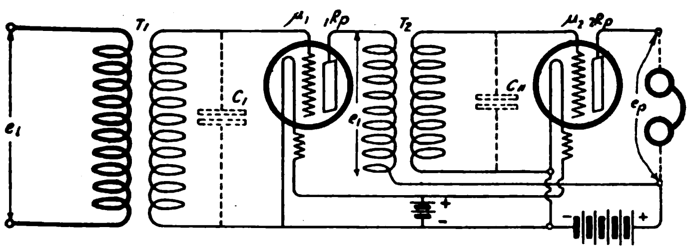


Figure 2. Circuit of the two-stage transformer-coupled amplifier.

It is sometimes desirable to keep the voltage input constant, since the amplification may vary with changing input, particularly at the higher frequencies. In this case the slide-wire resistance r is left constant and R_1 and R_2 are made so large that the adjustments in R do not appreciably affect the current through it. Proper shielding and grounding precautions must be taken, to insure that there is no sound in the telephones except that due to the amplified voltage across r. The system is grounded at G; it may be necessary to place the alternator and transformer at a distance from the amplifier. Sometimes it becomes necessary to provide an electrostatic shield for the amplifier, even at the audio frequencies used. The final adjustment to silence in the phones, when r is made equal to zero, is sometimes accomplished by adjusting R_1 and R_2. R_1 and R_2 are usually of the order of magnitude of 8,000 ohms each, $R = 50 - 500$ ohms and $r = 0 - 10$ ohms.

The sort of measurement described here is open to criticism in that it disregards the input power consumed by the amplifier, and, likewise takes the voltage across a given pair of telephone receivers as a criterion of the output of the amplifier. Power considerations both at the input and the output are neglected entirely. Now, of course, the input impedance of the first tube is not infinite, but may be as low as 100,000 ohms. Moreover, the amplifier is likely to affect profoundly the operation of the detecting device with which it is used in radio reception owing to the fact that it consumes appreciable power from this device. In order to specify completely the performance of an amplifier, the power amplification under given operating conditions, or the voltage amplification and input and output impedances should be stated. However, this is not intended to furnish a complete rating of the amplifiers, but only to give certain indications of the behavior of instruments of this type. A pair of telephone receivers having about 3 henries inductance and 2,000 ohms d.c. resistance, of this type "P-11," were used throughout the measurements.

EXPERIMENTAL RESULTS

I. TWO-STAGE, TRANSFORMER-COUPLED AMPLIFIER, IRON CORE TRANSFORMERS

A simplified sketch of connections of the first amplifier tested is given. In figure 2 e_1 is the radio-frequency input voltage, e_p the audio-frequency voltage across the telephones, T_1 and T_2 are iron-core transformers. The following data and constants were obtained for the various parts of the apparatus before amplification measurements were made.

COUPLING TRANSFORMERS

The only specifications known for these transformers were the open-circuit impedance ratios and curves showing the variation in apparent input inductance and input resistance with frequency. These curves were taken with open secondary, making the tuning effect of the distributed secondary capacity very pronounced. When used in the amplifier, there is an added secondary capacity of 10 to 20 $\mu\mu f$, and the secondary is also closed through a conductive path of 100,000 to 1,000,000 ohms resistance. Consequently such data on the transformers alone may have little significance in connection with their operation in the amplifier. However, as a rough indication of the load in the plate circuit of the first tube, the total effective input impedance was calculated from these curves taken with open secondary for the second transformer, T_2. This impedance as a resonance function of frequency is shown in curve C of figure 3. The voltage transformation of the transformers is another factor which varies greatly with the frequency and with the load on the transformer, owing to the tuning effect of the secondary capacity. A logical way to measure this would be by using a very sensitive electrostatic voltmeter, and maintaining a high-resistance load on the secondary such as is furnished by the input circuit of a tube. Such measurements were made upon one transformer, with open secondary, and a maximum value of voltage transformation was obtained at 1,600 cycles, the step-up ratio was 17/6. This high ratio is due, of course, to the so-called "resonance rise" in secondary voltage. The voltage transformation with no current in the secondary windings, obtained by short-circuiting the distributed capacity of the secondaries with a telephone receiver, is shown for both transformers in curves B and A of figure 3. The scheme of connections for this method of measuring the transformer ratio is sketched upon the figure. When no sound is heard in the phones the ratio r_1/r_2 is the transformer ratio, that is, it is very closely the actual ratio of turns. It takes no account of the rise in secondary

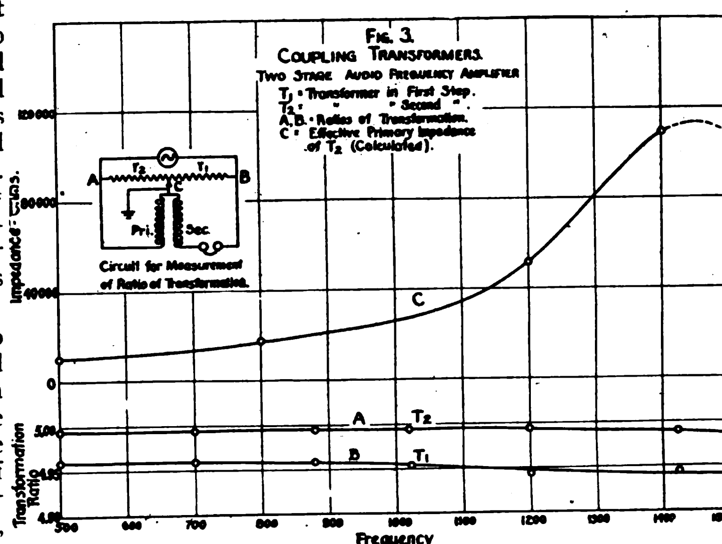


Figure 3. Graphs of first and second step transformation ratios and effective primary impedance.

voltage which occurs where displacement currents flow through the distributed capacity of the windings, and which is a transient and variable thing in an amplifier, though it may produce a much greater amplification per stage than would be indicated by the turn ratio.

TUBES

Tubes of the VT-1 type were used, at a fixed value of filament current and plate voltage. At the operating conditions the measured values of amplification constant and output resistance for tubes 1 and 2 are $\mu_1 = 6.7$, $_1R_p = 13,300$ ohms, $\mu_2 = 7$, $_2R_p = 1,100$ ohms.

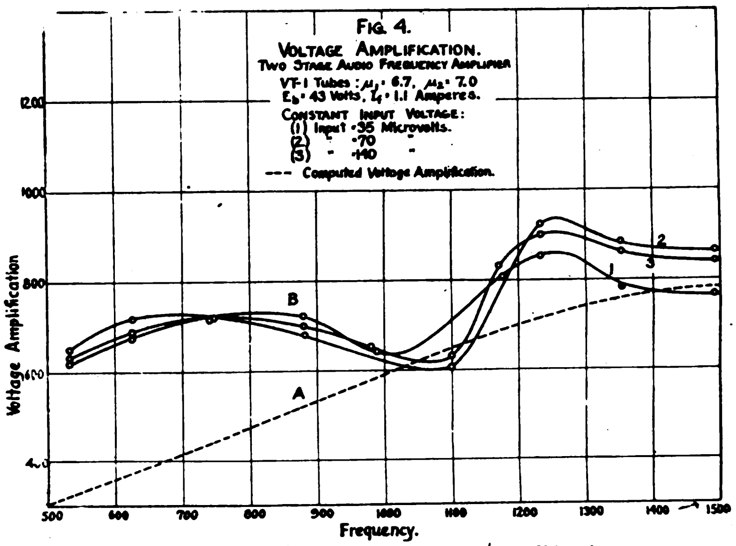


Figure 4. Graphs showing voltage amplification

An approximation of the overall voltage amplification of the combination was obtained by using for the transformers, the constant step-up ratios given by the ratios of turns, and effective values of input impedance (for T_2) calculated from the measurements of effective resistance and inductance taken with open secondary. This may seem rather inconsistent until it is remembered that the amplification per stage varies to a much smaller extent with the load put upon the tube by the transformers than with the step-up ratios of the transformers. It was believed that in view of the fact that no accurate data was available on the step-up ratio taking account of the tuning effects, it would be desirable to find out how closely the amplification of an amplifier could be estimated from the ratios of turns. The approximate impedance of the telephones was calculated for different frequencies. The calculation of the approximate total amplification is quite simple. If t_1 and t_2 be the turn ratios of the two transformers, z_2 the input impedance of the second, and z_p the impedance of the phones which is chiefly reactive, we have for the voltage amplification of the first stage (figure 2) approximately:

$$\frac{e'}{e_1} = t_1 \frac{\mu_1 z_2}{\sqrt{{}_1R_p^2 + z_2^2}} \qquad (1)$$

For the second stage:

$$\frac{e_p}{e'} = t_2 \frac{\mu_2 z_p}{\sqrt{{}_2R_p^2 + z_p^2}} \qquad (2)$$

The overall voltage amplification is the product of the amplification for the two stages.

In figure 4 are shown: A, the overall voltage amplification as a function of frequency as calculated by equations 1 and 2; B, the overall voltage amplification, measured for three values of input voltage giving weak signals in the phones (35 microvolts), medium signals (70 microvolts) and loud signals (140 microvolts). It can be seen that the voltage amplification does not change much with the input voltage, and that for this amplifier the resonance curve is fairly flat. The increase in amplification above the calculated values, due to the tuning effects in the transformers, while marked, is not excessive, and it is evident that design calculations can be made for an amplifier with sufficient accuracy using the ratios of turns of the transformers. The irregular nature of the measured amplification curve is probably caused by capacity or regenerative effects, which might vary as the location of the amplifier is changed, and which certainly vary where different plate voltages and filament currents are used in the tubes.

II. TWO-STAGE, TRANSFORMER-COUPLED AMPLIFIER, AIR-CORE TRANSFORMERS

The amplifier is of a type similar to the one described in the preceding section, and having circuit connections represented also by the diagram of figure 2. It possesses the important differences that the two coupling transformers are exactly alike and are so wound that the distributed capacity of the secondaries is too small to give important resonance effects between 500 and 1,500 cycles. For this reason a separate fixed capacity is connected across the secondary of T_1, with the result that the secondary voltage of this transformer (working into the grid circuit of a tube) is a maximum at approximately 1,000 cycles. This inserted capacity has a magnitude of 500 $\mu\mu$f. The amplifier is thus particularly adapted for use with reception from 500-cycle spark transmitters, an audio-frequency note in the receiving circuit having its fundamental at 1,000 cycles. Thus in considering figure 2 with reference to this amplifier, we shall take C″ as equal to zero and C′ as 500 $\mu\mu$f.

TRANSFORMERS

The transformation ratio was measured for the transformers without the added secondary capacity by the null method, described in the preceding section. The conditions of this measurement are approximately the conditions of use for the second transformer, since the distributed capacity of the secondary windings alone is so small as to make the resonance peak occur at higher frequencies than those used in the measurements. Curve A of figure 5 shows the transformation ratio for both transformers, with zero current in the secondary, and no added secondary capacity. The resistance and inductance of the primary windings with open secondaries were measured on an inductance bridge and were found to be

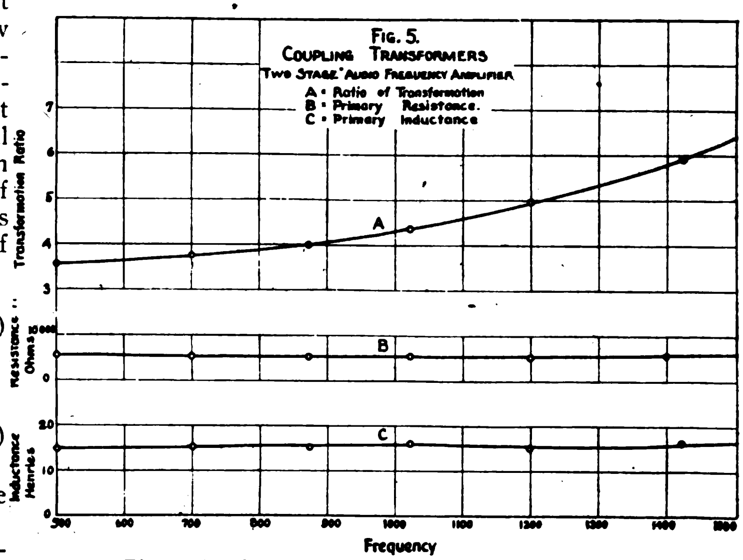


Figure 5. Graphs showing ratio of transformers, primary resistance and inductance

fairly constant at 5,500 ohms and 15 henries. Both quantities increased slowly but steadily from 1,200 cycles up. They are shown on curves B and C of figure 5.

CALCULATIONS AND MEASUREMENTS OF AMPLIFICATION

Using the tubes whose constants were given in the preceding section, the voltage amplification of the two stages was measured at different frequencies, using the 500-$\mu\mu$f tuning condenser placed in the amplifier by the makers, across the secondary of the transformer in the first stage. The results of these measurements are shown in curve A of figure 6. The sharp resonance obtained by using air-core transformers, with fairly low-resistance windings, and employing a separate tuning condenser, is clearly shown. Such an amplifier is excellent for reception of signals modulated at a given spark or tone frequency, but unsuitable for telephone reception, as the distortions due to the choking-out of the audio-harmonics are very marked.

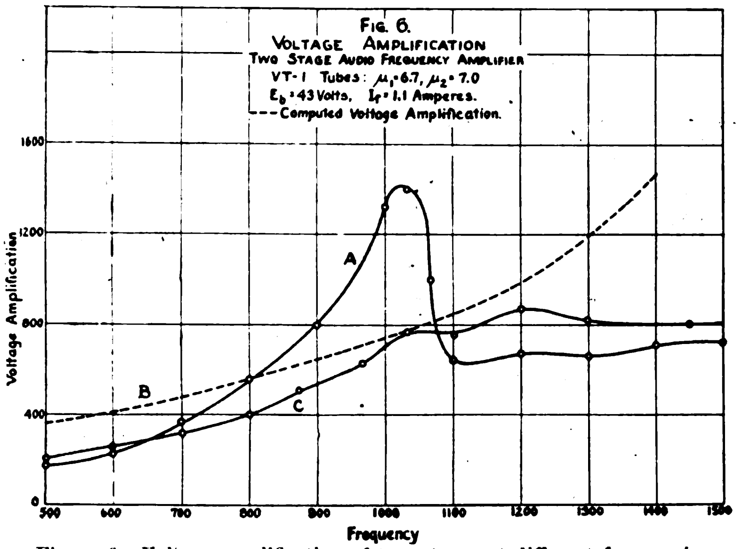


Figure 6—Voltage amplification of two stages at different frequencies

The theoretical amplification of the two stages disregarding the tuning effect of the condenser was calculated, using the impedances calculated from the curves of figure 5 and substituting in equations 2 and 3. The dotted line B of figure 6 shows the theoretical amplification as a function of frequency. The tuning condenser was then removed from the amplifier and the overall amplification again measured at various frequencies, the results of these measurements being shown by curve C of figure 6. The points determining curves A and C are each the mean of four readings, taken with 40, 70, 104 and 139 microvolts input. The variation in results with different values of input voltage was quite small. It is evident, again, that the minimum amplification for a given combination, disregarding the gain in amplification resulting from the resonance rise in secondary voltage, can be estimated from the constants of the transformers and the tubes. The consistently low measured values, as compared with the calculated values, and the decrease in measured values above a frequency of 1,200 cycles is due, undoubtedly, to the actual transformation ratio of the transformers being smaller when the appreciable input conductances of the tubes are connected across the secondaries than when the secondaries are left open. In view of the fact that the secondary impedances are extremely high, it is possible for them to work into the grid circuits of the tubes (of which the resistance is of the order of magnitude 500,000 ohms) with a maximum dissipation of power.

III. Four-Stage, Resistance-Coupled Amplifier

As a rule there is no place for resistance couplings in audio-frequency amplification. In the first place they are unnecessarily wasteful, since the considerations of power loss and reduction in plate voltage, which apply to radio-frequency resistance couplings, apply with equal force at audio frequencies. It may be desirable to use resistance couplings at radio frequencies, since it is usually impossible in any case to obtain greater amplification per stage than the amplification coefficients of the tubes, but for audio-amplification of rectified signals, transformer couplings are usually desirable, since it is possible to step up the voltage in the coupling transformers at low frequencies, and to translate this increased voltage into increased power by means of the tubes. However, in certain special cases, such as the reception of telephone signals, where no distortion is permissible over a wide range, of audio frequencies, a resistance coupled amplifier can be used to advantage. A four-stage resistance-coupled amplifier was designed in this laboratory for a special purpose, and, incidentally, the voltage amplification was measured by methods described in this paper.

The design calculations on a resistance-coupled amplifier to be used at audio frequencies are simple. The voltage amplifications per stage is very closely:

$$\frac{e_p}{e_i} = \frac{\mu R_p}{R_o + r_p}$$

where μ and R_p are the coefficients of the tube and r_p is the coupling resistance. At low frequencies the relative magnitudes of the coupling resistance, R_p, the stopping condenser on the next grid and the leak resistance of the next tube, can be so adjusted as to make the shunt impedance on r_p, formed by the latter two quantities in series, extremely large, without making the stopping condenser so small as to cause an appreciable voltage drop across it due to the flow of grid current through it. The diagram of connections, together with the magnitudes of all electrical quantities are shown in figure 7. Using coupling resistance of 75,000 ohms, disregarding the leak resistances (2 megohms) and taking the amplification coefficient and output resistance of the VT-1 tubes as 6 and 15,000 ohms, respectively, a calculated voltage amplification of 5 per stage is obtained, with 4.45 for the last stage, at 800 cycles. This makes the total voltage amplification from input to phones,

$$\frac{e_p}{e_i} = 553$$

The measured value of voltage amplification for the combination was 550 to 600 at 500 cycles, with a slight increase with increasing frequency.

The methods in measurements described in the foregoing sections are not presented as being ideal for measuring or for rating an audio-frequency amplifier. The "voltage amplification" or the ratio of voltage supplied from the output to a telephone receiver of given impedance to the voltage put into the amplifier is an unsatisfactory thing, although it indicates roughly the relative merit of one amplifier compared with another, when working into similar telephone receivers. This leads immediately to the point that the terms amplifier and amplification have no significance in themselves. An ordinary step-up transformer is a voltage amplifier, and can be very appropriately rated in terms of the open-circuit

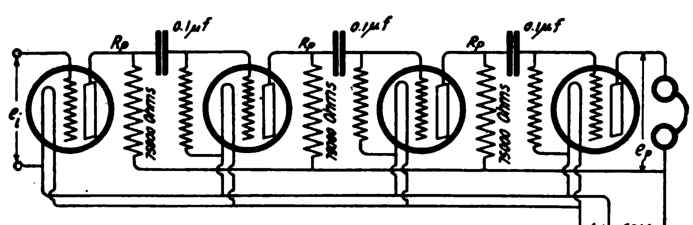


Figure 7—Circuit diagram of four-stage resistance coupled amplifier

voltages. A useful amplifying combination of electron tubes is not fundamentally a voltage amplifier, but a power amplifier, that is, a device for increasing the power of an alternating-current wave at the expense of power drawn from a d.c. source. It does not increase voltage at the expense of current as a transformer, but increases voltage at very nearly constant current, particularly in the amplifiers using input transformers, when the current flowing into the amplifier may be of the same order of magnitude as the current in the telephones, while the power supplied to the input is a small fraction of the power dissipated in moving the telephone diaphragms and heating the windings. These facts are usually taken to be self-evident, but they are sometimes forgotten in discussing and rating amplifiers. The fundamental quantity in which we are interested in rating an audio-frequency amplifier which is used for reception of signals is the ratio of audibility when the telephones are connected at the output of the amplifier, and the amplifier input connected in the detector circuit, to the audibility when the phones are connected in the detector circuit. At once we are confronted with the difficulty that the relations between audibility and voltage and current in telephone receivers are known only approximately. Hence about the best indication that can be specified for the output is the voltage across an impedance of the order of magnitude of the telephone impedance. This can be stated with sufficient accuracy for a class of receivers. For the input, the impedance should be specified and the voltage for the given output voltages. In order completely to describe the amplifier the two quantities, input impedance and voltage ratio, should be specified for frequencies covering the audio range and the harmonics thereof.

Signal Distortion Prevented

A METHOD of preventing signal distortion has been explained by R.V. Hartley, who claims that his method is best adapted to radio telephone systems in which a carrier alternating or oscillating current is subjected to the influence of the voice current.

In the usual radio telephone system the modulated carrier wave is amplified to the desired amount and then radiated by an antenna tuned to the carrier wave frequency or neighboring frequency. Thus side band frequencies which differ most from the frequency to which the antenna is tuned are noticeably suppressed, thereby distorting the modulated wave and impairing the reproduction at the receiving station.

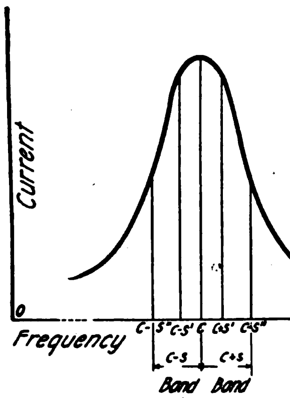


Figure 1

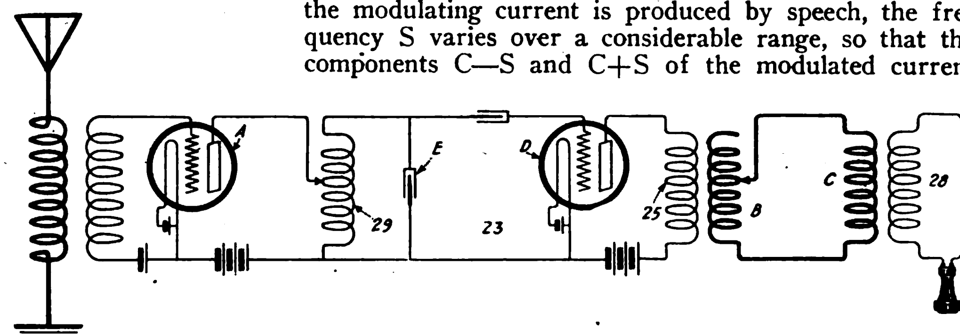


Figure 5

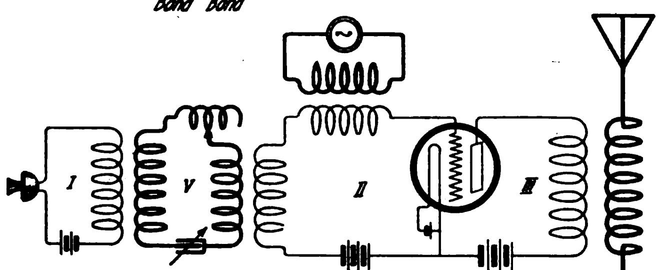


Figure 2

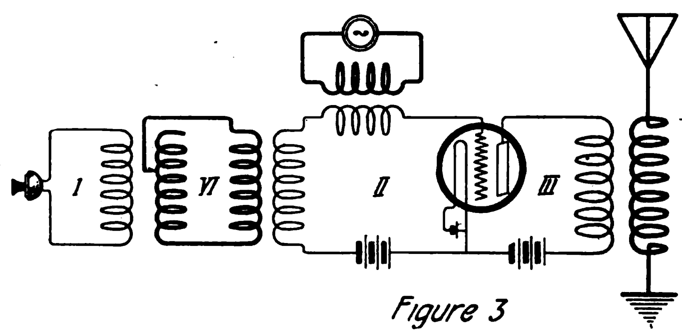


Figure 3

Various circuits to prevent signal distortion

same proportion to each other as those of the original voice currents, and the effect of distortion by the antenna is overcome.

Figure 1 shows the relation between the strength of current induced in the transmitting antenna and the frequency of the current, C denoting the carrier wave frequency, to which frequency the antenna is tuned. The current in the antenna is a maximum at the frequency C and falls off rapidly with either an increase or a decrease in frequency. If S denotes the frequency of the current employed to modulate the carrier wave at a transmitting station, the modulated high frequency current is made up of three components, viz: C, C—S and C+S. In case the modulating current is produced by speech, the frequency S varies over a considerable range, so that the components C—S and C+S of the modulated current form bands upon either side of the carrier frequency C. The current in the antenna due to these side band frequencies is indicated in figure 1, where S′ and S″ denote a relatively low and relatively high speech frequency, respectively. C+S′ and C—S′ are the components of the modulated current due to the speech frequency S′ and C+S″ and C—S″ are the components due to the speech frequency S″. Assuming that S″ is the highest speech frequency present in the modulating current and that the lowest speech frequency is very near zero, the side bands C—S and C+S will be as indicated in figure 1. It is evident that the components C+S″ and C—S″ are attenuated by the antenna to a greater extent than the components C+S′ and C—S′. As stated above, the resonance

One remedy for this defect is to increase the damping of the antenna, thus making its impedance more nearly uniform over the band of frequencies being transmitted. This increased damping involves dissipation of power in the added resistance. It is desirable therefore, to prevent such distortion without adding to the damping. This is accomplished by providing means between the transmitter and the modulator for increasing the amplitude of the voice currents of higher frequency relative to those of lower frequency in the same ratio that the impedance of the antenna circuit increases for frequencies differing from the carrier frequency by the amount of voice currents. In this manner the amplitudes of the side band currents in the antenna are brought into the curve may be flattened by increasing the damping of the antenna or other tuned circuit, which will make the attenuation more nearly the same for all frequencies. This is objectionable, however, as it decreases the efficiency. It would be possible also to employ a wave filter which would attenuate both the frequencies C—S′ and C+S′ more than the frequencies C—S″ and C+S″, but such a filter would be relatively complicated and not so efficient as the method described.

Referring to figures 2, 3 and 4, each of these figures shows a radio-telephone transmitting system having an antenna circuit, inductively coupled to the modulator having the input circuit II and the output circuit III. The high frequency generator is inductively connected to the circuit II through the transformer. The transmitter circuit I contains the telephone transmitter, the battery and the primary of a transformer.

Figure 2 shows the tuned circuit V containing the variable condenser and the variable inductance. This circuit is inductively connected to circuits I and II by the transformers. The circuit V is tuned to a frequency in the range of the upper voice frequency or somewhat above this range, the purpose being to transmit the voice currents of higher frequency with greater facility than those of lower frequency, thus imparting relatively great amplitudes to the higher frequencies.

Figure 3 illustrates a second method of compensating for the antenna distortion. In place of the circuit V of figure I a linking circuit VI is employed. A resonance transformer connects this circuit to the circuit I. The secondary coil is connected into circuit with an adjustable contact. By properly adjusting the amount of inductance of the secondary which is not in inductive relation with the primary coil with respect to the remaining portion, the transformer may be made to have its maximum efficiency at a frequency somewhat above the voice range.

Figure 4 illustrates a third method of effecting the compensation in the low frequency circuit. The transmitting circuit I is connected to the modulator by a transformer and an adjustable impedance having large resistance and small or no inductance is connected in series with the transformer secondary 16. An adjustable inductance coil is bridged across the input circuit and is in series with the impedance with respect to the secondary. The purpose in having the resistance of the impedance coil relatively large is to assist in making the current in the circuit constant for all frequencies.

The operation of the systems shown in figures 2, 3 and 4 is as follows: The voice currents in circuit I figure 2 induce currents in the tuned circuit V which has a natural frequency in the range of the upper frequencies of the voice currents or above that range, so that the amplitudes of the higher frequencies are increased relative to those of lower frequency. The energy of the current in circuit V is impressed upon the input or grid circuit II of the modulator. The current from the generator induces a current of high frequency in the circuit II. The output current of the tube is modulated and the alternating current component of the modulated current induces a modulated oscillatory current in the antenna circuit. This current consists of a component of carrier frequency and components of frequencies differing from the carrier frequency by the voice current frequency. The currents whose frequencies differ most widely from the carrier frequency are noticeably suppressed by the antenna, due to the frequencies being appreciably different from that to which the antenna is tuned. But the amount of suppression having been compensated for by the action of the tuned circuit V, the resultant current is undistorted.

The operation of the system of figure 3 is similar to that of figure 2, except that the compensation is effected by the transformer. This transformer is designed or adjusted to have maximum efficiency for a frequency somewhat above the voice range, so that the higher frequencies are thereby given relatively great amplitudes.

The system shown in figure 4 operates differently from that of figure 2 only to the extent that the compensation in the low frequency circuit is effected by the selective action of the impedance of the circuit. The variable inductance coil offers negligible impedance to the lower voice frequencies but marked impedance to the higher frequencies. The impedance coil offers substantially the same impedance to currents of all frequencies. The drop in potential across the inductance coil therefore increases with the frequency, so that the effect is the same as that produced by the tuned circuit V of figure 2 and the transformer circuit VI of figure 3.

It is understood, of course, that an amplifier may be inserted between the circuits III and IV to amplify the modulated current to any extent desired.

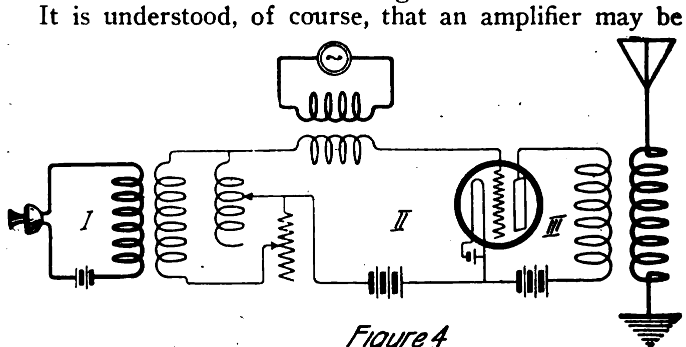


Figure 4

In this circuit compensation is effected by the selective action of the impedance

Figure 5 illustrates a radio receiving station using a distorting transformer such as that shown in figure 3.

Referring to figure 5, an antenna is connected through a transformer to the input circuit of a vacuum tube amplifier A, the output circuit of which is connected to the input circuit of the vacuum tube detector D by means of variable impedance 29. The output circuit of the detector D is connected through transformer 2, 3, to a circuit B, C, the function of the transformer B, C, being the same as that of the transformer in figure 3. The telephone receiver is inductively connected to the circuit B, C, by means of a transformer. A condenser E is shunted across the inductance and the circuit is tuned to the carrier wave frequency. The high frequency modulated current which is induced in the antenna is amplified by the amplifier A, after which the detector D with its associated circuits functions in the usual manner to produce currents of speech frequency from the high frequency modulated current. The transformer B is designed or adjusted to be more efficient for the speech currents of higher frequency than for those of low frequency, whereby compensation may be made for the distorting effect of the high frequency circuits of the system.

The Dimensions of Inductances

By Philip R. Coursey, B.Sc., A.M.I.E.E.

IN ordinary electrical engineering work use is frequently made of the formula $H = \frac{4\pi}{10} \cdot \frac{IN}{l}$. expressing the value of the flux in lines of magnetic force per square centimetre in the inside of a magnetic circuit of length l round which a current of I amperes flows N times. This formula is the basis of one often used to calculate the inductance of a coil, viz. $L = \pi^2 D^2 \frac{N^2}{l}$., since the inductance of the coil can be numerically expressed as the number of linkages which the flux makes with the turns of the coil per ampere of current flowing through the winding.

The inaccuracy of this simple formula for all except extremely long coils, or completely closed magnetic circuits, has led to its frequent modification by many radio workers. One of the most useful of these is that first devised by Prof. Nagaoka of Tokyo, and of which details are published in the Bulletin of the Bureau of Standards, Vol. 8. The modification introduced takes the form of a correcting factor k, which is always less than unity, but which closely approaches that figure for extremely long windings. This factor corrects for the uneven distribution of the magnetic flux near the ends of the coil, as, were the flux always uniform the simpler formula would be correct for all cases. Tables of the values of this factor k are given in the bulletin above referred to in terms of the ratio $\frac{D}{l}$. This formula, viz. $L = \pi^2 D^2 N^2 k/l$, is very convenient for the calculation of the inductance of a coil when its dimensions l and D are given, since k can be found from the tables, and the expression then evaluated, but it is not nearly so useful for the more practical problem of the design of a coil to have any desired inductance value.

In a recent article, tables were given to aid the design of a coil using a formula due to Lorentz which suffers from the same disadvantage. It is not generally known however, that Nagaoka's formula as given above may very easily be modified in such a manner that the design of a coil thereby becomes comparatively easy, so that all unnecessary "trial and error" methods can be eliminated.

Taking the above formula, we may write it as follows:

$$L = \pi^2 D^2 n^2 l\, k$$

or $L = \pi^2 D^3 n^2 \left(\frac{lk}{D}\right)$, where $n = N/l =$ the number of turns of wire per centimetre length of the coil, $D =$ the diameter of the winding measured to the centre of the wires, and $l =$ the axial length of the coil. In this form it is much more useful (as will be shown below) provided we have access to a table or curve giving values of the factor (l k/D). Values of this may be worked out from the tables and formulae given by Prof. Nagaoka, and some curves obtained by the writer in this manner have been published in the "Electrician" (London).

For still greater convenience in use we require the inductance to be given in microhenries, and all the dimensions to be in inches. We may therefore rewrite the above formula again, thus:

$$L = \pi^2 D^3 n^2 \left(\frac{l\,k}{D}\right) \text{ [inductance and dimensions in cms.]}$$

$$= D^3 n^2 \left(\pi^2 \times \frac{l\,k}{D} \times 2.54 \times 10^{-3}\right) \text{ [inductance in microhenries and dimensions in inches.]}$$

$$= D^3 n^2 k_1$$

in which we have written k_1 for the whole expression

$$\left(2.54\,\pi^2 \frac{l\,k}{D} \times 10^{-3}\right)$$

In order to simplify the calculations, values of this factor k_1 are set out in the table below, and may be used directly in this formula in a manner which we will now discuss. For convenience in setting out the values of this factor k_1, and of the factor k_2 referred to below, all the figures in the table have been multiplied by 10000, so that if these factors are used in the formula directly from the table, it is necessary to divide the answer by this figure (ten-thousand) in order to obtain the correct results for the inductance in microhenries.

(1) Given the number of turns per inch (n), as determined by the size of the wire, and given a suitable diameter (D) in inches, to find the length of winding, l in inches, required to yield a given inductance. We have $L =$ microhenries, known, also D and n, so that we can at once work out the appropriate value of k_1 by direct substitution, thus:—

$$k_1 = \frac{L}{D^3 n^2}$$

Referring to the table below, we find the corresponding value of the ratio $\frac{l}{D}$, and by multiplying this by the known value of D we at once get l the length of the coil in inches.

(2) Given the maximum length of the coil (which may perhaps be determined by some structural considerations of the panel or unit on which the coil is to be mounted) and the number of turns of wire per inch, to find the diameter required for a given inductance. We now have L, l and n given, so that the above arrangement of the formula is not quite so suitable. It is easy, however, to throw it into a convenient form—thus:

$$L = \pi^2 D^2 n^2 l k \quad \text{[inductance in cms., and dimensions in cms.]}$$

$$= n^2 l^3 \left(\frac{D^2 k}{l} \times 2.54 \times \pi^2 \times 10^{-3}\right) \quad \text{[Inductance in microhenries and dimensions in inches]}$$

which may be written,

$$L = n^2 l^3 k_2$$

Values of k_2 are also given in the subjoined table. In this case from the given data we can calculate k_2 and then from the table get $\frac{l}{D}$. Then the required diameter $=$ the length of the coil divided by this value of $\frac{l}{D}$.

(3) Given convenient values for the length and the diameter of the coil, to find the number of turns that must be wound on per inch of the coil so that it may have the required inductance. We now have L, l, and D given, so that either of the above arrangements of the formula may obviously be employed.

(4) Given all the dimensions of the coil, viz. l, D, and n, to find its inductance. Again in this case either of the above forms may be employed, since given l and D their ratio is known and therefore also both k_1 and k_2 from either of which the inductance follows immediately.

Ratio $\frac{l}{D}$	k_1 ($\times 10^4$)	k_2 ($\times 10^4$)	Ratio $\frac{l}{D}$	k_1 ($\times 10^4$)	k_2 ($\times 10^4$)
0.01	0.08764	87640	1.00	172.6	172.6
0.02	0.3063	38290	1.50	289.5	85.76
0.03	0.6311	23370	2.00	410.2	51.29
0.04	1.049	16390	2.50	532.5	34.09
0.05	1.537	12290	3.00	655.1	24.27
0.06	2.126	9842	3.50	781.8	18.23
0.07	2.774	8089	4.00	904.0	14.12
0.08	3.486	6810	4.50	1030.0	11.31
0.09	4.264	5851	5.00	1153.0	9.223
0.10	5.095	5095	5.50	1276.0	7.690
0.15	9.926	3080	6.00	1402.0	6.488
0.20	16.03	2004	6.50	1529.0	5.565
0.25	22.90	1466	7.00	1653.0	4.818
0.30	30.38	1126	7.50	1778	4.215
0.35	38.78	942.0	8.00	1903	3.717
0.40	47.32	739.1	8.50	2028	3.303
0.45	56.50	620.1	9.00	2152	2.952
0.50	65.88	526.9	9.50	2279	2.659
0.55	75.56	454.0	10.0	2404	2.404
0.60	85.13	394.1	15.0	3663	1.085
0.65	95.81	348.9	20.0	4908	0.6137
0.70	106.5	310.6	25.0	6162	0.3945
0.75	116.9	277.1	30.0	7415	0.2747
0.80	127.9	250.0	35.0	8670	0.2021
0.85	138.7	225.9	40.0	9926	0.1551
0.90	149.6	205.2	45.0	11180	0.1227
0.95	161.2	188.0	50.0	12430	0.0994

ALL VALUES OF k_1 AND k_2 IN THIS TABLE MUST BE DIVIDED BY TEN THOUSAND TO GIVE CORRECT RESULTS IN FORMULA.

The following numerical examples to illustrate each of these four possible cases which may arise in practical design should serve to explain how to use the tables to the best advantage. For anyone requiring to work out many coils it is recommended that he plot out curves from the figures given in this table, so that the values of k_1 and k_2 may be obtained easily from them for all intermediate values as well as for those tabulated. Greater speed is thus obtainable in using the formula.

Numerical Examples.

[1] Given coil diameter = 4″, number of turns per inch length = 25, inductance required = 1158 microhenries, to find the length.

We have, $k_1 = \frac{L}{D^3 n^2} = \frac{1158}{64 \times 625} = 0.02895$

Hence, from table $l/D = 1.5$

Therefore, $l = 1.5 \times 4 = 6''$. = required length.

[2] Given coil length = 6″, number of turns per inch length = 25, inductance required = 3260 microhenries, to find the diameter.

We have, $k_2 = \frac{L}{l^3 n^2} = \frac{3260}{216 \times 625} = 0.02771$

Hence from table, $l/D = 0.75$.

Therefore, $D = 6/0.75 = 8$ inches = required diameter.

[3] and [4] The calculations for these cases follows a similar procedure, using either one of the arrangements of the formula, as more convenient.

A Complete Radio Cabinet

A RADIO CABINET in which both the sending and receiving apparatus are installed, has been designed by W. E. Booth, who states that the apparatus is thus made more accessible for inspection and repairs than in other forms of installation.

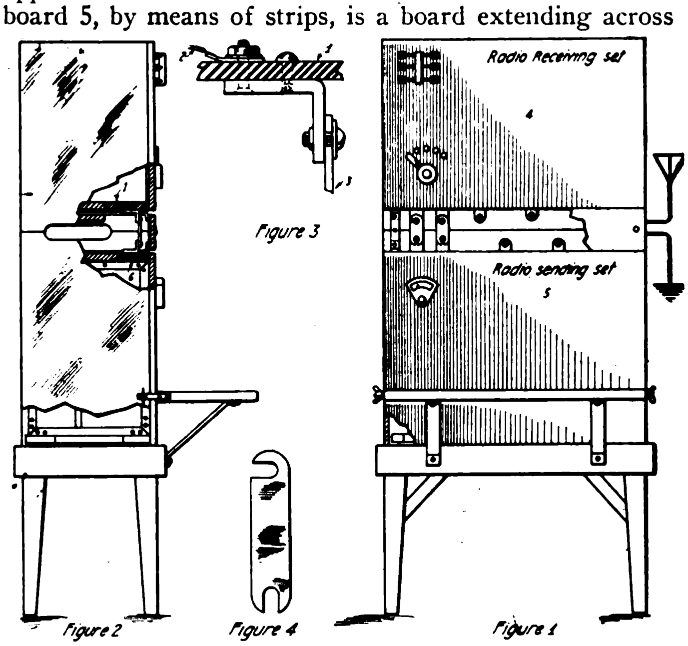
The terminals for each set are so arranged that good electrical connections between units are assured. This is accomplished by mounting the sets independently so that either set can be removed without disturbing the other. The sets are mounted in the cabinet with space at the front for the terminals so that the necessary connections can be conveniently made.

In figures 1 and 2 the cabinet, adapted to be supported by legs, is provided with a shelf for the operator. The cabinet is made in two sections, removably mounted one on the other. Within the top section is a radio receiving set, having the instrument board flush with the front of the cabinet. On the insulated terminal board 1 are mounted the terminals connected to the radio receiving set.

As shown in figure 3, the terminal is fastened to the terminal board 1 by a screw. Electrical connection is made from the lead to terminal by bolt and nut. Connector 3 is clamped to the other end of the terminal by means of a screw.

The shelf and terminal board provide a supporting base upon which the radio receiving set is mounted. An angle strip is fastened to the back of the instrument board 4 and to the under side of the shelf and terminal board 1. The bottom of the strip beneath the terminal board 1 and the shelf is in sliding contact with the top of a strip, fastened to the top section. Figure 1 shows this strip at one side of the cabinet and a similar strip not shown is provided at the other side. The front end of this strip and the front end of a similar strip fastened to the lower section are bent so that another strip may be fastened thereto. This latter strip at the left side of the cabinet and a similar strip at the other side provide a support for a cover. A screw passes through each end of the cover into each of the strips. The receiving set including the instrument board 4, the terminal board and the shelf is removable from the section when the cover connectors and strips are removed.

The radio sending set has an instrument board 5 which forms a part of the front of the cabinet. Fastened to the instrument board is the terminal board 6, to which the connections for the sending set are brought, the terminal board being provided with terminals similar to the terminals on the receiver. The board is fastened to the bottom section and extends across its top to protect the apparatus below it. Fastened to the bottom of instrument board 5, by means of strips, is a board extending across



Side, front and detailed views of the radio cabinet

the bottom of the lower section and supporting the sending set. A sliding board engages at each end a strip fastened and raised above the bottom of the cabinet.

The shelf is held in position by means of the braces and thumb nuts which are threaded on bolts fastened to the sides of the cabinet. Fastened to each side of the shelf is a strip which is clamped by thumb nut to hold the shelf in position.

When the connectors, cover, and shelf are removed, the sending set may be withdrawn from the cabinet without otherwise disturbing the receiving set.

A space is left between the sending and receiving sets into which the terminals project. This makes it convenient to properly connect the sending and receiving sets by means of the connectors. See figure 4. The connections to the antenna may be made from the lugs through the side of the cabinet.

The sending and receiving sets are independently mounted within the cabinet, and either set may be removed without disturbing the other. Because of the proximity of the terminal boards of the two sets, the necessary electrical connections may be easily made.

A Novel Power V. T.

By H. J. Round of London

THE particulars of an improved vacuum tube has recently been disclosed by H. J. Round, of London.

Referring to the illustration, A is a hollow metal tube closed at its inner end, and sealed at the outer end into the glass of the bulb and acting as the anode. It is surrounded by a grid, the lead from which passes out through the glass at B. The filament is arranged as a coil around the grid and is maintained in position by glass supports, the leads from it being sealed through the glass at C. D is a tube which is arranged along the axis of the anode A and through which cooling fluid is introduced. E is a cage or sheath of metal surrounding the filament for the purpose of preventing the emission from reaching the glass. This sheath may be given a negative charge of electricity and the connection F is used for this purpose.

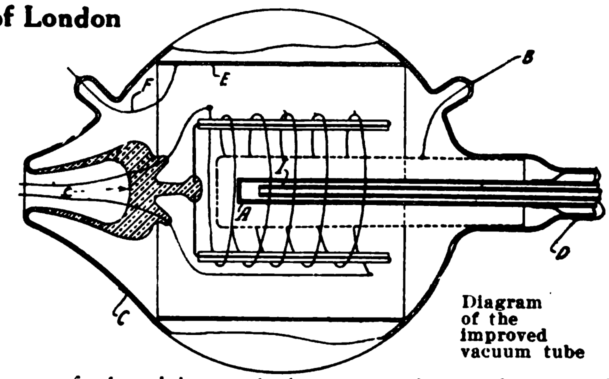


Diagram of the improved vacuum tube

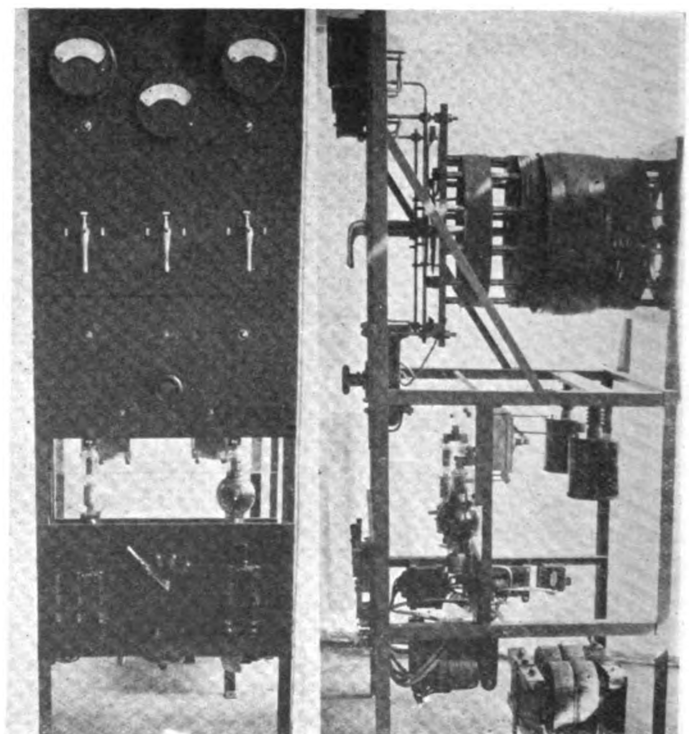
Two New Coastal Stations Use Tube Transmitters for First Time in Ship-to-Shore Work

TWO new coastal stations for ship-and-shore work employing tube transmitters, have recently been put into service by the Radio Corporation of America. One is located at Chatham, Mass., on Cape Cod, call letters WCC, wave-length 2,200 meters, and the other at Belmar, N. J., call letters WNY, wave-length 300, 425 and 600. Both stations are of the most modern type throughout and tube transmitting sets, of two kilowatt capacity each, are employed. The use of tube sets marks a distinct advance in the commercial radio industry.

These new stations have been located to the best advantage geographically and will afford greatly increased facilities to all ships engaged in the European and southern traffic. The normal range of these stations is 500 miles daylight.

The equipment at the Cape Cod station, in addition to the two kilowatt tube set for ship-to-shore work, will later include a tube set of five kilowatt capacity, the most powerful tube set so far built for use in ship and shore work. The range of this larger set will be 1,500 miles and will take up the work formerly done before the war by the old Cape Cod station, WCC. This station will be used for ship and shore message work, broadcasting traffic on regular schedules and will also transmit press on regular schedule on a wave-length in the neighborhood of 3,000 meters in connection with the "Ocean Wireless News," the daily newspaper of the sea.

These new stations of the Radio Corporation will be connected by direct wires to the main traffic office at 64 Broad Street, New York, from which point the trans-oceanic stations of the Radio Corporation are also controlled.



Front and side views of the ship-and-shore station tube transmitter

The three new tube sets, the first to be used in ship-to-shore work, are built upon an iron framework seven feet high, 32 inches wide and 36 inches deep. Three panels of dilecto provide mountings for the necessary control switches and indicating instruments. Two Pliotron tubes are used in the set, in vertical position, each tube being of 1,000 watts in the case of the two kw. set and 2,500 watts in the case of the five kw. set capacity, respectively. The latter tubes are of the largest capacity so far built for commercial work.

The sets have been designed to work on a line voltage of 220, 60 cycles, single phase, and in the case of the larger set, this voltage will be stepped up to 25,000 volts in the plate transformer which has a split secondary, each tube operating on 12,500 volts. A self-rectifying circuit, which has recently been developed by the engineers of the Radio Corporation, is employed in the operation of these sets, the tubes acting as oscillators and rectifiers at the same time.

New Legislation

THERE are four bills before Congress as proposals to change the existing law governing radio communication.

Two were introduced in the House of Representatives by Congressman White of Maine, and copies of these were introduced in the Senate by Senator Kellogg of Minnesota.

All have practically the same purposes, principally to give to the Department of Commerce the full supervision of radio and enforcement of the laws, and to register by license receiving as well as transmitting stations.

The first bill, H. R. 4132, was introduced on April 18th by Congressman White; the duplicate appeared in the Senate on May 4th introduced by Senator Kellogg as S. 1627.

The later bill, H. R. 5889, was introduced in the House of Representatives on May 6th sponsored by Congressman White "by request," which is understood to mean that it had been prepared along lines suggested by the Department of Commerce. A corresponding, or duplicate, bill has been introduced in the Senate by Senator Kellogg and appears as S. 1628.

Both of the House bills have been referred to the Committee on Merchant Marine and Fisheries and hearings will be begun at an early date.

In many respects the new bills carry similar provisions to those of the existing law, and these need not be reviewed; where changes are contemplated, however, the following summary will acquaint THE WIRELESS AGE readers with their meaning, stripped of legal verbiage:

H. R. 4132 (Senate 1627)

The first sections of this bill define the terms "radio communication", the "apparatus" used in radio communication, "radiograms", "public correspondence", "radio station", and also define the territory in which the latter is to be affected by the proposed law as the United States and all of its possessions, but is not applicable when transmission is kept within any one state.

The bill gives the Secretary of Commerce full power in the regulation of radio communication in the United States and its territory. This includes the authority to divide radio stations into special classes and such classes as he may deem necessary, and also includes the authority to issue licenses for radio stations and operators and the assignment of bands of wave lengths for the use of the various classes of stations established by him. The Secretary of Commerce is also responsible for the enforcement of the law except in the case of Government-owned radio stations where regulations of the Department of Commerce are to be enforced by the departments of the government controlling such stations.

The Secretary of Commerce is directed in this bill to advise with and assist **persons of United States citizenship** in the establishment of radio communication facilities with foreign countries. He is also authorized to advise and assist licensed persons in the United States, to operate transoceanic radio stations between the United States and foreign countries, although this assistance shall not be in the form of financial or political support of any kind.

An advisory committee for radio communication is established by this bill to whom the Secretary of Commerce shall refer **for examination and report** such matters as he may deem necessary in connection with the following:

(a) Administration or improvement of radio laws, regulations and treaties of the United States.

(b) The study of scientific problems involved therein.

(c) Scientific progress and commercial use of radio communication as related to the use of this means of communication by the several branches of the Government.

The advisory committee is to consist of **seven members** of whom one each shall be designated by the Secretary of War, Secretary of the Navy, the Postmaster General, the Secretary of Commerce to represent these respective departments; one from the Bureau of Standards, to be appointed by the Secretary of Commerce, and two persons not otherwise employed in the government service, of recognized attainment in radio communication, to be designated by the Secretary of Commerce.

No radio stations other than those belonging to or operated by the United States shall be used for any purpose except under and in accordance with licenses to be issued by the Secretary of Commerce. Illegally operating radio station is punishable by a fine not exceeding $500 for the first offense and by a fine not exceeding $1,000 or one year's imprisonment for both for each offence thereafter.

Licenses for AMATEUR radio stations and for stations used exclusively in experimental work and operation and for the operators thereof, shall be issued without cost to the licensees. Reasonable fees, fixed by the Secretary of Commerce, may be charged for issuing **all other licenses.**

Stations which have been formally licensed by the Secretary of Commerce cannot be transferred to the management or control of any aliens or their representatives, nor to any foreign government or representatives thereof, nor to any company, corporation, or association organized under the laws of any foreign government or in which any officer or any director is an alien or of which more than one-fifth of the voting capital stock is owned or controlled by aliens or their representatives, nor to any company, corporation or association which is dominated or controlled by alien interests, nor to any corporation unless it is agreed that a representative of the Secretary of Commerce may attend any meetings of its stockholders or directors. The acceptance of a license for a radio station shall be held to constitute such an agreement. The license may be revoked by the Secretary of Commerce for violation of these provisions.

No license shall be granted to any station, the operation of which is likely to unduly interfere with the operation of existing Government or licensed stations, nor to any station not open to general public correspondence, nor to a station which is not in the interest of the general public service. **but the Secretary of Commerce shall grant licenses to such experimental stations as in his judgment may be useful in the development of the art and to technical and training school stations used for purposes of instruction and to AMATEUR stations not operated for financial profit, or as a part of a business, such licenses to be issued with such restrictions as in the judgment of the Secretary of Commerce will prevent any interference with the operation of Government or commercial stations.**

A penalty of $2,000, or imprisonment for not more than five years, or both, is provided in the case of any person knowingly making untrue statements in the application for a license for any class of station. Every application is required to be signed upon oath or affirmation.

The actual operation of every radio station for which a station license is required, shall be carried on by a person to whom an operator's license shall have been issued. No person shall operate a radio station of any kind except under and in accordance with the operator's license issued by the Secretary of Commerce. Operating a radio station without a proper operator's license shall be punishable by a fine not exceeding $100 for the first offense and $200 or imprisonment for not more than two years for each offense thereafter. **This section is not to apply in the case of radio telephone stations regularly licensed for public service.**

The provisions governing the issuing of operators' licenses are practically the same as in the existing law.

A penalty of $500 for the first offense and $1,000 for subsequent penalty are provided in the case of malicious or wilful interference with radio communication which any licensed or Government radio station is attempting to carry on.

Penalties of $500 and $1,000 for the first and subsequent offenses are provided for in cases where the contents or of any radio communication is divulged or published, by any person not authorized by the sender to deliver the communication to the addressee, or where information contained in a radiogram is used for private benefit or the benefit of any one not entitled thereto; providing, this does not apply to the receiving, divulging, publishing or utilizing of the contents of any radiogram intended for the use of the general public or relating to ships in distress.

No person owning, controlling, or operating a licensed radio station or stations, is permitted to form a partnership, combination or association with any person owning, controlling or operating submarine cables or land telephone or telegraph systems in such a way to limit competition to and from the United States, without the consent of the Secretary of Commerce.

This bill repeals the Act of August 13, 1912, entitled "An Act to Regulate Radio Communication" insofar as the provisions of that Act are inconsistent with the present bill.

(Continued on Page 34)

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

A Quick and Accurate Relay Key

By Aubrey Whitney

First Prize $10.00

I HAVE used several types of relays, but none of them equal the one described in this article. It has several points of advantage. First, it is quick

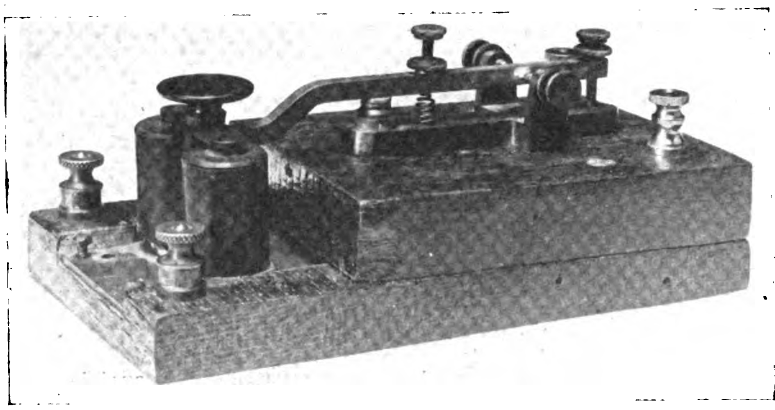


Figure 3. Complete view of the relay key

and accurate in operation. It will work as well with a "bug" as with a small key. Second, it is easy to adjust and reassemble. Third, it can be used as a key in case your "bug" fails to operate.

The photograph gives a good idea of the complete instrument; therefore not much explanation is necessary. Figure 1 shows a side view, giving dimensions of the base and position of various parts, while figure 2 is a top view of the lower base. The magnets and brass plate were secured from an old 20-ohm sounder. I would suggest using four ohms if your battery is only four volts.

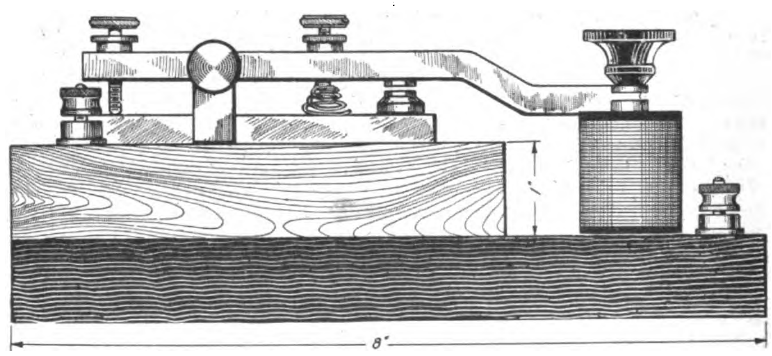


Figure 1. Side view, giving dimensions of base and position of various parts

A groove is cut in the lower base the size of the brass plates and ⅜-inch deep, as shown in figure 2. The plate is held to the base by means of a No. 2 wood screw. The plate is separated from the base by a shim about ⅛-inch long and ¼-inch in diameter. Screw No. 2 goes through the shim and into the base. The shim acts as a pivot or bearing so the magnets may be adjusted by screws 3 and 4. Screw No. 1 is separated from the base by a small piece of tin to keep the screw from going into the wood. Binding posts A and A-1 are connected to the magnets. If care be taken in cutting the groove to get the right depth, there would be no need for further adjustment of the magnets. The magnets may be adjusted over a ⅛-inch space. Should it become necessary to move the magnets up or down more than ⅛-inch, the top base will have to be removed.

The key used for the relay was an old Overland with ⅜-inch silver contacts, which will carry 2 kw. without sticking. The key base is 4¼ inches wide, 5¼ inches long and one inch thick.

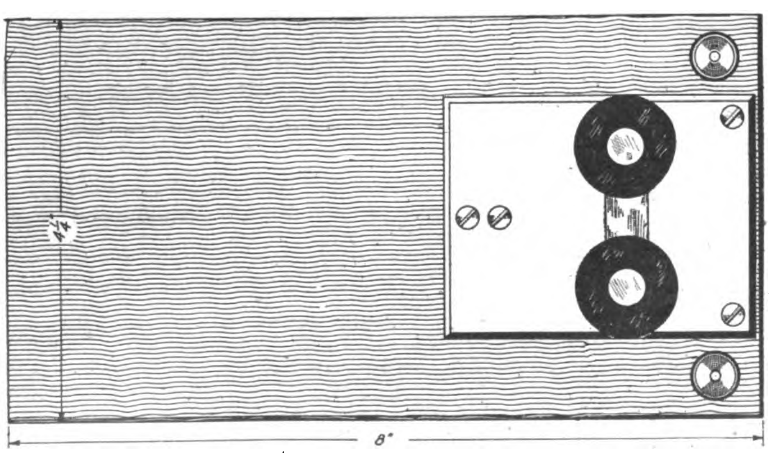


Figure 2. Top view of the lower base

The armature of an old sounder is fastened to the key lever by the knob, the knob being used to hold the armature secure and also to use for emergency sending. The magnets should be separated from the armature at a distance which will work the best without sticking. In most cases it will be found to be about ⅛-inch. The binding posts at the rear end are connected to the transformer and power supply. The binding posts in the front are connected to storage battery and "bug" or speed key.

This relay can be made without any special tools and the cost will not be prohibitive. Another advantage is that it can be put together in a short time by anyone, regardless of their mechanical ability and, lastly, its action in service is all that could be desired.

Relay Key Used With a Vibroplex

By Maurice B. O'Neill

Second Prize $5.00

THE relay key about to be described was used successfully for eighteen months, with a vibroplex, on a 2 kw., 500 cycle Fessenden transmitter, aboard the S. S. Parismina. It was constructed entirely from an old telegraph key and sounder.

In figure 1, A is the lever of a small telegraph key, cut at the dotted line and the corners rounded. A small hole is drilled one-half an inch above the center of the hole on the end which has been cut as shown in diagram C. This is to hold one end of a small spiral spring to be described later. B is a brass standard which supports the sounder bar and armature of a telegraph sounder, and is cut at the dotted line. C shows the method of mounting movable contacts between standards, with sounder armature at the short end of a key lever. The armature should have a clearance of an eighth of an inch from the base. The proper point of the lever bearings should then be marked off and drilled, each being in the exact center of the brass standard and the same distance from the base end. The holes should not be drilled entirely through the standard, but just deep enough to provide a smooth bearing for the lever trunnion points. D is a side view of C and shows the method of using round battery nuts to secure proper space between the lever and brass standards to allow movement of the lever and bring the armature nearer the pole pieces.

The contacts may be made from silver coins—dimes being used on the one described. They may be soldered or welded to the flat head of a battery or machine screw one inch in length, taking care to have the screw head in the exact center so that the contacts will come in proper alignment when finished.

The radiators are made from washers 3/4-inch in diameter and 1/16-inch thick. The spacers are hexagon battery nuts with their corners rounded.

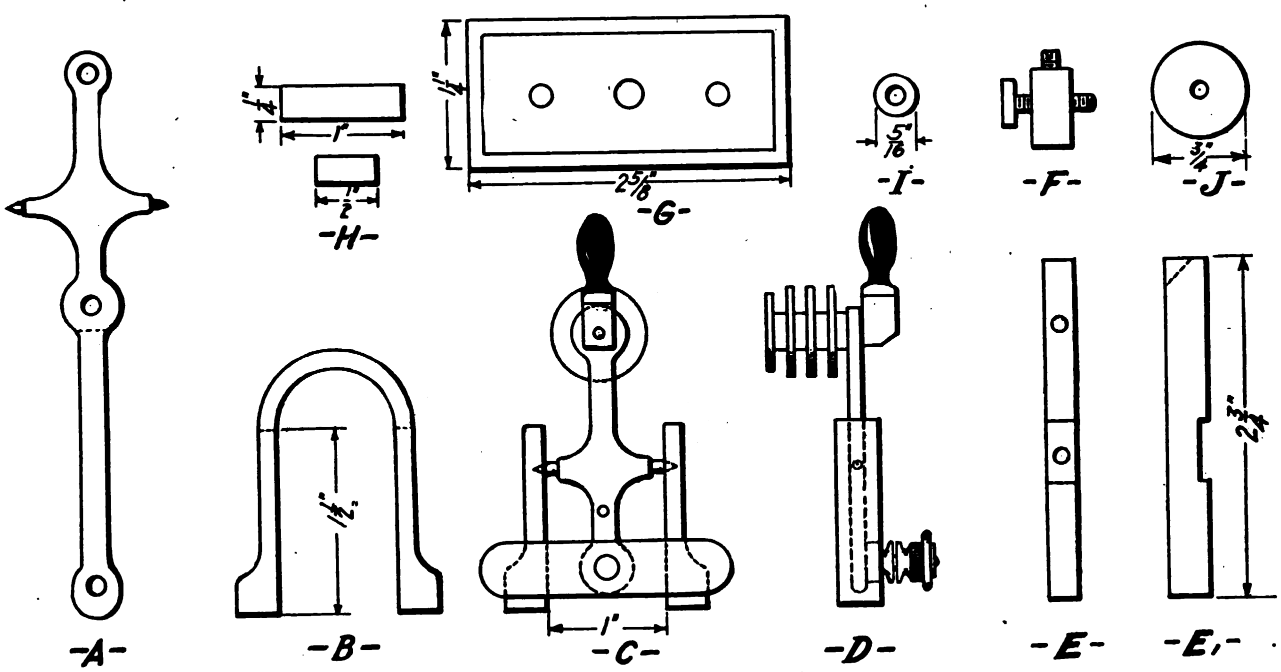


Figure 1. Constructional details of various parts of the relay key.

The stationary contact is made in the same way as the movable contact and will fit in the place formerly used for the brass sounder screw and locknut that strikes the sounder anvil. E is the sounder bar with the armature removed. The tapped holes that were made use of as a sounder bar are in the proper place to be used for the relay key, and only one hole need be drilled and tapped in the end to secure it to the base. E-1 is a side view of E and shows where the top of the bar should be cut on a bevel. This is, of course, optional with the builder, as it is only for appearance. At the small notched portion of E-1, which formerly served to countersink the sounder armature and already threaded, one of the sounder adjustment screws with locknut is used to adjust the tension of the spring, as shown in figure 3. The spring is easily made from the plunger spring of a bicycle, motorcycle or automobile valve. A short length of thin fishing twine is used to insulate it from the stationary contact, as shown in figure 3.

F is a piece of brass, which may be round or square, and is 3/8-inch in diameter and 5/8-inch long, drilled and tapped at each end to receive an 8/32-inch screw. It is drilled and tapped through its diameter to receive an 8/32 inch screw to stop the action of the spring on the movable contact and to adjust the distance between the contacts. F may be made from an ordinary binding post, such as is shown for the magnet connections of the relay in figure 3 by putting a small rod through the place ordinarily used for the wire, and locking the adjustment with the thumb nut.

G is a small base, which may be made from hard rubber, fiber, etc., 2 5/8 inches long, 1 1/4 inches wide, and 1/4-inch thick, upon which the sounder magnets are mounted in the following manner:

The top of the pole pieces of the magnets are drilled and tapped to receive 8/32-inch iron screws. H is two pieces of iron, one inch long, half inch wide and a quarter of an inch thick, drilled to receive the 8/32-inch iron screws, the heads of which are countersunk in the small base. Before mounting the magnets a machine screw is put through the center hole in the small base to secure it to the wooden relay base. The magnets are mounted so that the pole pieces are close to, but not touching, the armature of the movable contact when the contacts are touching evenly over their entire surface, in a true vertical position.

I shows appearance of hexagon battery nuts after corners have been rounded off to be used as spacers. J gives dimensions of washers used for radiators.

The base of the instrument may be made from mahogany or other suitable material, six inches long by 4½ inches wide, with a half-inch bevel. The small brass tacks under the sounder base are used as feet for the relay key. The binding posts of the sounder are used for the transformer connections to the movable and stationary contacts. Those taken from the key are used for the relay magnet connections. The knob on the telegraph key switch is mounted on a brass block ¼-inch by ⅜-inch, as shown at C, and provides means of releasing contacts, should they stick.

Figure 2 shows position of parts fixed to base. Contacts are left out for sake of clearness.

Figure 3 shows side view of complete instrument. The contacts are shown slightly separated. Adjustment of the contacts for wear is made by moving the stationary contact, giving it a turn in the threaded standard E and locking in position by the thumbscrew which enters from the opposite side of the standard and acts as a jam to hold contact in its new position.

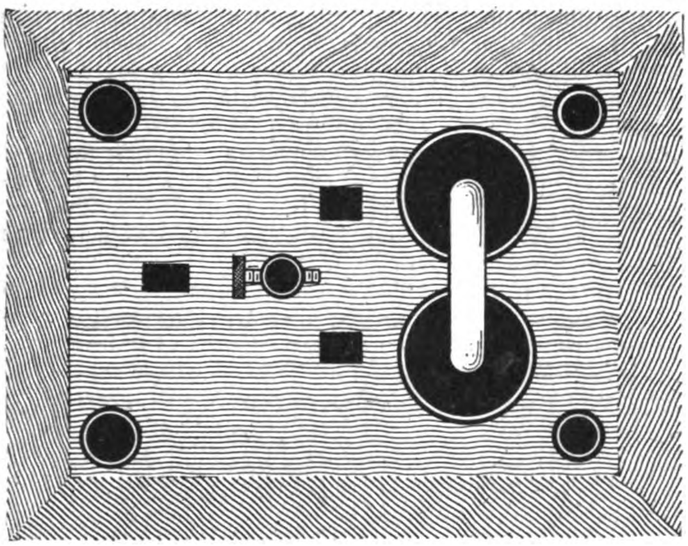


Figure 2. Position of parts fixed to base

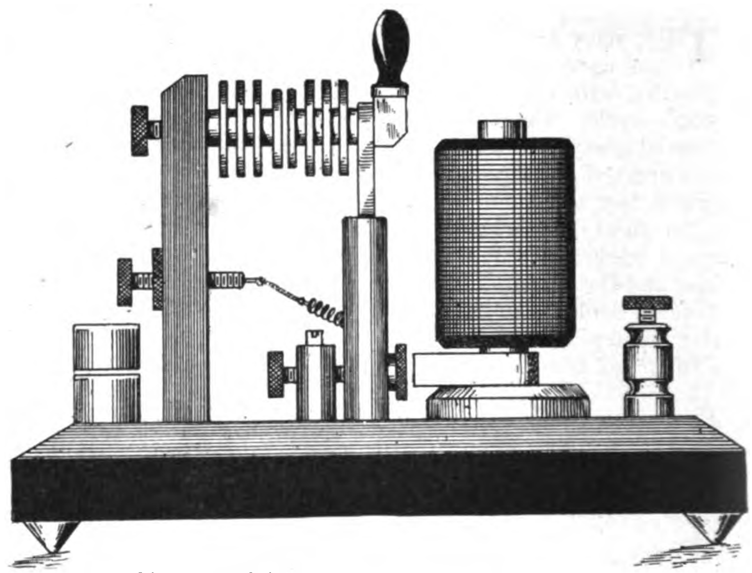


Figure 3. Side view of the complete instrument

A Relay Key for a 1 KW Set

By L. J. Froxler, Jr.

Third Prize $3.00

THE following is a description of a relay key designed to handle normally a current of from 10 to 15 amperes and, for short periods of time, a current up to about 25 amperes. This key is of the closed magnetic circuit type, with a coned plunger which when attracted to the core of an electro-magnet brings a brass plate in contact with a set of brushes connected in one side of the power circuit. A departure from the usual practice is suggested in substituting for the silver or other expensive contact points of comparatively small area, and consequently poor heat dissipating ability, the inexpensive and easily replaceable contact pieces just referred to which, on account of the large surfaces exposed to the air, can readily dissipate heat, while due to the wiping action of the brushes, the contact surfaces are kept clean.

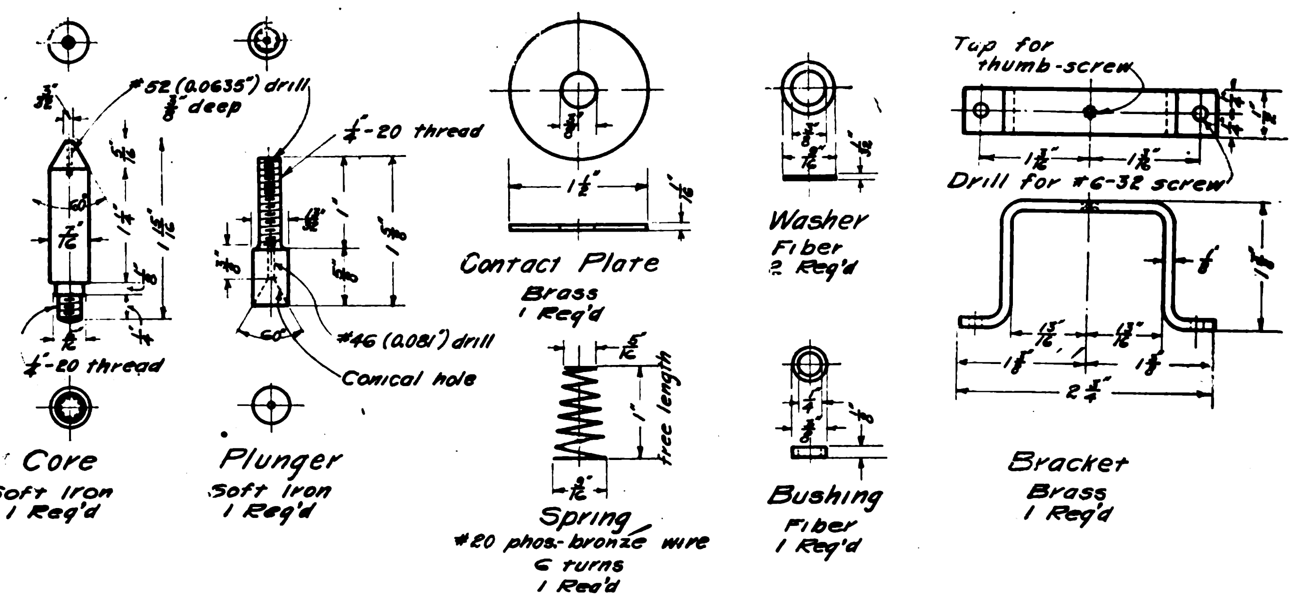


Figure 3. Constructional details of various parts of the relay key

Figure 1 is an assembly drawing of

the key. The component parts of the magnetic circuit are shown in figures 2 and 3. The frame and magnet support are made of 1/8-inch sheet iron and are held together by means of four a drive fit in the 5/16-inch hole in the magnet support. Its lower end is threaded for an iron locknut, between which and the magnet support an iron washer is inserted. A pin of No. 14 drilling leaves a V-shaped hole, as shown in the section view (figure 1). The core is a push fit in the brass tube, while the plunger should just clear the wall of the tube.

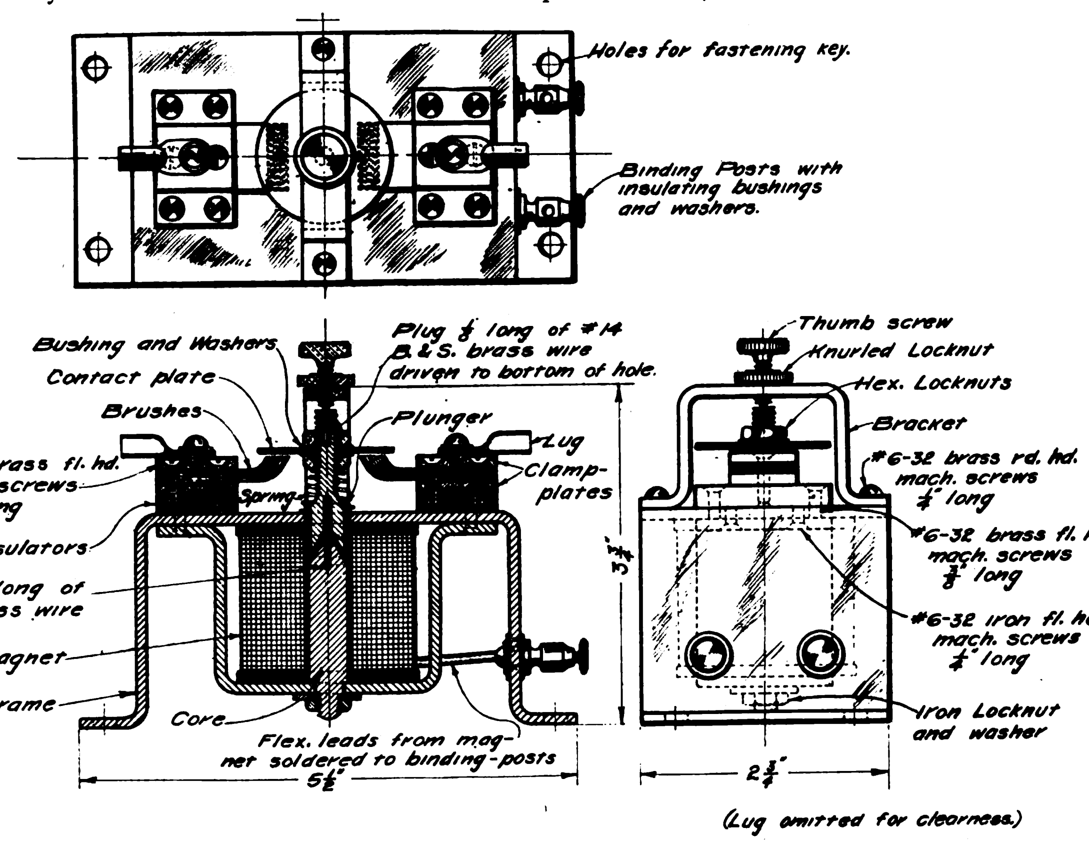


Figure 1. Assembly diagram of the key.

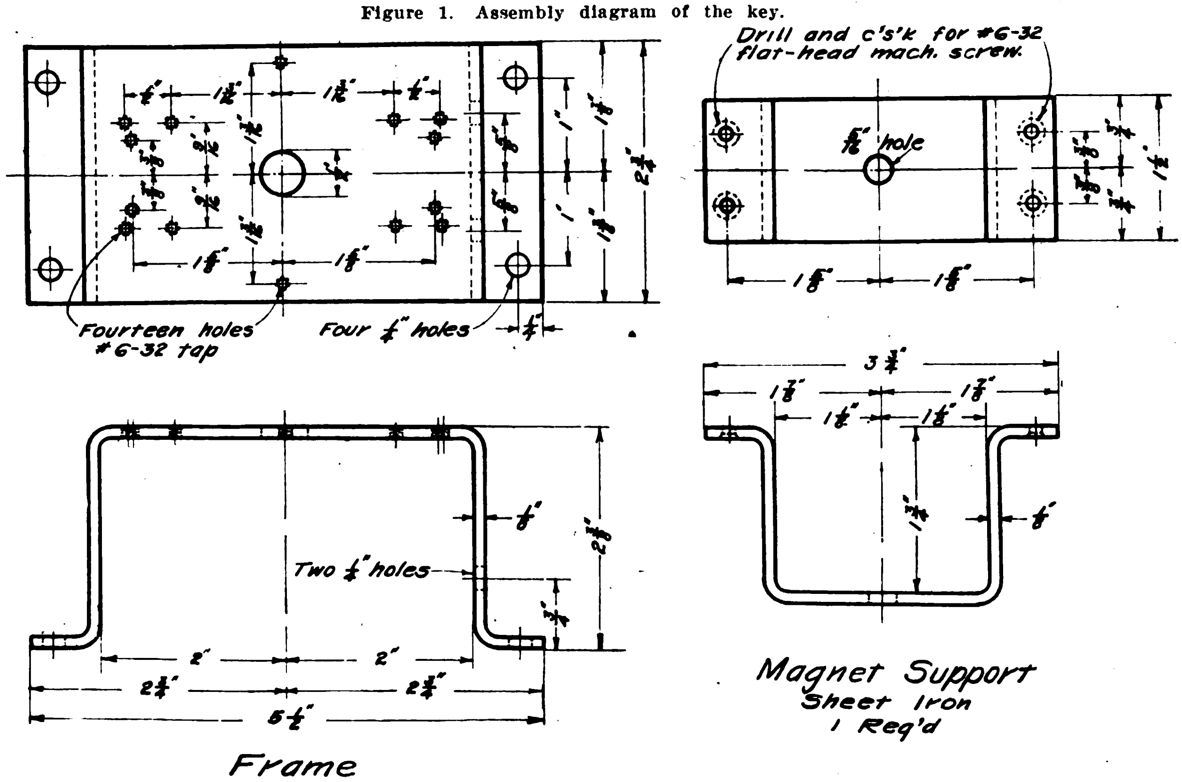
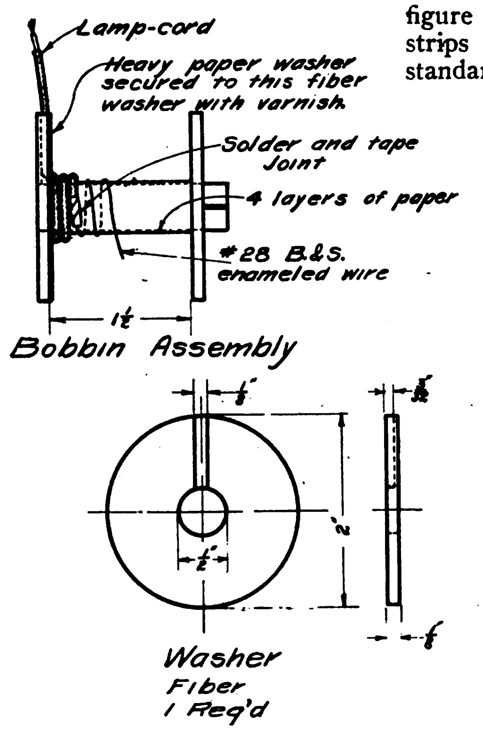


Figure 2. Dimensions and constructional details of the magnetic circuit

flat-head iron machine screws. The surfaces in contact should be accurately filed and scraped to as near a true plane surface as possible.

The core and plunger should be of soft iron, well annealed. The core is brass wire driven into the hole in the top of the core (see figure 1) acts as a guide for the lower end of the plunger, a similar function being performed by the tip of the thumb-screw for the upper end of the plunger. The

Figure 4 shows the magnet bobbin, assembled and in detail. It consists of a ½-inch brass tube of about No. 22 B. & S. gauge wall, over which two fiber flanges or washers are driven, so as to give an interflange length of 1½ inches. A fine saw-slot is cut longitudinally in the tube so as to prevent the circulation of eddy currents which are induced by changes in the magnetic



leads are cut to the proper length and soldered to the binding posts on the side of the iron frame.

Details of the brushes, brush insulators and clamp plates are shown in figure 5. The brushes consist of 12 strips of No. 28 (1/64-inch) W. S. standard gauge, springy phosphor-

these screws so long that they touch the iron frame, as this may short-circuit the key. The fiber pieces are in turn fastened to the iron frame with flat-head screws.

The contact plate is shown in figure 3. Two locknuts hold it in place on the stem of the plunger and from the

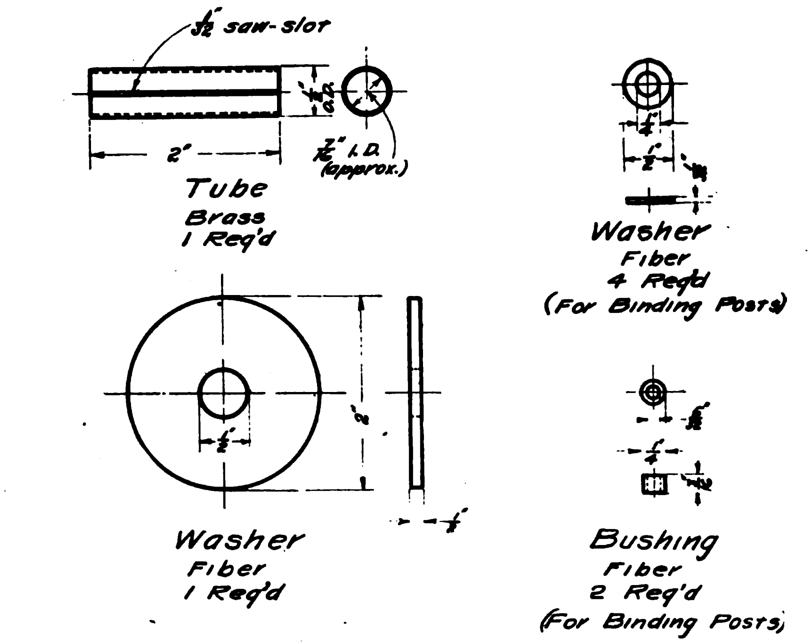


Figure 4. Diagram of the magnet bobbin assembled and in detail.

flux brought about by making and breaking the circuit of the electro-magnet and by variations in the field caused by the moving plunger. These currents are objectionable because they hinder the rapid operation of the key. To prevent the saw-slot from being bridged by the core, the portion of the latter in contact with the tube should be varnished. The tube extends slightly beyond the top of the iron frame and serves to center the base of the spring. One of the washers of the bobbin has a radial slot through which the lead from the inner end of the winding is brought out. A 2-inch heavy paper washer should be secured with shellac to this washer. Before beginning the winding, four layers of strong paraffin paper should be wrapped around the tube. A 12-inch length of lamp-cord serves as the lead for the inner end of the winding, and after passing through the slot in the washer this lead is wound two or three times about the tube in order to take up strain, and spliced to the inner end of the winding. The winding consists of 30 layers of No. 28 B. &. S enameled copper wire, with two wrappings of thin paraffin paper between each layer. About half a pound of wire is required. The outer end of the winding is also spliced to a length of lamp-cord. The coil is now wrapped with oiled linen or other suitable material, over which a protective layer of cord is wound and varnished. The flexible

bronze, ¾-inch wide, bent into the shape shown, the contact ends being slightly separated from each other. These strips, well cleaned, so as to make good electrical contact with each other, are clamped between two plates

latter, while a conical spring holds it normally away from the brushes. The plate may be rotated about its axis so as to bring new portions of its surface into use. A thumb-screw carried by a bracket regulates the travel of the

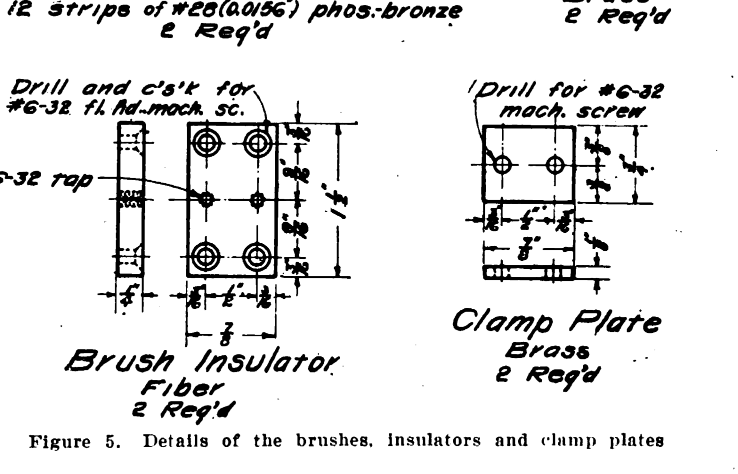


Figure 5. Details of the brushes, insulators and clamp plates

and secured to fiber pieces by means of flat-head machine screws ⅝-inch long. Care must be taken not to have

plunger. The end of this thumb-screw is turned to a diameter of 3/64-inch for a distance of $\frac{5}{16}$-inch.

Two lugs capable of taking a No. 12 wire are shown for making connections to the power circuit, but, if desired, studs may be sweated in the tapped holes of the upper clamp plates and binding posts screwed in.

A source of about 10 volts D. C. (six to eight dry cells) should be used to energize the magnet. A more snappy action may be obtained by applying voltages up to 15 directly to the magnet winding, but above this point a suitable resistance should be connected in series with the winding to prevent overheating of the latter; the proper value of resistance to use being calculated on the assumption that the resistance of the winding is 65 ohms and the maximum allowable current through it, one-quarter ampere.

By means of the lock-nuts and thumb-screw the contact place should be adjusted to have just sufficient movement to prevent arcing and permit well-defined making and breaking of the current. The separation of the contact surfaces need be very small. Attention is called to the fact that there are two breaks in series and therefore the total gap in the circuit is twice the distance between the plate and the brushes. The brushes should be trimmed so that all strips break contact with the plate simultaneously, which may be ascertained by noting whether the sparking is confined to one spot, which will be evidenced by undue burning in this spot, or is uniformly distributed over the entire contact surfaces.

In order to reduce sparking and too rapid wearing away of the contacts, a large condenser should be connected, either across the key or across the primary of the transformer. The proper value of capacity to use in order to completely eliminate sparking depends upon the constants of the circuit and is best found by trial. A high resistance carbon rod, such as is sometimes used for protecting low-voltage circuits against high-frequency surges, may be substituted for the condenser.

New Transcontinental Amateur Record

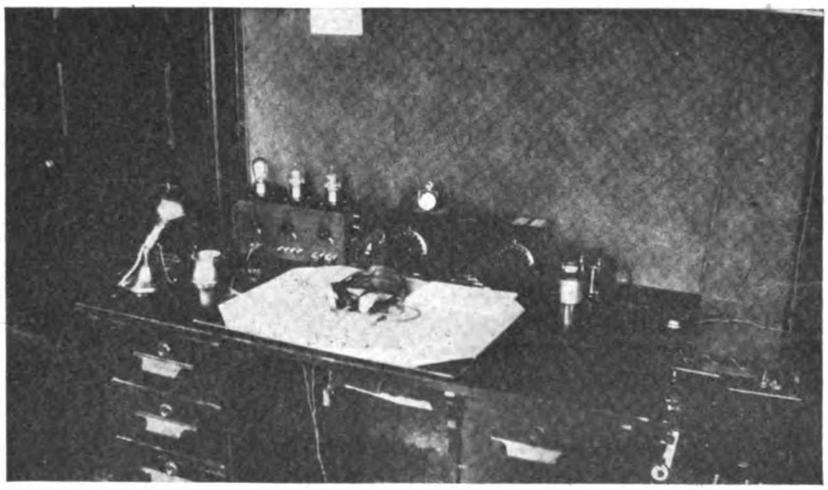
SIGNALS from amateur radio station 2BK, employing a spark transmitter, owned and operated by Carl E. Trube, 6 Livingston Avenue, Yonkers, N. Y., have been heard at amateur station 6KA, owned and operated by F. E. Nikirk, Los Angeles, Calif. The overland air-line distance between the two points is approximately 2,500 miles.

The signals from 2BK station, which is one of the most active and best-known stations of the Second District, were heard by Mr. Nikirk, at Los Angeles, at 4:38 A. M., Eastern time, April 18. Some time previously Mr. Trube and Mr. Nikirk had agreed by mail upon a transcontinental test between their stations. They arranged to conduct these tests on April 14, 15, 18, 19 and 20, the object being, of course, to effect transcontinental communication between the two stations.

The signals from 6KA were heard by Mr. Trube on the 14th, but owing to heavy static this is not a certainty. On the days following 2BK and 6KA were both in communication with amateur station 9OE, at Wichita, Kan., but the signals did not get all the way across the country until the morning of the 18th, when 6KA reported to 2BK, by mail, that he had heard the signals from 2BK at 6KA so distinctly that there could be no doubt in the matter.

This performance establishes another transcontinental record for amateur radio spark transmission on 200 meters. So far, two Pacific Coast stations have been heard on the Atlantic Coast, 6ZK, Sunnyvale, Calif., and 6EA, Los Angeles, Calif. This is, however, the first time since the war that an Atlantic Coast station has been heard on the Pacific Coast. Amateur station 2PM was heard in pre-war days by a Los Angeles station.

The antenna at 2BK station is a 4-wire, T-type, 72 feet long over all, 55 feet high. The wires are pure stranded copper, spaced five feet apart. The station is located in the Hudson Valley, and is, in fact, in a poor location. There are several trees nearby, and a large steel school building is just about half a wave-length to the east. Whether this acts as a reflector or not is not known; however, the ease with which signals carry to the west may be due to this fact. It is noticeable that work within 150 miles to the north and east by this station is practically impossible.



2BK receiving set with detector and two-step audio frequency amplifier. Key and remote control switches at right

The ground system is quite extensive, consisting of water, gas and sewer pipes, furnace and flues, gutters, leaders, about 100 feet of buried pipe and 30 buried medium-sized furnace castings. All joints soldered, of course. The idea has been to get as much area as possible enclosed by the ground system, and to this end four wire fences are used in addition. Although wet weather improves the range of the station, the soil is good and the normal range is fairly consistent. It happened that a severe rainstorm prevailed here at the time 2BK was heard on the coast. A noteworthy feature of the antenna and ground leads is the fact that they are straight lines, and thus as short as possible. The ground lead is composed of 17 No. 14 copper wires, and is 15 feet long.

The transmitter is located in a closet, which is so placed as to put the apparatus in almost a straight line from the antenna center to the ground. The only bends in either lead are where they enter through the wall of the house. A magnetic switch is used for change over in preference to an anchor gap, as the station is, of course, remote controlled. The transformer is a 1 kw. United Wireless open core type. The secondary voltage is about 30,000. Power is supplied direct from a 110-volt A. C. line. A home-made oil immersed glass plate condenser of .014 mfd. calculated capacity is used. The condenser has $\frac{3}{16}$-inch glass dielectrics, which are somewhat assisted by a

Prize Contest Announcement

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

Radio Frequency Amplifiers

Closing date, July 1, 1921

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

Prize Winning Articles Will Appear in the September Issue.

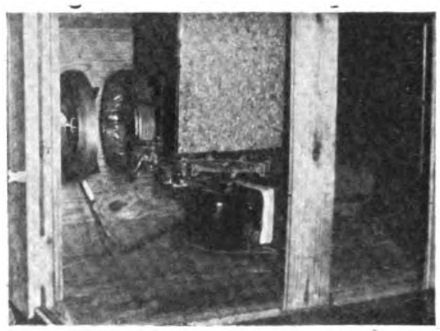
Many amateur operators are successfully employing radio frequency amplifiers in their receiving circuits at this time, and there are some who would like to try this type of amplifier, but fear they have not quite enough "dope" to go ahead. This is a chance for the more advanced experimenters to help the amateurs and "cash-in" on our prize money.

Amplifiers should contain at least two stages but may consist of as many as are practical.

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, it's practicability and general utility, originality and clearness in description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. 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

paper wrapping, soaked in oil, around each metal plate. Twenty-four dielectrics, effective area 108 square inches each, are used. The gap is a home-made affair, consisting of eight studs (1¼ inches wide by 1/16-inch thick, brass), so mounted as to have a total diameter of 12 inches, mounted on a 1/6 H. P. synchronous motor (1,800 r. p. m.). The gap is not enclosed in an individual case. The oscillation transformer is unusual. The primary is a fraction over one turn, secondary 5½ turns; neither has any dead end. The primary is so made as to give an effective conducting surface 24 inches wide. The surfaces are so arranged that they cannot touch, thus reducing high frequency resistance to a mini-



Rotary gap and oscillation transformer

mum. The secondary is also of copper, 1¼-inch wide strip being used. Each of these coils is about 12 inches in diameter outside; 4¼ inches is the usual clear space between primary and secondary; during the tests, 4½-inch was used; looser coupling has not been found advantageous.

The receiver is another bit of home-made apparatus. The variometers, in particular, are the same ones used at this station before the war. In brief, the receiver is a straight variometer regenerative and two stage audio frequency amplifier. Signals have been received on it from 5ZA, Roswell, New Mexico. The wave-length range is 180-310 meters only.

The antenna current of the station averages about four amperes on a Weston thermo-couple radio frequency ammeter. However, this figure varies from 3.5 to 4.6 amperes, depending on gap adjustment and power characteristics.

The station has done consistent work during the latter part of this season, having worked into five states beyond the Mississippi and having been reported in three more. This station has worked 340 miles without difficulty with broad sunlight at each end, and been copied solidly at 360 miles on a galena detector and loose coupler.

Total number of states and provinces where 2BK has been heard is 33. All this transmission has taken place on a wave-length between 200 and 205 meters.

A full description of 6KA station is not available but the signals were heard on a regenreative receiving set. Mr. Trube is a junior at the Stevens Institute of Technology. Although he is only at this time twenty years old he has had an amateur radio station for the last seven years.

Trans-Atlantic Amateur Tests Fail

THE Trans-Atlantic Amateur transmitting tests, which took place on February 1, 3 and 5, and in which twenty-five American amateur transmitting stations took part, failed as no signal which could be definitely identified as having been transmitted in this country was heard by the receiving stations in England.

The receiving stations, all of which used radio-frequency amplification, were interfered with considerably by harmonics from high power stations on long wave lengths and by some of the receiving stations which used self-heterodyned receivers, contrary to the conditions of their licenses and the rules of the contest. These self-heterodyned receiving sets radiated enough energy to seriously interfere with other stations in their vicinity and were no doubt responsible to a considerable degree for the failure of the tests.

Long-Wave Station Broadcasts—Useful Data for Amateurs

THE following table of long-wave stations, which periodically broadcast press, weather reports, and other information, compiled by Mr. L. P. Burt, of Catatonk, N. Y., is published for the information of amateurs interested in long-wave reception. All transmitting times have been reduced to 75th meridian time, for general convenience. The list is as correct as far as recent data is obtainable. In the table "S" and "U" refer to spark and undamped respectively. "P" is for press, "W" for weather reports, and "T" for time signals.

Desiring to try for NPM, for instance, the amateur can feel around at what he judges to be 11,200 meters at 7.00 P. M. with the certainty that NPM is sending and can recognize time signals even if regular signals are too weak to read. This offers a means of comparison between different hook-ups of the receiving set or amplifier.

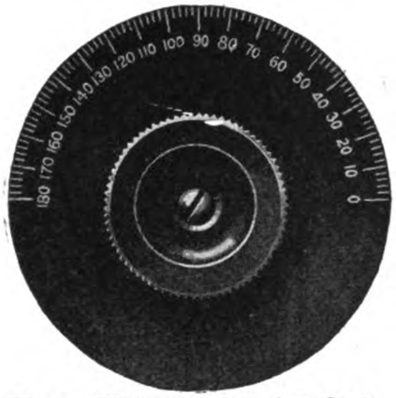
In view of recent excellent accomplishments in receiving at 200 meters, it would seem that it might be possible to pick up the smaller foreign shore stations which work on more favorable wave lengths and use several times the power of the amateur. This would seem to offer an interesting field of investigation to amateurs interested in long-wave, or long distance, receiving.

The schedule of long wave stations follows:

12:00	Midnight	Pt. Isabel	2350	S	W
2:30	A. M.	BZM	1500	S	P
3:00	"	YN	5000	U	P
3:00	"	NAH	1500	S	P
3:00	"	NFG	4000	U	P
3:00	"	NBA	2400	S	P
3:59-					
4:04	"	YN	15000	U	T
4:30	"	MPD	2700	S	W
4:45	"	FL	2500	S	W T
5:00	"	NPL	9800	U	P

AMRAD

Knob and *Dial*



Given FREE with $5 Order

CLIP out this coupon, indicate choice of Amrad articles amounting to $5 or over, send with remittance to nearest Amrad dealer as listed in March Wireless Age and receive your order by return mail with free Knob and Dial included.

COUPON

....Panel Rheostat	$1.75....
....Tube Base	.90....
....Detector Stand	2.50....
....Adjustable Resistance	3.00....
....Cabinet and Panel 5x5	3.25....
....Cabinet only 5x5x6	2.00....
....Cabinet only 10x5x6	3.25....
....Formica Panel, 5x5	.75....
....Formica Panel, 10x5	1.50....
....Formica Panel, 10x10	4.50....
....Panel Bracket	.18....
....Knob & Dial, 180°	.80....
....Knob & Dial, 90°	.80....
....Knob & Screws	.55....
....Dial only, 180°	.45....
....Dial only, 90°	.45....
....Bushing, 3/16"	.12....
....Panel Switch	.35....
....Switch Point	.03....
....Binding Post, large	.30....
....Binding Post, medium	.15....
....Tinned wire, No. 16 lb	.76....
....(Knob & Dial, 180° or 90° FREE)	

Name ....

Street ....

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

This Offer Void After July 1, 1921

AMERICAN RADIO AND RESEARCH CORPORATION

201 College Avenue
Medford Hillside, Mass.

KENNEDY EQUIPMENT

Thousands of dollars

have been spent by radio amateurs and experimenters for inferior apparatus. There was a time when they could get nothing else.

To-day it is different. The up-to-date experimenter is no longer content with his former limitations. With the development of the high grade equipment now available he demands apparatus built according to real professional standards.

In this development the COLIN B. KENNEDY COMPANY has been a leader. From its very beginning its policy has been to manufacture apparatus which is "built to a standard, not to a price."

Ask your dealer for a demonstration of Kennedy Receiving Equipment. Give it a thorough examination in comparison with the best of other makes on the market. Form your own opinion of its design, workmanship and performance. Our unreserved guarantee on every item bearing the Kennedy trade-mark is your final protection.

If your dealer has not yet put in a stock, send direct for our catalog and price list.

THE COLIN B. KENNEDY CO.

INCORPORATED

RIALTO BUILDING SAN FRANCISCO

"EVERYTHING IN RADIO"

WESTERN RADIO ELECTRIC COMPANY

Send for Our March

STOCK BULLETIN AND PRICE LIST

550 South Flower Street — Los Angeles, Cal.

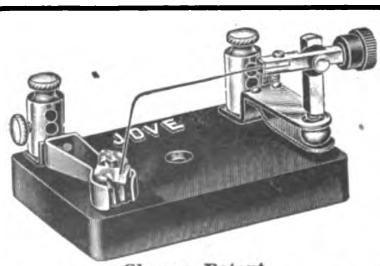
CONSOLIDATED RADIO CALL BOOK

Third edition, Price $1.50

For Sale By

WIRELESS PRESS INC.

326 Broadway - - - N. Y. City



Ghegan Patent

Bunnell Instruments Always Satisfy

Our Jove Detectors Simplest and Best

Beware of Infringing Imitations

Sample mailed for $2.00 Tested and Guaranteed Galena 25 cents

Our Keys, Spark Gaps, Condensers, Transformers, etc., are high grade but inexpensive

Distributors of Standard Electric Novelty Company Type B "Cyclone" Audion Batteries. Also DeForest, and all other makes of High Class Wireless Apparatus.

Send stamp for our No. 42-W Catalog.

J. H. BUNNELL & CO. - - - - - 32 Park Place, New York City, N. Y.

5:00	"	NAX	1500	S P
5:00	"	NBA	7000	U-S T
5:00	"	NBA	4000	U P
6:00	"	FL	2500	S P
7:20	"	BZR	1600	S W
8:00	"	BZM	1500	S W
8:30	"	NBR	1700	S W
10:00	"	FL	2500	S P
10:00	"	NAJ	1512	S T
10:45	"	UA	11000	U P
12:00	Noon	NAA	2650	S T
12:00	"	NSS	17000	U T
12:00	"	NAR	1500	S T W
12:00	"	NAT	1000	S T
1:00	P. M.	NBA	7000	U-S T
1:00	"	NAX	1500	S T
2:40	"	POZ	3600	S W
3:00	"	VCE	600	S W
3:00	"	NPG	4800	U T
3:00	"	NPL	9800	U T
4:30	"	MPD	2700	S T
6:30	"	FL	2500	S W T
7:00	"	POZ	3600	S T
7:00	"	NPM	11200	U T
7:20	"	BZR	1600	S W
7:30	"	XDA	5300	S T
8:00	"	BZM	1500	S W
8:30	"	NBR	1700	S W
9:00	"	NAH	1500	S P
10:00	"	NSS	17000	U T P
10:00	"	NAA	2650	S T W P
10:00	"	NBA	1500	S P
10:00	"	XDA	5300	S P

More Trans-Oceanic Work

HUGH Robinson, of Keyport, N. J., who, with his son Harold, owns and operates amateur radio station 2QR, has received another letter from Scotland, this time from James M. Miller, of Aberdeen, Scotland, stating that conversation and music from 2QR station have again been heard there. This is the second time that music and conversation from the Robinson station has been reported from Scotland. The previous report, made by George W. G. Benzie, of Aberdeenshire, Scotland, stated that conversation and music from 2QR station had been heard there on October 6, of last year.

In the letter recently received from Mr. Miller, he states that he picked up 2QR station on the night of November 18, between 7.10 and 7.20 p. m., Greenwich mean time, and also on November 19, 6.15 p. m. to 6.54 p. m., G. M. T.

Mr. Miller reports having heard the following on November 18:

Gramophone Records: (Duet) "The Moon hath raised her Lamp above." (Band) "El Capitan March." (Song) "Smile Awhile." The Transmitting station then spoke as follows: "Hallo! Hallo! Hallo! I hope you have heard me all right. I went on to a thousand metre wave length today, but will go back tomorrow and Saturday onto two hundred metres. Good-by, Good-bye-ee. 2QR, 2QR, 2QR; Harold Robinson, New Jersey, Harold Robinson, New Jersey. Harold Robinson, New Jersey.

Picked up at 6.15 to 6.52 p. m. G. M. T., Friday, 19th Nov., 1920:

Gramophone Solo, "The Saftest of the Family"; song, "Echo." "Hallo!" (3 times). I find I'm not radiating so well on this wave length (200 metres); I guess I'll go onto 600 metres. The atmospherics are bad tonight. I'll change in 4 minutes. Hallo! (3 times). Wait! (3 times). Hallo! (4 times). Mr. (name missed). I'll now give you the famous song that was heard in Scotland "Roaming in the Gloaming." Song, "Roaming in the Gloaming." Band Selection, "Gondoliers."

This brings the transmission for today to an end. I may not transmit tomorrow, but if I do I go to the 600 metre set as the 200 set is not working quite so well and I guess you never know how far you may be heard. Good-bye. 2QR (3 times.) Robinson, New Jersey (3 times).

Mr. Robinson states that his station has been heard at Fargo, N. D., 1,650 miles, which is the greatest overland distance over which his station has so far been reported. Music and conversation have also been reported from the following points, all

of them considerably over 500 airline miles distant from 2QR: Ashland, O., Dover, O., Mokane, Mo., York, Neb., St. Louis, Mo., Rockville, Ind., Canton, Ill., Boone, Ia., Kitchener, Ont., and Houma, La.

The radio set used for this transmission is the same one described in a previous issue of THE WIRELESS AGE. It employs four 5 watt transmitting tubes. The antenna current is normally 1 to 1¼ amperes. The antenna is 65 feet long.

Mr. Robinson states that the conversation reported as being heard on November 18 and 19 by Mr. Miller checks with the log kept at 2QR station, and that it is a substantially correct record. The conversation was purposely of an irregular nature and Mr. Robinson states that the report made by Mr. Miller includes these irregularities, and that it should therefore be conclusive proof that voice and musical transmission from 2QR station have been actually heard in Scotland, a distance of 3500 miles from the point of transmission.

(Continued from Page 21)

H. R. 5889 (Senate 1628)

This bill defines the term radio communication and allied terms in practically the same manner as H. R. 4132.

It provides that a license shall not be required for the transmission or exchange of radiograms or signals by or on behalf of the Government of the United States, but **every Government radio station shall be subject to the regulations of the Secretary of Commerce so far as concerns wave lengths and other matters affecting interference, and any Government station while open to general public service, commercial or press service, shall so far as the Secretary of Commerce shall specify, be subject to the regulations applying to radio stations licensed for similar service.**

A person within the jurisdiction of the United States shall not use or operate any apparatus for the **reception**, with intent to divulge or publish the contents of any radiogram **from any foreign country** or, other than **distress** calls, from any **foreign ship** except under or in accordance with **a license in that behalf** granted by the Secretary of Commerce.

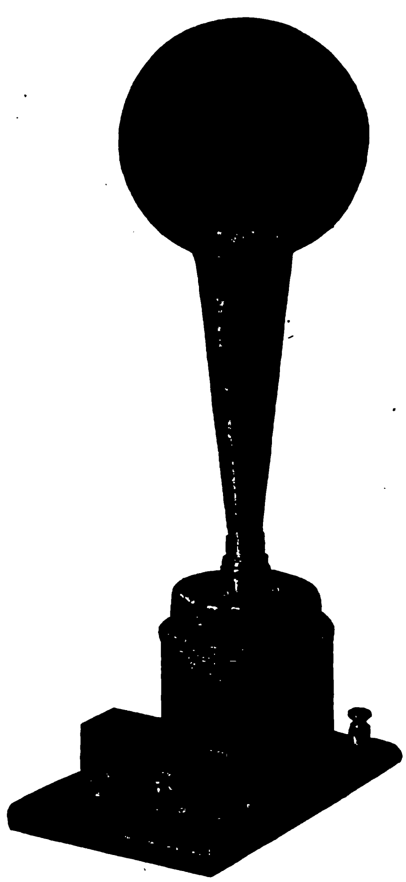
The Secretary of Commerce may grant licenses to other **receiving stations** when **any public purpose will be served** thereby.

The **Amateur** is not mentioned specifically by name, but in one section it is provided:

The Secretary of Commerce is authorized to grant licenses to radio stations to use any amount of power or wave lengths when these are actually engaged in conducting experiments for the development of the science of radio communication or the apparatus pertaining thereto, with such restrictions as will insure the least interference.

All licenses are to be in such form as the Secretary of Commerce shall determine **and shall be issued only to citizens of the United States or to companies incorporated under the laws of some State or Territory of the United States.**

The Secretary of Commerce is authorized to classify stations and operators, assign wave lengths, limit the pow-



All your friends want to hear that radiophone music—but so many phones cannot be put in one circuit.

THE RADIO MAGNAVOX

will solve your problem and allow everybody to listen in. With suitable amplifers the signals and music can be heard by all. Remember that full field current need not be used except for the very weakest signals, or when extreme volume is necessary.

Price $45.00
at your dealers'

If you are building a radiophone or have one it will pay you to investigate Magnavox transmitter microphones.

THE MAGNAVOX COMPANY

Oakland, Cal.

LEARN WIRELESS At Home

The Demand for Good Wireless Operators far Exceeds the Supply

The N. Y. Wireless Institute will make you an operator—AT HOME—in your spare time—quickly, easily and thoroughly. No previous training or experience required. Our Home Study Course was prepared by L. R. Krumm, formerly Chief Radio Inspector, Bureau of Navigation, New York. Our experts are able to impart their practical and technical knowledge to *YOU* in an *easy to understand* way—will direct your entire course. The graded lessons mailed to you will prove so fascinating that you will be eager for the next one. The instruments furnished *free*, will make it as easy to learn the Code as it was to learn to talk. *All you will have to do*, is to listen.

BIG SALARIES Wireless operators receive excellent salaries ranging from $125 to $200 a month and it is only a stepping stone to better positions. There is practically no limit to your earning power. Men who but yesterday were Wireless Operators are now holding positions as Radio Engineers, Radio Inspectors, Radio Salesmen at salaries up to $5000 a year.

Travel the World Over

A Wireless Operator can visit all parts of the world and receive fine pay and maintenance at the same time. Do you prefer a steady position without travel? There are many opportunities at the numerous land stations or with the Commercial Wireless or with the Steamship Companies.

FREE Post-Graduate Course

A one month's Post-Graduate Course, if you so desire, at one of the largest Wireless Schools in N. Y. City. New York—the Wonder City—the largest port in the World and the Headquarters of every leading Wireless and Steamship Company.

EASY PAYMENTS A small payment down will enroll you. We will make the payments so easy that anyone ambitious to enter the fastest growing profession—Wireless—may do so.

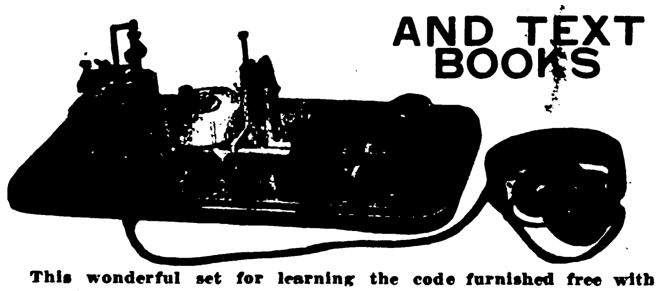
Send for FREE Booklet

Without obligating you in any way, send for our booklet "How to become an Expert Wireless Operator"—it is free. Mail the coupon attached, or postal or letter—*but do it to-day.*

NEW YORK WIRELESS INSTITUTE

Dept. 260, 258 Broadway New York City

FREE Instruments AND TEXT BOOKS



This wonderful set for learning the code furnished free with our course.

We furnish free to all students, during the course, *the wonderful receiving and sending set exactly as produced in the illustration.* This set is not loaned but *given* to all students completing the Course.

The Transmitter shown is the celebrated *Omnigraph* used by several Departments of the U. S. Government and by the leading Universities, Colleges, Technical and Telegraph Schools throughout the U. S. and Canada. Start the *Omnigraph*, place the phone to your ear and this remarkable invention will send you Wireless Messages, the same as though you were receiving them through the air, from a Wireless Station hundreds of miles away.

When you apply for your license, the U. S. Government will test you with the *Omnigraph*—the same model *Omnigraph* as we furnish to our students. Ask any U. S. Radio Inspector to verify this.

NEW YORK WIRELESS INSTITUTE,
Dept. 260, 258 Broadway, N. Y. City.

Send me, free of charge, your booklet "How to Become an Expert Wireless Operator," containing full particulars of your Course, including your *Free Instrument Offer.*

Name ....

Address ....

City or Town .... State........

er and fix rates. Such regulations shall be established with due regard to the technical development of radio communication.

An advisory committee, similar in composition and numbers to that provided for in H. R. 4132 is included, the only change being that the Bureau of Standards is not specifically mentioned.

Enforcement of all provisions of this act and subsequent acts and all international radiograms is delegated to the Secretary of Commerce.

The Secretary of the Navy is authorized to use radio stations and apparatus under the control of the Navy Department for the reception and transmission of press messages offered by any newspaper published in the United States, its Territories or possessions, or published by citizens of the United States in foreign countries, or by any press association of the United States, and also for the reception and transmission of private commercial messages—provided that the rates fixed for the reception and transmission of any such messages shall not be less than the rates charged by privately owned and operated stations for like messages and services, and private stations are incapable of meeting the normal communication requirements.

This bill repeals the existing radio law, the Act of August 13, 1912.

Kingston Radio Association

AN association has been formed in Kingston, Ontario, for all amateurs in Kingston and vicinity. At the first meeting the following officers were elected: Honorary President, Capt. S. A. Lee, M. C.; President, Orton H. Donnelly; Vice-President, Robert Davis; Secretary-Treasurer, Staff Sergt. T. G. Brown; Traffic Managers, Harold Stewart and Gordon A. Thompson.

A QST is being sent out every evening at 7 o'clock to all amateurs, and the station is to be fitted up for both transmitting and receiving in the new clubrooms which the association is soon to occupy.

Meetings are held every Friday evening at 7:30 sharp. Correspondence is solicited from other clubs.

The Eastland Oil Belt Radio Club

AT a recent meeting of the Eastland Oil Belt Radio Club the following officers were elected: President, Carroll Wood; secretary and treasurer, Harold Martin; assistant secretary and treasurer, Yancy Cummings; chief instructor, Hamlin McWilliams; librarian, Eugene Harrison.

The members of this club possess individual receiving sets, and their club station call is 5GF. Fellow amateurs and clubs are invited to communicate either by wireless or mail to Harold Martin, 806 South Seamen Street, Eastland, Texas. Club meetings are held every other Friday.

The Radio Society of South Africa

A GENERAL meeting of the Radio Society of South Africa was held at the University, Cape Town, South Africa, on the evening of February 25, 43 members being present. The Chairman, Professor A. Ogg, outlined the grading of the members, the allocation of call signs, the printing of the constitution and by-laws, and the examination of members requiring certificates.

H. E. Penrose delivered a lecture on "Construction of Amateur Apparatus" and, illustrating with actual apparatus, he explained the fundamental requisites of an elementary type of receiving instrument using a crystal detector. The advantages of different types of aerials were given, and the necessity for a good "earth" and well-soldered joints was emphasized. Various hookups were described, and details were given whereby low resistance telephones could be satisfactorily used.

Meetings of the society are held on the last Friday of each month. Communications should be addressed to the Provincial Hon. Secretary (Mr. A. T. Stacey), P. O. Box 2055, Cape Town.

DURING the month of February of this year, 1,040 licenses for amateur radio stations were issued by the Department of Commerce, as compared to 714 in February, 1920, an increase of approximately 30 per cent.

THE Department of Commerce warns amateurs in the April issue of the Radio Service Bulletin to apply for renewal of existing licenses for amateur stations prior to their expiration. Attention is called to the fact that the operation of an amateur station after the license has expired, is a violation of the radio law, for which the penalty of a $500 fine is provided, and which may also result in the confiscation of the apparatus used. Failure to apply for a renewal of an amateur license prior to its erpiration may result, at least, in the call letters of the station being rescinded and reassigned to some other station.

THE Police Department of Buffalo, New York, has inaugurated a system of police alarms by radio in connection with the amateur stations in and about the city. It is requested that all amateurs within range of the transmitting station at Buffalo police headquarters listen for the bulletin which will be sent out at 6 p. m. daily, and which will carry reports of stolen automobiles including the make, license number, motor number and other information which may help to identify stolen cars. Amateur station operators are requested to turn this information over to their local police departments. The system used is the same as has been in effect in New York City for several months past.

THE Lehigh Valley Radio Club of the Allentown, Pa., district was organized recently at the Allentown, Y. M. C. A. with thirty charter members. This new club will be one of a chain of three to include Bethlehem and Easton, Pa. Officers elected were as follows: Kenneth Keck, president; William F. Smelzer, vice president; H. W. Buttler, secretary and treasurer, and William J. Kries, assistant secretary and treasurer.

RADIO Inspector John F. Dillon recently closed an amateur radiophone station at Oakland, California. It is stated that the station was operated without a station license or an operator's license and that an apparently official call had been unlawfully used. The licenses of two other operators of amateur radio stations in the San Francisco district have been cancelled because of operating stations in a way that caused wilful and excessive interference with legitimate messages.

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.

E. A. T., Trinidad, Colo.

Q. 1. What is the difference between Bakelite Dilecto and Bakelite Micarta, and which is the preferred one for wireless use?

Ans. 1. The difference between these two materials is in their chemical content, and both these names are trade names. Either one of them is satisfactory for use on wireless apparatus.

Q. 2. What is the best material for a panel type transmitter? Is the ebonywood made by the Johns Manville Co. suitable for this purpose?

Ans. 2. The best material for a transmitting panel is either hard rubber, slate, bakelite, or some hard, dry wood, well shellacked. The ebonywood should be satisfactory.

Q. 3. I am building a wireless station at the foot of a hill, Eastern slope, and the aerial is run half way up the side of the hill. Will the signals coming from the opposite side of the hill be affected? If so, what can be done to overcome this obstacle? The aerial is to be an inverted L, two wires, 300 feet long.

Ans. 3. The signals coming from the West will be somewhat reduced if the hill contains very much metal deposit. To

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!

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

Amplifying Transformers

Amrad unmounted $5.00
Amrad mounted 7.00
No. Z-7392 Clapp Eastham unmounted 4.00
No. Z-7392A Clapp Eastham mounted 6.50
No. 226-W Federal, mounted 7.50

Audion Control Panels

No. RORA Grebe in cabinet with hinged cover, splendid value...$12.50
No. RORH Grebe in cabinet with tickler connections 17.00
Amrad, Type A, in cabinet........ 15.00
No. ZRD Clapp Eastham 12.00
No. Y-4 Acme in cabinet.......... 10.00
No. P-1 Paragon, "Adams Morgan" special moulded, very compact 6.00

"B" Batteries

No. 7623 Standard 22.5 V small....$1.50
No. 7625 Standard 22.5 V large.... 2.65
No. 7650 Standard 22.5 V variable.. 3.50
No. 763 Eveready 22.5 V small 2.25
No. 766 Eveready 22.5 V large 3.50

Condensers (Vernier De Forest)

No. CV-1010 .001 without vernier in glass case $17.50
No. CV-1013 .001 with vernier in glass case 19.50
No. CV-1500 .0015 unmounted without vernier attachment 13.95
No. CV-1510 .0015 without vernier in glass case................ 18.95
No. CV-1513 .0015 with vernier in glass case 20.60
Note—Any of the above vernier condensers are admirably adapted for radiophone work.

Condensers (Variable)

No. C-1 Connecticut .001 Mfd. mounted $6.50
No. C-2 Connecticut .001 Mfd. panel mounting 6.50
No. 1 Chelsea .0012 Mfd. mounted .. 5.00
No. 2 Chelsea .0012 Mfd. unmounted 4.75
No. 3 Chelsea .0006 Mfd. mounted.. 4.50
No. 4 Chelsea .0006 Mfd. unmounted 4.25
No. 5 Chelsea dial 1/4" or 3/16" shaft 180°, pure bakelite 1.00

Condensers (Fixed mica type)

No. ROCC Grebe .0002 Mfd.........$1.00
No. ROCD Grebe .0005 Mfd......... 1.20
No. ROCE Grebe .001 Mfd.......... 1.60
No. ROCF Grebe .005 Mfd.......... 3.80
No. ROCA Grebe .0002 Mfd. and .5 megohm leak 1.20
No. ROCB Grebe .0002 Mfd. and 3 megohm leak 1.20

Condensers (Low voltage)

No. ES-355 1 MF 500 Volts........$1.25
No. ES-356 2 MF 500 Volts........ 1.25
No. 21AA Western Elec. 1 Mf. 1000 V AC 2.50

Weston Meters (Model 301)

O-100 Milli-Amps flush $8.50
O-300 Milli-Amps flush 8.50
O-500 Milli-Amps flush 8.50
O-1 Ampere flush 8.50
O-3 Ampere flush 8.50
O-5 Ampere flush 8.50
O-50 Volts flush 8.50
O-500 Volts flush 21.25

Hot Wire Meters (Flush or front Mtg)

No. 127 Gen. Radio 1/2 ampere....$7.75
No. 127 Gen. Radio 1 ampere.... 7.75
No. 127 Gen. Radio 2 1/2 ampere.... 7.75
No. 127 Gen. Radio 5 ampere.... 7.75
No. 127 Gen. Radio 10 ampere.... 7.75

Regenerative Receivers

No. CR-2 Grebe 175-680 meters....$51.00
No. CR-3 Grebe "Relay Special" 175-680 meters 65.00
No. CR-3A Grebe with tube control 175-375 meters 45.50
No. CR-5 Grebe's "Super-special" 175-3000 meters. Tube control self contained. Ideal for jewelers 80.00
No. CR-6 Grebe 175-680 meters, Detector and two step amplifier self contained, a complete set $200.00
No. CR-7 Grebe 500-20000 meters "Long Wave special," complete set 210.00

Telephones

Baldwins Type C Navy Standard ..16.50
Baldwins Type E "Super-Sensitive" 20.00
Baldwins Type F Very small, light 21.00
Brandes "Superiors" New Headband 8.00
Brandes "Transatlantics" New Headband 12.00
Brandes "Navy Type" New Headband 14.00
No. CW-834 Western Elec. 2200 ohms 14.00

Magnavoxes

Type R-3 Magnavox loud speaker latest model just out..........$45.00
Magnavox Radiophone hand transmitter 25.50
Magnavox Radiophone transmitter tone-arm 37.50

Vacuum Tubes

No. UV-200 Radiotron (Detector) ...$5.00
No. UV-201 Radiotron (Amplifier).. 6.50
No. UV-202 Radiotron 5 Watt Transmitter 8.00
No. UV-203 Radiotron 50 Watt transmitter 30.00
No. UV-204 Radiotron 250 Watt transmitter 110.00
(Radiotrons always in stock. Send US your orders)

Transformers (Transmitting)

No. P-1 Thordarson 250 Watt Type "R" $14.00
No. P-2 Thordarson 500 Watt Type "R" 22.00
No. F-1 Acme 500 Watt with bakelite panel completely mounted. 30.00

Condensers (Transmitting Dubilier)

No. D-100 250W, 10000 V, .007 Mf.$19.00
No. D-101 500W, 14000 V, .007 Mf. 30.00
No. D-102 1000W, 21000 V, .007 Mf. 45.00
No. D-103 1000W, 25000 V, .007 Mf. 50.00

Rotary Gaps

No. 443 Murdock 4000 RPM $18.50
No. 124 Klitzen Latest Model 25.00
No. B-1 Benwood, Bakelite model.. 25.00

Rotors

No. 443 Murdock, 3/16, 1/4 or 5/16" shaft.$3.00
No. T-1 Thordarson, 8 or 16 point.. 5.00
No. B-1 Benwood, Original 8, 10 or 14 point 8.00
No. H-1 Hyrad, 10 point, 9ZN type. 9.95

Oscillation Transformers

No. T-1 Thordarson "Special" $10.00
No. TXL-100A International, Ideal for 1/2 K.W. sets, splendid value 14.95
No. Z-652 Clapp Eastham, large, 1 K. W. size, very efficient 17.50

C. W. Inductances (Phone Work)

Type 181 Tuska $7.50
Type 181 Tuska knockdown 5.00
Type 182 Tuska (magnetic type) ..10.00
Type 183 Tuska (Tickler type) 12.50
Type 170 Tuska Filter 16.00

C. W. Transformers (Phone Work)

Acme 200 Watt mounted $20.00
Acme 200 Watt unmounted 16.00
Acme 50 Watt mounted 15.00
Acme 50 Watt unmounted 12.00

Choke Coils (Phone Work)

Acme 1 1/2 Henry 500 MA double coil.$8.00
Acme 1 1/2 Henry 500 MA single coil. 6.00
Acme 1 1/2 Henry 150 MA double coil. 6.00
Acme 1 1/2 Henry 150 MA single coil. 4.00

Resistances (Phone Work)

No. 1 Ward Leonard 5000 ohms....$2.25
No. 2 Ward Leonard 10000 ohms... 3.50

Telephone Transmitters

No. 329-W Western Electric $4.25
No. 5175-A Connecticut 4.25
No. 5176-A Connecticut with short adj. arm 5.25

Variometers

No. M-1 Murdock, complete with knob, dial and panel $7.50
No. M-2 Murdock, Vario-coupler complete with knob, dial and panel. 8.50
No. ZRV Clapp-Eastham Variometer complete with dial 6.50
No. ZRU Clapp-Eastham Vario-coupler, complete with dial 7.50

"Let 'PITTSCO' products, super-service and delivery solve your Radio problems"

SEND US YOUR ORDERS TODAY!

Send ten cents in stamps for Catalog No. 22. Over 100 pages, over 150 illustrations, over 600 items.

"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.**

overcome this, use an additional stage in the amplifier.

Q. 4. What effect will the hill have on the transmitting range of station?

Ans. 4. The hill, if containing much metal, will absorb some of the radiated energy.

* * *

J. J. H., Steamer "Maskinonge."

Q. 1. Referring to Bucher's "Wireless Experimenter's Manual," diagram No. 212, page 264, would you kindly advise me if this telephone transmitter would work on a plate voltage of 110 volts D. C.

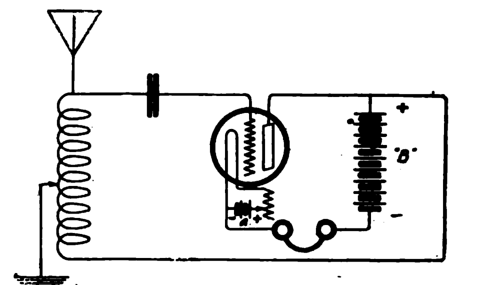
Ans. 1. This transmitter will work on 110 volts D. C., but you will not get the distance out of it that would be possible if you used a higher voltage. It should, however, easily transmit 10 miles.

* * *

D. H. F., Philadelphia, Pa.

Q. 1. Will you please give me a detector hook-up, using the following instruments: Primary coil of a 5,000-meter coupler, fixed condenser, vacuum tube, grid condenser, filament rheostat, phones, B battery and A battery.

Ans. 1. Here is your hook-up:



S. M. S., Seattle, Wash.

Q. 1. In the February, 1921, issue of your magazine (page 31), there is an article on tapped inductances. The last paragraph of this article contains the following statement: "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 question I want to ask is how to find the number of turns for each inductance value. I am familiar with logarithms, but I cannot find any formula for the above calculation. If there is any, could you give it, and, if not, would you please tell me some way of figuring it out?

Ans. 1. The formula required is given in the article on page 31.

* * *

F. O., New York City.

Q. 1. As per your descriptive article on page 23, April issue, can I find out if the receiver, as described, can be made up by an amateur without infringing on any patents? Where could the parts be secured? Can I secure further dimensions of the bank wound inductance?

Ans. 1. This circuit is patented and unless special arrangements are made it cannot be duplicated. We are therefore unable to give you the data requested.

* * *

L. C. H., Atlantic City, N. J.

Q. 1. My April issue of WIRELESS AGE shows a very fine article on the Grebe set, pages 23 and 24. Would you kindly let me know the dimensions of the bank wound section 12 and the detailed action of the inductance. If you will kindly send me this information, I will complete the set in a short time and send you a picture of sets made from your WIRELESS AGE. I think that the sets are nothing to be ashamed of for amateur work.

Ans. 1. Same as F. O., New York City.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of the Wireless Age, published monthly at New York, for April 1, 1921.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared J. A. White, who, having been duly sworn according to law, deposes and says that he is the editor of the Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation) etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Wireless Press, Inc., 326 Broadway, New York City.

Editor, J. Andrew White, 326 Broadway, New York City.

Managing Editor, none.

Business Manager, J. D. Conmee, 326 Broadway, New York City.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock).

Wireless Press, Inc., 326 Broadway, New York City.

E. J. Nally (850 shares), 233 Broadway, New York City.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustee or in any other fiduciary in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

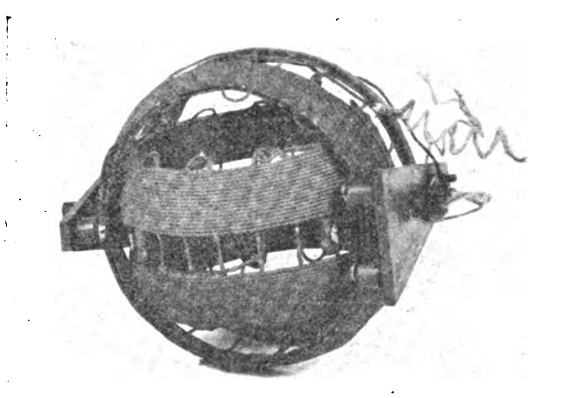
J. ANDREW WHITE.

Sworn to and subscribed before me this 16th day of March, 1921.

M. H. PAYNE.

(My commission expires March 30, 1922.)

THEY ARE BETTER AND CHEAPER



Patent applied for

The users of the HURADIO VARIOMETERS are getting the results.
We guarantee them to satisfy any Radio Man.
For bringing in C.W. and Radio Telephone Signals they are without a Peer.
Try a set of them. Money back if they do not satisfy you.

Electrically Perfect
No Distributed Capacity
Mechanically Perfect

HURADIO VARIOMETERS, without knob or dial $5.50 each
Vario-couplers, without knob or dial ....$5.50 each

We have a PUNCTURE PROOF CONDENSER for filtering purposes which is *guaranteed* to stand up, not "blow up." Has a lower power factor loss, will smooth out the ripples on your rectified A. C.; will reduce your generator hum to a minimum.

Your first cost the only cost; we guarantee them and will replace or refund your money if they are not satisfactory to you.

2 MFD	Guaranteed	1000 V.	250 Watts	$ 5.00 Each
5 MFD	"	1000 V.	500 "	$10.00 "
2 MFD	"	2500 V.	500 "	$15.00 "

Other sizes and capacities, quoted on application.

Radiolectric Shop, 919 Huron Rd., Cleveland, Ohio

D-L INDUCTANCE COILS 1-2 PRICE

Order Now. Best Coils Given Out First. All Are Good.
Some Slightly Shop Worn

They are unmounted, and cover the wave lengths, as follows:

D-L-25,	130-375	70c
D-L-35,	180-515	73c
D-L-50,	240-730	76c
D-L-75,	330-1030	80c
D-L-100,	450-1460	85c
D-L-150,	660-2200	90c
D-L-200,	930-2850	95c
D-L-250,	1300-4000	$1.00
D-L-300,	1550-4800	1.05
D-L-400,	2050-6300	1.13
D-L-500,	3000-8500	1.20
D-L-600,	4000-12000	1.33
D-L-750,	5000-15000	1.40
D-L-1000,	6200-19000	1.50
D-L-1250,	7000-21000	1.63
D-L-1500,	1200-25000	1.80

All parts for the amateur and anything in Radio we have

AMERICAN ELECTRO TECHNICAL APPLIANCE CO.
235 Fulton Street New York, N. Y.

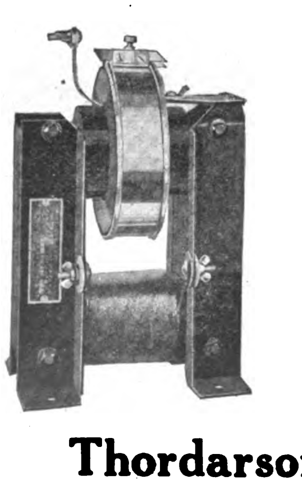
Our catalogue contains 24 pages, not 84 as previously stated

An Addition to the

THORDARSON ["GOLD MEDAL"] LINE

Type "RS"

TRANSFORMER



¼ K.V.A	8,000 volts	$15.00
½ "	10,000 "	20.00
1 "	15,000 "	30.00

Transformers, Oscillation Transformers, Condensers, Spark Gap Rotors

Thordarson Electric Mfg. Co.
511 South Jefferson St. CHICAGO

SMALL ADS OF BIG INTEREST

A MEETING PLACE FOR BUYERS AND SELLERS

Space in this department costs only 30 cents a line. Minimum space eight lines. Payable in advance.

WANTED—An A1 Radio Operator as head instructor in Radio School. A college graduate with some trading experience preferred. Address Box I, c-o *Wireless Age*, N. Y.

SPECIAL GARAGE MOTORS—Manufactured by the General Electric Co. 1 H. P. $78.50; 2 H. P. $110.00; 3 H. P. $128.50; 5 H. P. $166.50. All sizes both single and Polyphase Motors for immediate delivery. Special charging generators, all voltages. Write for catalog. Motor Sales Dept., 8 West End, Pittsburgh, Pa.

AUTO MOTORS SUPPLIES—Buick, Michigan, Stoddard-Dayton, E. M. F., Cadillac, Overland, Continental and Buda Motors. All types, $50.00 each and up. New Dixie Magnetos $20.00 Splitdorf High Tension Magnetos $10.00. Kellogg Pumps $3.50. Auto-Lite Generators, new, $10.00. Air Gauges 65c. Remy Ignition Coils, new, $3.00. Electric and gas headlamps, coils, distributor heads, air compressors, etc. Write for catalog. Motor Sales Dept., 8 West End, Pittsburgh, Pa.

FOR SALE—MODERN DUPLICATE U. S. NAVY RECEIVER. NEW, CAPABLE OF RECEIVING SIGNALS 7,000 METERS; REASONABLE. WHAT IS YOUR PRICE? S.O.S., 600 TRIBUNE.

WANTED—Experienced amateur operators east of Chicago having or who can rig up for long wave up to 4000 meter receiving apparatus with 2-stage audio-frequency-amplifier, vacuum tube detector, 2 storage batteries A & B. Address G. F. Von Kummer, 116 Nassau Street, New York.

PORTABLE BATTERY CHARGERS for Wireless operators, Car Owners, Garages, etc. Average recharge cost ten cents. Price fifteen dollars and up. Attaches to lamp socket. Operates unattended. Weight 10 lbs. Rotary Rectifiers for Battery Stations, Bul. 8, Harkleroad Company, 2204 So. Michigan Avenue, Chicago, Illinois.

UNMOUNTED LONG DISTANCE RECEIVING INDUCTANCES. These are duo lateral wound coils, each tapped at five points. Two coils with a tickler make an unbeatable receiving combination. Range 2500 to 25000 meters, Arlington to Lafayette. Prices: Primary and Secondary Coils $3.50 each; Tickler Coil $2.00. Send $9.00 for the three coils and diagram, and make a guaranteed receiving set. P. J. Stockwell, Reading, Massachusetts.

"STOP! LOOK! and ACT!"

With every Radio Magnavox purchased from us we are giving absolutely free one new standard Radiotron pliotron V.T. amplifier UV201, $6.50, or one Navy Type A-P V.T. amplifier, $7.00 This Radio Magnavox is the latest development of the Magnavox Company. This new loud speaker gives forth the same volume of sound as the older model at about half the price. Signals may be heard all over the house, permitting a watch without head receivers, and with suitable amplification speech or music may be amplified to such a degree as to be loud enough for dancing. Price $45.00. This offer expires June 30. Besides this generous offer, we also furnish free with all makes of vacuum tubes, detectors, amplifiers and power tubes, the latest type of the Remler bakelite rheostat of suitable capacity, or Clapp-Eastham panel mounting rheostat with enameled resistance wire wound on 180° bakelite form. Radiotron V.T Detector UV200, $5.00; Radiotron UV201 pliotron amplifier, $6.50; Radiotron 5-watt power tube UV202, $8.00; Radiotron UV203 50-watt power tube, $30.00; Radiotron UV250 watt power tubes, $110.00; A-P V.T. Detectors, $6.00; A-P V.T. navy amplifier, $7.00 A-P transmitting tubes, $7.50. Only new and high grade radio apparatus carried in stock. "Remember us." The Kehler Radio Laboratories, Dept. 6, Abilene, Kansas.

22½ Volt Batteries

NOVO MANUFACTURING CO.

424 West 33d Street, New York, N. Y. — 531 So. Dearborn St., Chicago, Ill.

RADIO AND MODEL ENGINEERING

Edited by M. B. Sleeper

A Bulletin of designs and data for the Radio Experimenter of average means and shop equipment.

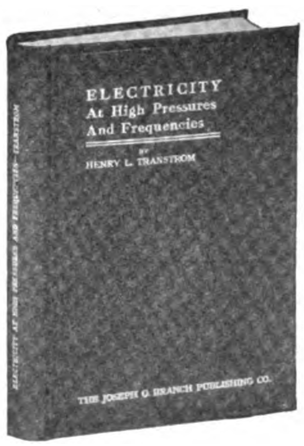
Out on the first of each month. Send twenty-five cents for the May, June and July issues.

Published by

The General Apparatus Co., Inc.
570-D West 184th St. - New York

Spectacular Tesla Experiments

HIGH FREQUENCY CURRENTS



SECOND EDITION

A FASCINATING BOOK THAT EVERY EXPERIMENTER NEEDS

The Book itself is well written, explaining all the fundamentals of high frequency currents, devoid of any obstruse mathematics and technicalities which would only hamper the average student.

Printed in large type, 266 pages, 141 original illustrations, bound in stiff paper, $2.50, postpaid; or in cloth, $3.00, postpaid.

Order Your Copy Today

The Joseph G. Branch Publishing Co.
3800 Lake Park Avenue, Chicago, Ill.

MESCO RADIO BUZZER

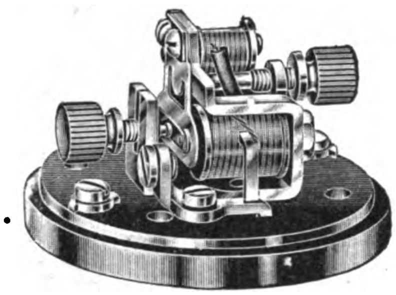


Illustration Shows Buzzer With Metal Cap Off

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 3.9 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type. All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensite base to insure constancy in operation.

This buzzer is also made to operate on a 6-volt direct current, a feature making it valuable for communication and other purposes where a 6-volt current is available. It has also been approved by the U. S. Government.

Diameter 2 in., height 1¼ in. The cap is attached to the base by a bayonet joint.

List No.		Price
55	Mesco Radio Buzzer operating on 1.5V	$2.50

WIRELESS MANUAL N12

You should have it even if only superficially interested. Around about you every day you read of some marvelous occurrence in which wireless played a distinguished part. It may not be entirely clear to you. The Manual will explain it. To the student of Wireless Telegraphy, the Manual contains much that is indispensable to a proper understanding of the art.

It contains 200 pages, fully illustrating and describing the many instruments used in Radio. 45 pages cover general instructions, diagrams, station calls, tables, codes and other information.

The book is printed on highly finished paper with a two-color cover and measures 9 x 5¾ inches.

Containing as it does a fund of valuable information not generally contained in a catalogue, it approaches nearer a text book in the fascinating field of wireless telegraphy. No expense has been spared to make it accurate and reliable.

No Wireless Experimenter Should be Without the Mesco Wireless Manual. We ask 25 cents (25c) for it—give you a coupon receipt which can be applied on any future order. Send your name and address now, and get one of the most complete, comprehensive and reliable wireless books published.

MANHATTAN ELECTRICAL SUPPLY CO. INC.

17 Park Place, New York — 114 S. Wells St., Chicago — 1106 Pine St., St. Louis — 604 Mission St., San Francisco

RADIO CORPORATION

STANDARD GRID LEAKS

(24 Different Resistance Values)
100,000 ohms to 6 megohms

PRICES

Grid Leak and mounting as shown $1.25
Grid Leak Units any value ...... .75
Mounting ...... .50

FREE

Write today for our special bulletin on the use of grid leaks in radio circuits.

The Radio Corporation's Grid Leaks are accepted as the standard of Radio Laboratories throughout the United States. Every radio experimenter using vacuum tubes for reception needs one. Permanence and reliability are the outstanding features. See your dealer or write direct to

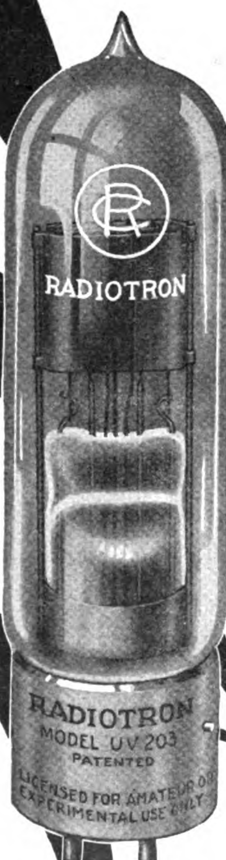
SALES DIVISION, COMMERCIAL DEPARTMENT, SUITE 1801.

RADIO CORPORATION OF AMERICA
233 BROADWAY - - - - NEW YORK CITY

When writing to advertisers please mention THE WIRELESS AGE

RADIOTRON TRANSMISSION

Summertime Transmission



AMATEURS, prepare for Summertime transmission. Do not let static interrupt your relay schedule—Do it the C. W. way.

Three highly efficient power tubes for C. W. transmission are now available to all amateurs and experimenters.

Radiotron U. V. 202 is well suited for low and medium power C. W. or I. C. W. transmission. It is rated at 5 watts; requires 7.5 volts at 2.35 amperes for the filament, and 350 volts at .045 ampere for the plate. The price of this tube is $8.00.

Radiotron U. V. 203 which is rated at 50 watts is the ideal tube for long distance relaying. The filament requires 10 volts at 6.5 amperes while the normal plate voltage is 1000 at .15 ampere.

Radiotron U. V. 204 is a 250 watt tube of exceptional capabilities. Filament requires 11 volts at 14.75 amperes and the plate circuit requires 2000 volts at .25 ampere. Unusually effective for laboratory and general experimental work.

Several thousand Radiotron Power tubes are now in use at amateur stations throughout the United States.

Radiotron
U. V. 203
50 Watts

Price
$30.00

Special Socket
for this Tube
$4.25 Each

End Mountings
for this Tube
$2.00 Per Pair

Radiotron
U. V. 204
250 Watts

Price
$110.00

The Radio Corporation's tubes are covered by patents dated November 7th, 1905, January 15th, 1907, and February 18th, 1908, as well as by other patents issued and pending. Tubes licensed for amateur and experimental use only. Any other use will constitute an infringement.

For detailed data see your nearest dealer or write direct to
SALES DIVISION, COMMERCIAL DEPARTMENT, Suite 1801

Radio Corporation of America

WORLD WIDE WIRELESS

233 BROADWAY ~ NEW YORK CITY