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The WIRELESS AGE

Volume 8 Number 1

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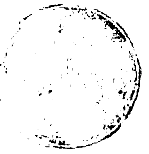


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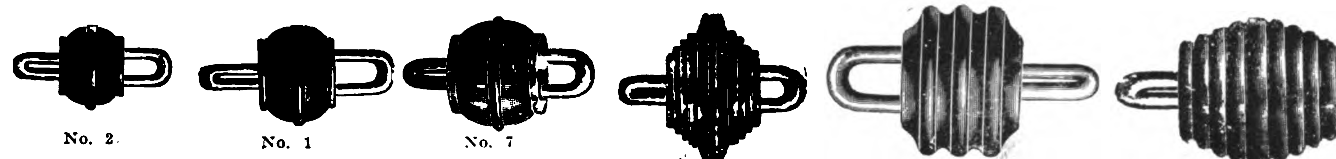

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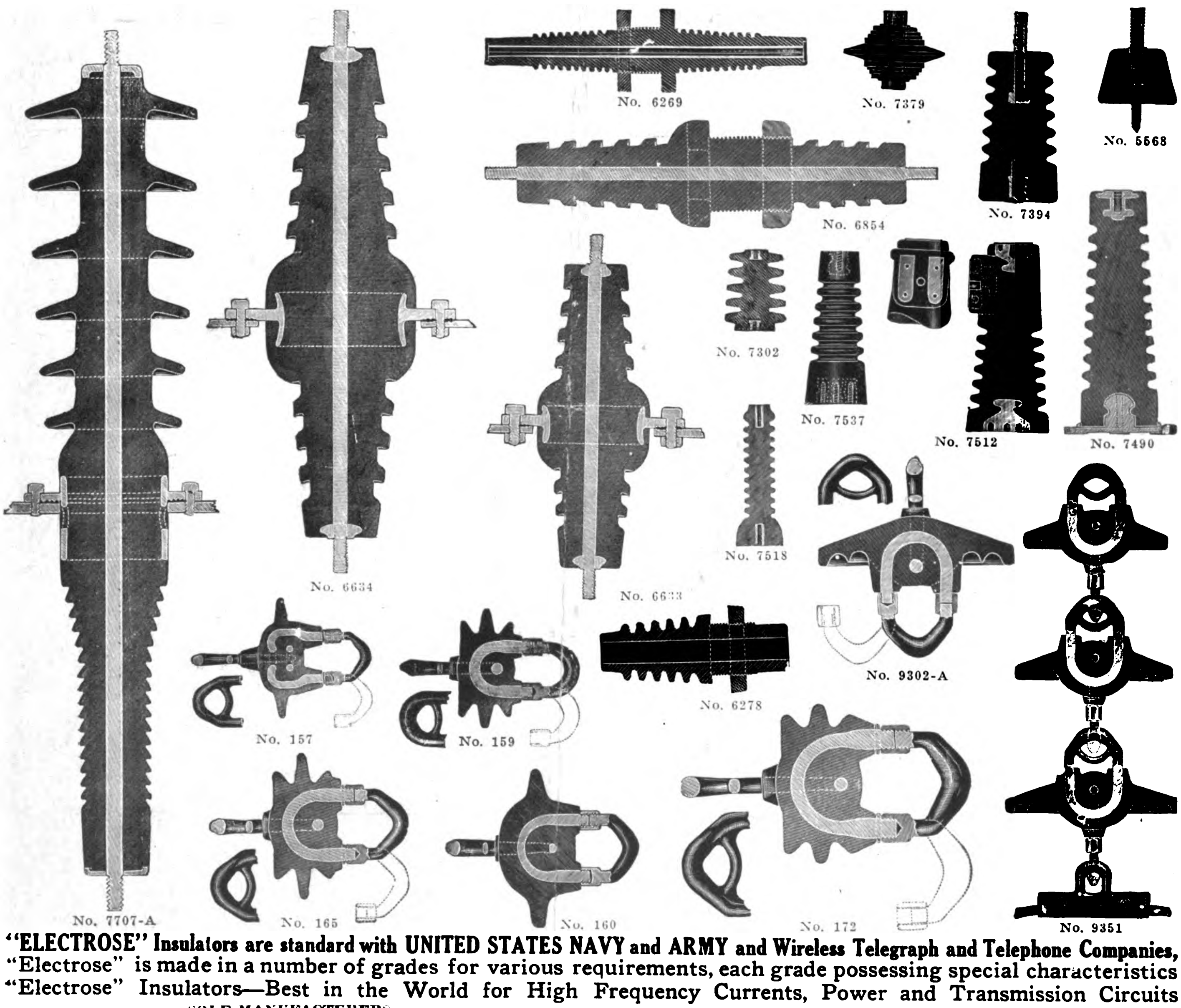

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Edited by J. ANDREW WHITE

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Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

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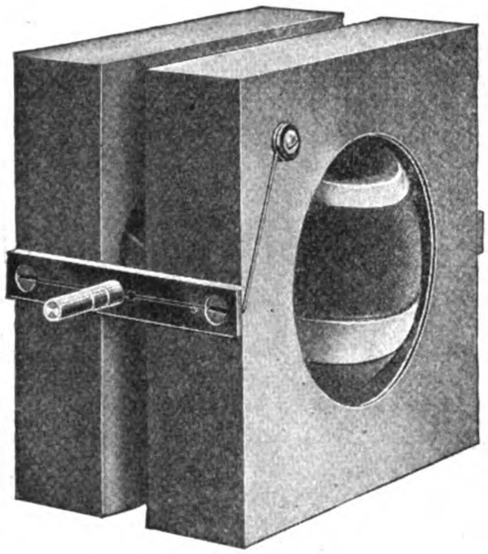

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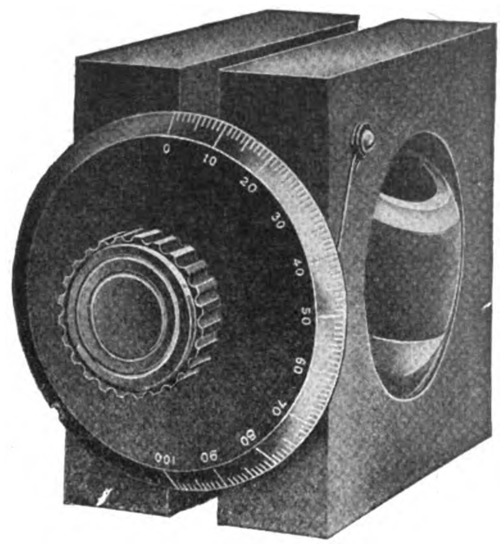

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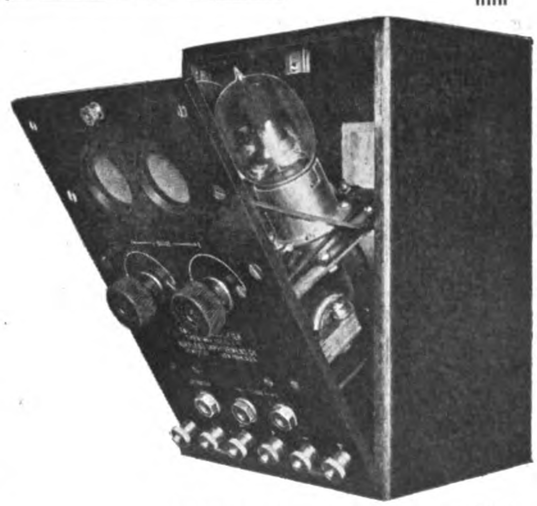

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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 8)

Vol. 8. No. 1. OCTOBER, 1920

THE WIRELESS AGE

296242

WORLD WIDE WIRELESS

Wide Expansion of Trans-Ocean Wireless Assured

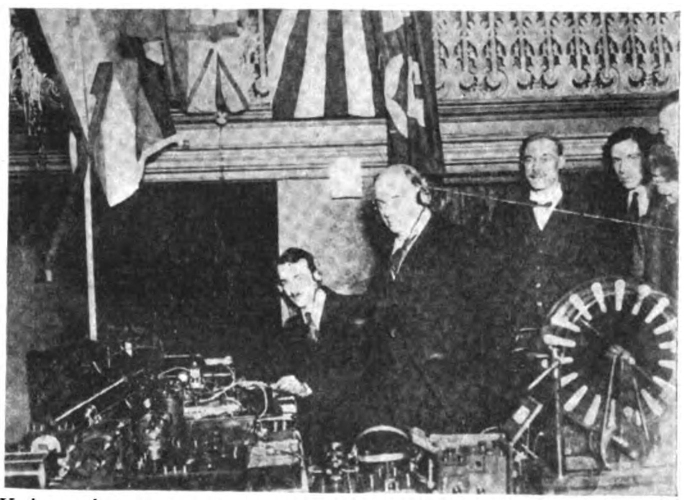
OF major importance in perfecting the world-wide extension of radio communication are recent arrangements consummated by the Radio Corporation of America, through its president, Edward J. Nally, who returned from a European trip on September 6th. He visited England, France, Germany, Belgium, Norway, Sweden, Denmark and Poland, holding a series of conferences with representatives of all the important wireless interests and the Government officials concerned with radio in the several countries.

Mr. Nally announces that long term traffic agreements were made for communication with England, France and Germany. Commercial arrangements affecting the future operation of the existing and highly satisfactory trans-ocean service to Norway were also perfected. Another agreement was made for a new service to be created by a special arrangement made in France through which provisional communication will be maintained between the Bordeaux or Lyons stations and the Radio Corporation's station at Tuckerton, N. J. Rehabilitation of the American station has already begun; Alexanderson alternators will be installed, the antennae will be greatly extended and a power line constructed for current supply from Atlantic City. Tuckerton will be connected by wire line with the main operating office in New York City and will be used solely for transmitting; the station at Belmar, N. J., will receive the messages from France. Later, this branch of overseas communication will be concentrated in the New York Radio Central Station, now being erected on Long Island, one of the five units of this gigantic station being allocated to France to maintain communication with a new super-high power station which is being constructed in the vicinity of Paris.

Other high powered installations are to be made in stations located in Denmark, Sweden, Belgium and Poland. In the existing British trans-oceanic station in Wales, which maintains communication with Belmar and New Brunswick, powerful Alexanderson alternators and new antennae will be installed, equipping the plant for operation on continuous wave and greatly increasing its message capacity. Marconi's Wireless Telegraph Co., Ltd., will also construct an overseas high power station for communication between England and South America in conjunction with the group of trans-oceanic plants which the Radio Corporation of America will erect in the vicinity of Buenos Aires for communication with New York.

The arrangement made with Germany for the exchange of commercial messages takes the form of a long term contract with Dr. Bredow, Director of the Ministry of Posts and Telegraphs, which will become operative immediately with the proclamation from the United States of peace with Germany. Meanwhile the messages which heretofore have been handled by the naval station at Annapolis will be transmitted by the Marion, Mass., station of the Radio Corporation.

Dr. Bredow has issued an official statement on the Radio Corporation's contract, announcing it a formal communication license and offsetting published reports that other radio interests in the United States had obtained concessions in the form of traffic agreements. The German Ministerial Director says of the agreement with the Radio Corporation: "The opening of this new connection is of the greatest importance to Germany, as now for the first time since 1914, it becomes possible to exchange telegrams free from London control, not only with North America, but also with Central America, South America, Japan and China." Noting that before the war 7,600,000 words per year were handled over the two German cable connections with North America and these, together with one cable connection with South America, were hardly sufficient for the traffic, Dr. Bredow states that an independent means of wireless communica-



Underwood

Listening to a wireless message from Africa at the trade exhibition held at Beckham, England.

tion was desired and that the new American radio connections made will contribute greatly to the development of commercial relations between the two countries. This observation is also included: "Tests were made between Nauen and Marion in order to determine the speed and reliability with which service could be carried on between these two most powerful stations of the old and the new world. These tests demonstrated the possibility of working duplex with high speed." He speaks then of the negotiations with the Radio Corporation and the necessity of obtaining formal permission from the German Government before starting its service, for which purpose Mr. Nally went to Berlin, "with the result that the American Company will be formally licensed to communicate with Germany on the day of the termination of the state of war between Germany and the United States. Until such time," Dr. Bredow concludes, "the traffic will be handled, without special arrangements, as it has been with the American naval station."

The Radio Corporation of America announces that the service is now in operation and commercial communication between the Marion and Nauen stations is being carried out with great success.

Dual System of Radio on Pacific Ships

COMBINATION sets of wireless telephone and telegraph instruments will be installed shortly on a number of steamships having contracts with the Radio Corporation of America. This will be a step far in advance of anything previously attempted in the line of communication covering freight and passenger service.

The first combination sets probably will be set up on the vessels of the Admiral line, and the Standard Oil and McCormick Company vessels also are in the list of those to receive the combination service.

Radio Cable to Pilot Ships

A SUCCESSFUL preliminary test of the radio piloting cable laid in the Ambrose Channel approach to New York Harbor as a means of piloting vessels to the harbor in foggy weather has been announced by the Navy Department. The test was made with the navy tug Algorma, which navigated the sixteen-mile stretch from the Ambrose Channel Lightship to the Narrows entirely on the bearing received from the electrical waves emanating from the cable.

An armored cable was used in the experiment, thereby overcoming the chief difficulty heretofore experienced of the cable being injured from time to time by anchors of small vessels dragging over it.

When the department has decided on the best type of receiving apparatus for the system, it was said, it is planned to give a public demonstration with a destroyer, for the benefit of shipping interests. The department believes the great possibilities of the system in adding to the safety of navigating harbors in thick weather have been proved by recent tests.

In brief, the principle of the radio pilot cable, as it is called, is to employ a cable through which flows alternating current. Ships intending to use the cable while passing in or out of waterways are provided with a pair of coils which intercept the electromagnetic waves emanating from the cable. By noting the relative strength of the waves reaching each coil, it is possible for the ship's navigator to determine when he is astride the cable. Once riding astride the cable, it is relatively easy to follow it along and thus steer a correct course.

In the New York Harbor installation, which follows the Ambrose Channel the cable consists of seven strands of No. 16 tinned copper wire insulated with a layer of 30 per cent. Para rubber 3/16-inch thick, over which is wrapped a layer of tape and jute, impregnated with a water-proof insulating compound. Over this layer of jute is an armor which consists of a wrapping of No. 12 galvanized steel wire. The overall diameter of this cable is approximately one inch. Some 87,000 feet of cable is required.

There are two anchors secured to the extreme end of the cable and only one anchor is used at each of the three other points along the cable.

A one-kilowatt motor-generator is used for supplying 500-cycle alternating current to the cable. The voltage may be either 125 or 250 volts. Provision is made for driving this generator from local source of current supply so as to maintain the motor-generator set at a constant speed. It is obvious that a fluctuation in the speed of the generator results in a change of note, which is apt to cause much confusion when using the cable. The amount of current flowing in the cable will be under control at all times and will range from one to eight amperes. A telegraph key is installed for the purpose of breaking the cable current in order to transmit signals; in fact, an automatic sending apparatus may be installed so as to send out given signals over and over again when necessary.

The receiving end aboard ship is quite simple. Two coils are required, each four feet square and wound with 400 turns of No. 24 S.C.C. copper magnet wire. Care should be exercised in making these coils so that each coil will have the same resistance and inductance values. Much depends upon this precaution as the signal strength received by each coil is the function of the resistance of each coil, and should their resistance be different, a signal strength of different intensity will be received by each coil when at the same distance from the cable. The best shape for the coils is the pancake. The wire can be wound in pancake form four feet square, with a winding space of one inch. The coils are impregnated in paraffin and then placed in wooden boxes with more paraffin in order to protect them from abrasion.

The coils should be placed over the side of the ship approximately amidship, one coil on one side and the other coil on the opposite side, below the surface of the water or slightly above the water line.

Big Companies Agree on Extension of Radio

SOME of the most important recent inventions, which make possible trans-continental telephoning, wireless telephoning at great distances, the transmission of words of command or public addresses by the loud-speaking telephone and the multiplex use of one wire, are licensed by an arrangement between the American Telephone and Telegraph Company, the General Electric Company and the Radio Corporation of America.

The arrangement was made at the suggestion of the Bureau of Steam Engineering of the United States Navy, which pointed out the commercial advantages of the combined use of these patents and the improved field for invention and development which such an arrangement would create.

The statement, which was made public by H. B. Thayer, President of the American Telephone and Telegraph Company, was as follows:

In January of this year both companies received letters from the Bureau of Steam Engineering of the United States Navy Department, referring to the wireless situation, and saying the bureau has consistently held the point of view that the public interest shall be best served by some agreement between the several holders of pertinent patents whereby the market can be freely supplied. The letter also urges the necessity of some such arrangement so that ships at sea can get the benefit of the latest devices, which would contribute to their safety and the safety of their passengers. The bureau states further:

In the past the reasons for desiring some arrangement have been largely because of monetary considerations.

Now, the situation has become such that it is a public necessity that such arrangement be made without further delay, and this letter may be considered as an appeal—for the good of the public—for a remedy to the situation.

Following this, negotiations were commenced between the two companies with a view to the exchange of licenses so that the General Electric Company and the Radio Corporation of America, with which it had become interested, would be able to further the development of the art of radio transmission and especially of wireless telegraphy, and the American Telephone and Telegraph Company could employ in its present nation-wide system such radio apparatus as is adaptable to wire transmission and, further, could supplement its wire system with wireless extensions where particularly adaptable as between shore and ships at sea.

Much has been done in radio communication by all parties of interest which can be made fully effective in the public service only by this co-operation of the several companies.

The worldwide wireless system of the Radio Corporation and the universal service of the Bell System are thus brought into a harmonious relation that will facilitate the use by the public of the present wireless telegraph facilities of the Radio Corporation, and, as the art advances, will enable the American Telephone and Telegraph Company to extend its telephone service to ships at sea and to foreign countries.

The public interest lies in the fact that by exchange of licenses, as suggested by the Government, the patents of each company will be utilized to greater advantage and the progress of the art of electrical transmission and communication will be accelerated in America as in no other country.

Radio Message Circles the Earth

SIGNALS from the new Lafayette wireless station in France were received Aug. 21, at the Otter Cliffs naval radio station, Bar Harbor. It was the first transatlantic test of the French station, which is one of the most powerful in the world with a sending radius of 12,000 miles. Operators at Otter Cliffs said the signals were excellent.

Although the Lafayette station was started and built by the American navy, it will be turned over to the French Government as soon as tests of it are completed. The station has eight towers, each 820 feet high. Tests already made show its audibility is five times that of the great German station at Nauen.

The first message sent out by the new station was:

This is the first wireless message to be heard around the world and marks a milestone on the road of scientific achievement.

In a radio message of reply Secretary Daniels said:

Congratulations upon the successful completion of the gigantic radio station named for that distinguished Frenchman whom all Americans honor. Designed to serve a military purpose, it will now serve to bind closer the cordial relations which have always existed between France and the United States.

In behalf of the United States I desire to express my pleasure upon the achievement of the Lafayette radio station in transmitting the first message to be heard around the world. We are happy to recognize in this powerful signal a symbol of that force and sympathetic understanding with which the voice of France shall be heard by its sister Republic.

Radio Prevents Aviation Accident

UNKNOWINGLY demolishing part of their landing gear while taking off at Kelly Field Lieuts. James G. Haizlip and Hickey flew to McAllen and would in all probability have crashed in attempting to land if a mechanic at Kelly Field had not seen the accident and telegraphed to McAllen telling officers there of the mishap. In the meantime the fliers were headed for McAllen not knowing that the left wheel was lying on Kelly Field.

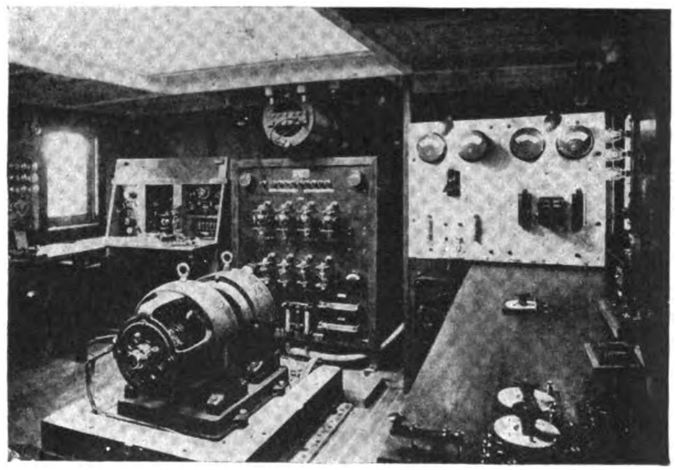
Officers at McAllen went out on the field and when they saw the ship coming they signalled with rockets to stay in the air and while the ship circled overhead the radio operator at McAllen got into wireless communication with the pilot and told him that he was without a left wheel on his landing gear.

With this knowledge he was able to land without serious mishap by swerving the machine as much as possible and landing on one wheel and slowing up enough so that the sudden stop would not wreck the ship.

Chinese Radio Station Opened at Pekin

FORMAL announcement has been made that the Government wireless station at the Temple of Heaven, Pekin, is open for service and that all telegraph offices in Pekin will accept radiograms at the same rate as those charged for land messages for transmission to Kalgan, Wuchang, Woosung, Shanghai and Foochow. Special rates apply to radiograms sent to ship and aviation stations, and such messages are accepted only by the central office.

The new wireless service gives Pekin improved communication with some of the most important commercial centres in China. Kalgan, Chihli Province, handles much Mongolian trade; Wuchang, Hupeh Province, is one of the Wuhan cities (the others being Hankow and Hanyang), which have a combined population of about 1,500,000; Woosung is in Kiansu Province, fifteen miles from Shanghai, where the larger ocean steamships anchor; Shanghai, the leading port of China; Foochow, Kukien Province, has a large export trade in tea.



Underwood

View of Marconi's receiving set for his new fog signal device, aboard the Electra

Radio Storm Warnings for English Ships

SHIPS at sea within range of British wireless shore stations are to be protected by warning radio signals, whenever gales of forty miles an hour threaten. Using a wave length of 600 meters (1,968 feet) at full power, the safety signal will be sent out ten times at brief intervals, followed by the warning.

Marconi's Guests Dance to Music by Radio

SENATOR WILLIAM MARCONI'S guests recently danced aboard his yacht Electra to the music of an orchestra playing in London, so distinct was the transmission by the wireless telephone upon which the inventor has been experimenting. Daily Marconi receives the latest news from London by this medium, giving in exchange Neapolitan songs by applying a phonograph to the telephone.

The inventor expects to proceed to the Adriatic Sea late this month to continue his experiments. He said he would visit Ancona, Venice and Trieste, and would like to go to Fiume if the political situation permitted.

Radio Service to Poland

THE Radio Corporation of America, announces that radio service between the United States and Poland is now in operation.

Should All (Radio) Men be Created Equal?

Discussion of a Vital Problem

Editor's Note—In the September issue, a widely experienced wireless man who has the advancement of radio at heart registered a protest at the new conditions in the commercial operators' field. Some of the responses to the Editor's invitation to readers to participate in a discussion of the subject are printed below.

RELATIVE to Mr. Jones' article in the September issue entitled, "Should All (Radio) Men be Created Equal?" I have a suggestion or two to make that may be of added interest.

Mr. Jones states in his article that he expects yells of "Murder" from those to whom it is directed. And he *has* started something! However, as he says, that matters little.

His article is directed at the class of men who are at present running the good old radio game into the ground—tourists and undeveloped youngsters.

I heartily endorse the entire article and the suggested wage scale, with the exception—or rather, addition—of one thing. Mr. Jones uses the sliding scale in reference to length of service alone and makes no provision for class of ships. There is as much difference between the duties of a radio operator on a freight ship and those of one on a Class A or B passenger ship as there is between day and night. Who is going to take a continuous watch and real work job when one can get the same money in an easier and, on the whole, pleasanter one?

The majority of freight ships carry one operator who handles a message or two occasionally, shines brightwork now and then, and has the rest of the time to himself. He has opportunities to make extra cash checking cargo, making up ships papers, and even standing a quartermaster watch or working on deck. He has long trips and longer stays in port. He has no uniforms to buy or keep up and his expenditures for clothing need be very small. Hence his entire salary can be counted net profit.

In these days, a passenger ship is a very different proposition. At the present time very few are carrying three operators, so we need concern ourselves with only those carrying two. Each operator stands twelve hours watch per day, during which he ***works***. Subtracting from the remaining time that necessary for meals and sleep, and you will see that the operators have very little time to themselves for recreation. It is necessary to have blue and white uniforms and to keep them laundered and in repair. Linen must be spotless at all times. This item amounts to real cash each month. Passenger vessels have comparatively short trips and the minimum time in port, giving operators very little time off.

At the present time operators on freight and passenger ships are receiving the same salary. This does not seem fair as most companies require freight ship experience before they will give one a job on a passenger vessel.

I would suggest using Mr. Jones' wage scale for freight ships, and for passenger vessels an advance of $25, or the following:

No second class men

1st class license—first six months	$100
1st class license—second six months	125
1st class license—third six months	135
1st class license—after two years	150
1st class license—after five years	175

Extra grade license—advance of 10% over the above for the same length of service. —LEIGH M. TOWNLEY.

I RESPECTFULLY submit the following answer to Mr. Edward T. Jones' article:

I note that he suggests that commercial operators be started with $75 per month instead of the prevailing rate of $125, so that they would have something to look forward to. I would like to ask him if he thinks $125 is such a fabulous sum that an operator would strive to succeed and remain in the service so that he would receive this ***large amount?***

No doubt he will remember that in his time when operators received $50 and $60 a month there were not many young men who were willing to study some four or five months so that they could get their first grade license. Most of them started out with their second grade license, which can be classed as an apprenticeship license.

Mr. Jones will no doubt agree with me when I state that quite a large number of young men are now in the game because of the increased wage. If this was now cut down to $75, as suggested by Mr. Jones, it would do a good deal of harm to commercial radio operating, inasmuch as it would put commercial wireless telegraphy back quite a few years. Many of the young men of today the leaving good positions to take up the radio game with an eye to the future development.

Where, may I ask, is a place where a bright young man cannot get $30 a week with a good chance for advancement?

Many of our commercial operators would be forced to abandon the game if the salary was cut down to $75. The salary they now receive is little enough as it is, and I think that this should be increased to a more substantial sum. The following scale, which gives more for experience, I think would be acceptable to all operators.

Second grade	$125
First grade	150
First grade after first year's experience	175

Also an additional $25 for the senior operator.

—WILLIAM SAFYER.

DOES Mr. Jones mean that a second grade license man is unqualified for commercial service and should be so regarded?

Should all operators receiving a Government ticket, upon entering the commercial service, receive a certain specified sum lower than standard scale, or does he mean to say in general, that a man upon receiving any kind of license is unqualified for service?

Probably Mr. Jones would say that not all, but a good percentage are unqualified—***although licensed by the U. S. Government!*** Here I agree with him, but let me inform him that any man or person who comes out with a commercial ticket (except second grade) ***is qualified*** (by the U. S. Government) to operate any station.

According to his license he is qualified for the position, but the question of finding out whether a person is *actually* qualified rests entirely with the employer. I was no expert myself—***neither were you***—when we started. All the blame, Mr. Jones states, for the present conditions rests with the employers who hire operators without first examining them to their satisfaction.

I admit that a good crowd is being let loose from schools and elsewhere who go home and memorize the Government Exam. Book from "A to Z," get a license, then they get a job. When something goes wrong with the outfit out at sea, they are stuck. Yet some of these fellows have the preference over the poor unfortunate who at the time of the code test is excited or nervous, as the case may be, and probably gets a second grade ticket.

The whole trouble has arisen because some of the fellows who are making a living out of it "crab" it all for themselves. Don't think for a minute, Mr. Jones, that I am yelling "Murder," but simply bucking those in the labor organizing game. —JAMES V. CANDIDO, I R.E.

Wireless In Forest Fire Fighting

By S. R. Winters

THE first wireless telephone outfit used this last summer in the National forests of Montana as fire-fighting equipment, was rescued from a conflagration which threatened the lookout station.

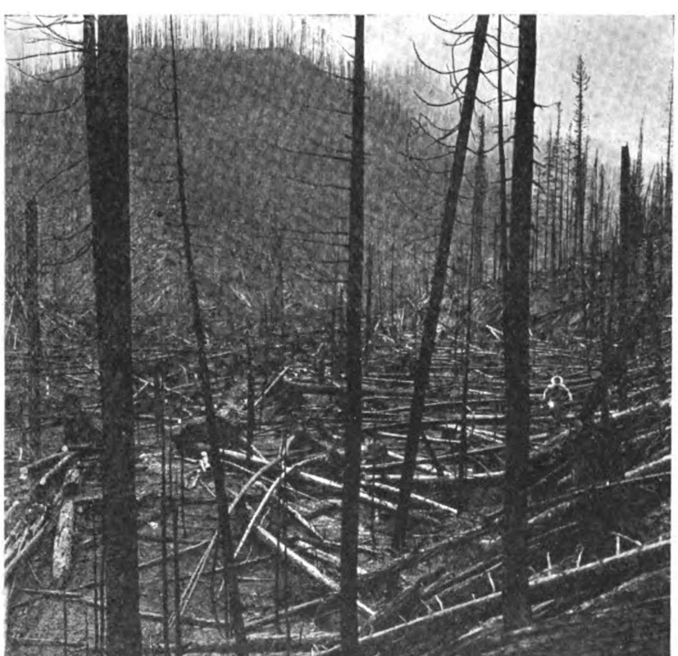
Within this incident lies a story of pioneering quite as impressive as the thrilling acts of our forefathers in conquering wild beasts and building a civilization in a wilderness. The difference in the accomplishments is in the perspective of ultimate aims; and certainly the perpetuation of inventive skill in the desolate forests is relatively as significant in the motives that prompted the venturesome efforts.

Located on Beaver Ridge, at an elevation of 8,000 feet, the lookout tower was in a menacing position from the raging forest fires surrounding the lonely habitat of the forest ranger. The wireless telephone outfit had only been recently installed — and the first thought of the rangers was not that of saving the lookout tower but to rescue the product of inventive skill. The apparatus was quickly dismantled, packed, and skidded down the mountainside to a lake. Here, not unlike the pioneer days when the birch bark canoe was a medium of the Indians in taking refuge from their pursuers, a raft was hurriedly built. The wireless equipment was put afloat and, thanks to the foresight of the forest ranger, the communicating apparatus was saved for future usefulness.

The wireless mast and lookout station used by the U. S. Forest Service in the Northwest, located on the crest of Mt. Hood, 11,250 feet above sea level

The experiments of the U. S. Forest Service with the wireless telephone as an integral part of the fire-fighting organization in Montana during the summer of 1919 have justified an expansion of the idea. Twenty-four additional wireless sets, making a total of 26 in operation, have been recently borrowed from the Navy Department and will be installed this year. Their use in forewarning outbreaks of fires will embrace all the Western States which annually are afflicted with conflagrations taking a toll of timber valued at $40,000,000.

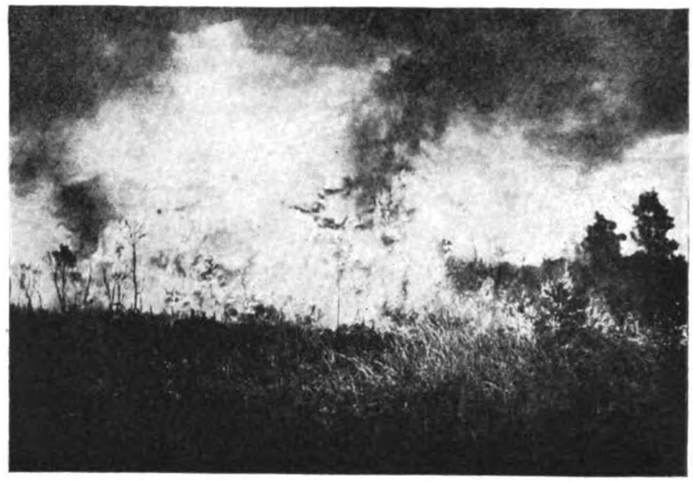
The radio telephone sets in practical use are port-



After the fire. This illustrates the damage and ruin wrought by forest fires which is now being fought by means of wireless

The type of wireless outfit rigged up in the National Forests

The automobile tourists going through forest fires which caused a great deal of damage to the timberlands in Oregon. On the road to Comstock, Ore.



Each fire, whenever it has gained head, has its own characteristics and requires generalship to combat it effectively

able, weighing only 65 pounds. Individual units have a range of 60 or 70 miles, saving a generous portion of the total of $78,000 which it would cost to meet the expense of $100 a mile for installation of telephone wires. Two wireless telephone stations having a range of 60 miles can be installed at a cost of $3,500, or less than three-fifth the expense of equipment of a telephone line over a similar distance. The wireless equipment can be operated without a highly trained personnel, raw recruits with a little instruction being able to manipulate the apparatus once it is installed.

At the isolated lookout stations, where these wireless sets are maintained, wireless messages from all coast points, ships at sea, Sitka, Alaska, and Mexico City are picked up without difficulty. A notable illustration is the receipt of a message from Admiral Rodman's flagship after the fleet had safely passed through the Panama Canal.

Universal, Honeycomb and Lattice Coils

By O. C. Roos,

FELLOW I. R. E.

(*Continued from August* Wireless Age)

It is intended in each instalment to "overlap" slightly in regard to the reiteration of basic lattice winding principles in order to save the reader the trouble of referring in detail to the previous instalment where these fundamental laws of lattice winding are introduced. As these laws have hitherto been unpublished it is believed that a good educational purpose will be served.—*Editor.*

Resume of Previous Instalments

Unsystematic practices in naming universal wound coils; proper classification; methods of hand-winding; winding chart for step-lattice coil; multi-lattice coils with one or more wires and their use in wavemeters or direction-finder loops; inductance formula; transformers with ferro-dust dielectric cores; development of lattice layer on a plane to show value of "swing-angle"; working formulas; tests to secure checks on coil constants; relations of cross-spiral and cross-step lattices; general method of designing multi-lattice coils.

Synopsis of Third Instalment

Laws governing width of coils in terms of "pitch" and "advance"; "odd" and "even" lattices; general relations involving "levels" and "layers"; studies in "radial" and "axial" transposition with resultant "banking" of wires and "levels"; handwinding and tapping of lattices; swing-angle as related to diameter of wire; design-factors

IN figure 22 we have an actual lattice winding scheme. To understand the building up of figure 22, follow the winding chart at the left of figure 24. The right hand chart applies to figure 23.

We clearly see that the number of cross-steps in a layer, at any given element—always the same as the number of turns—is the number of times that the advance, v, is contained in the pitch, p, which is always twice the swing, s.

The useful concept of a "level" instead of a simple layer is an important aid in analyzing lattice coils. Starting with zero level, we do not get a complete lattice pattern until one "layer" of two levels is completed. But the second and third or other similar levels may, under a different concept, be considered as one "layer." The simplest viewpoint, however, for counting the number of step or spiral "circuits" is the one used.

To simplify the discussion of figures 22 and 23 we use the advance itself as an angular unit. This is possible because the advance must eventually travel around to an axial plane through the initial winding "element," and it is an exact submultiple of the circumference; since a multiple of the pitch itself equals a multiple of the circumference.

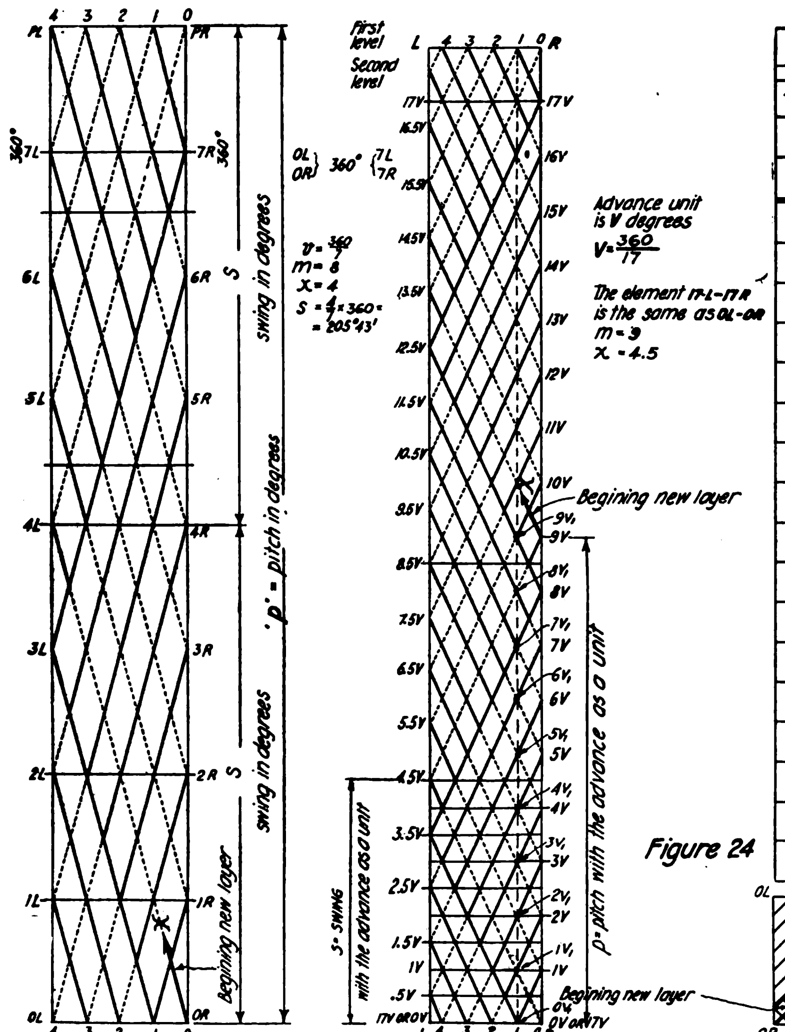
We see that $s = 4/7$ of 360° and $v = \frac{360°}{7}$ by examination of figure 22 which shows a developed surface pattern of the bottom lattice layer. The swing angle 4R-OR-4L, is even worse than that shown in figure 21 and, therefore, gives a poor inductive return on the wire used.

Length of Wire in Layer

We will examine figure 23 in order to deduce the general formula for length of wire in a layer.

The bottom level of the first layer starts at the element OV-OV at the extreme right. When one "step-circuit" has been made the wire crosses the element OV-OV at the point marked 1. If a line parallel to the line R-R is drawn through the points 1-1 in the elements OV-OV and R-L at bottom and top of figure 23 respectively, this line crosses any element of the coil, say, at 1V, 2V, etc., up to 9V, which is the element where a new layer starts; as shown by the arrow 9V-X. These points are shown by heavy dots on the cross-steps ending at 1V, 2V, etc., up to 10V and are numbered $1V_1$; $2V_1$; etc., to $10V_1$.

It would now be natural to assume, if this examination were carried no further, regarding the length of a layer, that a correction per circuit equal to $\frac{v}{360}$% of a "circuit" or turn is necessary, making a total correction for m circuits of 2K units of length. This, however, is not so, for if the wiring is traced out for a complete layer it is found that the layer is completed, not at the end of the first double swing to 10V at the right, but back at the beginning of the winding OV on the right. All the extra gains on (m-1) circuits are lost on the m^{th} circuit. Hence the formula for a layer is written $ly = \frac{360mK}{s}$ with no correction terms.



Figures 22 and 23—Comparison of "even" and "odd" lattice patterns

Coil Figure 22 — Even turns per layer m = 8 — $v = \frac{360}{7} = 51°26'$

L_v (Advance units on left)	R_v (Advance units on right)
	0
4	
	1
5	
	2
6	
	3
7	
	4
1	
	5
2	
	6
3	
	7=0
4	

Coil Figure 23 — Odd turns per layer m = 9 — $v = \frac{360}{17} = 21°10'$

L_v (Advance units on left)	R_v (Advance units on right)
0	
	0
4.5	
13.5	9
3.5	1
14.5	10
6.5	2
	11
15.5	
	3
7.5	
	12
16.5	
	4
8.5	
	13
.5	
	5
9.5	
	14
1.5	
	6
10.5	
	15
2.5	
	7
11.5	
	16
3.5	
	8

Figure 24

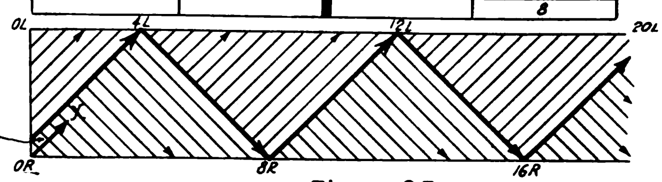


Figure 25

Figures 24 and 25—Winding charts for lattices shown in figures 22 and 23

CHECKING CHARACTERISTICS OF WINDING SHOWN IN FIGURE 22

First:—There is no "bedding," as all wires cross one another.

Second:—The heavy lines are upper level wires and the dotted lines are lower level wires; hence the levels alternate so as to give the appearance of a sort of folding action indicated in figure 25 by isosceles triangles with bases on opposite faces of the coil alternately disposed around the circumference. The outline of such a triangle may be traced as follows, remembering that element 360 is element zero and that element PL-PR is element 1L-1R.

To the left of the line starting at point 1 on element OL-OR and ending at 4L, all upper level wires go to the right upwards. To the right of the line drawn between point 4L and the point 7R, the same arrangement holds and the portion of the layer at the extreme right, shown between 7L-7R and PL-PR is really the part OL-OR, 1L-1R. The line OR-4L is the "folding boundary" marking the first step in a new level which has the same starting point as before at OR.

Leaving the part 7L-7R-PR-PL out of consideration it may be said that in the area OR-1-4L-7R the "down-and-right" wires are the top level and in the area OL-1-4L-7R-7L the "up-and-right" wires are the top level.

Third:—When using heavy wires in a lattice coil, a correction for the width of the coil may sometimes be allowed. This may amount to 100% of the diameter of the wire as shown in figure 30-B, but it is usually neglected in the case of small wires.

Fourth:—It is well worth a little trouble to study the layout of figure 22 and its analysis as presented in figure 26. Similarly figure 23 and its treatment in connection with figures 27 and 28 should be examined. The fact that lattice coils are really "banked" in a sense, both radially and axially is made clear in an unmistakable manner by these diagrams. The top and bottom levels are cyclically interchanged (figures 26 and 27) and the number of wires in a level—not layer—at any element of the coil is determined by the quotient of the swing (half the pitch) by the advance. In figure 22 we have 4 for this quotient. This gives us four wires each, or 5 and 3 on top and bottom levels, as shown in figure 26. In figure 23 we have 4.5 for this quotient. This gives us four and five wires on top and bottom levels respectively and a staggered progression of the advances on the faces of the coil; as can be seen by studying the cross sections in figures 22 and 23. These cross sections are made at the following places in figure 22:

PR-PL (1R-1L); 2R-2L; 4R-4L; 45R-45L; 6.5R-6.5L; 7R-7L (OR-OL); and at the following places in figure 23: OV, ½V, 1V, 1½V, 2V, 2½V, 3V, 3½V, 4V, 4½V. In all these ten sections the top and bottom wires at section OV, which is the start, are traced by a specific letter for every wire. T shows top level and B bottom level. Their initial positions in the level may be shown as corresponding to the numbers along the edge of OR-OV, as OB, 3T, 2B. The sequence of relative positions as the levels move axially along the cylinder from side to side, is shown by the alignment of the drawings. This fact shows the so-called "side-banking."

The convention has been here adopted to show sections at such elements without ambiguity regarding which way the wire is being directed during winding—whether to right or left. If the sections were taken exactly at 1V, 1.5V, etc., the wires in positions O or 4.5 would be "stationary," as it were. To avoid this the sections are all supposed to be taken slightly toward the reader, who is assumed to be at section 17V looking toward section OL-OR. The winding is clockwise looking along the axis from the right to the coil.

In applying figure 22 to figure 26 it should be remembered that the reader is above the coil at PL-PR, facing OL-OR. The winding is approaching the reader. All sections in figure 26, except the last at 7L-7R corresponding as shown in figure 22 to 360 degrees or zero (OL-OR), have as many steps or turns per layer (8) as there are "advances" in the "pitch." The extra wire is at 2T and starts the new layer. It is partly shown from OR to X.

The sequences in figure 26 "jump" about, while those in figure 27 are, by contrast, evenly distributed around the cylinder.

CHECKING CHARACTERISTICS OF WINDING SHOWN IN FIGURE 23

As this is a uni-lattice winding, differing from that shown in figure 22 only in having an odd number of "step-circuits" or "turns" per layer, we will consider its individual characteristics solely.

First:—The "folding level" boundary is the line starting from point 1 in OV-OV to 3.5V at left, then to 8V-R, 12.5V-L and 17V-R or O-R.

Second:—The advance in figure 23 is $\frac{360}{17}$ degrees, 21° 11′ approximately, and if the windings in figures 22 and 23 had the same layer diameter figure 23 would not pass the requirements for good relative wire economy versus low capacity.

As in figure 22 there is an over-lapping area, 17V-L-R-17V, which is the part also shown at OV-1V-1V-OV. The use of the word "folding-boundary" is justified by the aspect of figure 25 which shows that both the winding levels in figures 22 and 23 could be imagined as laid down in the form of a multiple-wire ribbon conductor folded alternately at OR-8R, 4L-12L, 8R-16R, etc., so as to lay in the direction of the arrows. This ribbon conductor would not have the lattice coil properties, however.

Turning now to figure 27 we find ourselves in a position to study a "moving cross-section" of the two levels that make up a lattice layer—from the point of view of figuring the wire in the coil. Figure 27 is superior to figure 26 for this purpose on two counts. There are more cross sections and these sections are here taken in figure 23 at equidistant radial cross sections of the winding, using the "advance" v, as the measuring unit-arc. Figure 27 shows as clearly as a moving picture could, the lateral (axial) and vertical (radial) banking of the lattice type of universal winding.

Starting out at a section through the element OV we notice nine wires in the layer, five in the bottom level and four in the top. This is true throughout the lattice layer, as shown in the section at ½V and subsequent sections.

It should be remembered that in the even type of lattice shown in figure 22, the bends in the wire come opposite each other on the coil faces. In the odd type shown in figure 23, they are staggered by half the advance.

In figures 26 and 27 the top level wires are marked with numbers showing their original arrangement in the starting section, and by arrows showing their axial trend. The "collision," as-it-were in levels from opposite "trends" only takes place in the first (or odd) levels!—they are taken care of by the fact that the wires moving toward the right in figure 27 have apparently the "right-of-way." The others jump to the top "level." This "right-of-way" is revised on the next swing-arc, 4.5V-9V, so that the uninterrupted trend on the bottom level is toward the left in that case.

In considering the gradual change of the swing-angle as new levels are added, figures 17 and 18 (see August WIRELESS AGE), illustrate the relative flattening of the cells. The axial "diagonal," H, of these lozenge-shaped cells is constant in length, because it is of necessity equal to the submultiple of the width expressed by $\frac{2wv}{p}$ which is constant in any coil and may be written $\frac{wv}{s}$.

This is not equal to the separation, h, between wires in a level, which is a variable distance, but only differs from it by a factor sec G. Hence h=H secG or $h=\frac{wv}{s}$ secG, as shown in figures 28B, 28C and 30A.

If one thinks of the first cross-step at the first level and at succeeding odd levels, until a skew surface like a propeller is mentally constructed looking toward the coil axis, a good idea will be obtained of the general change in direction and length of similar "families" of "cross-steps."

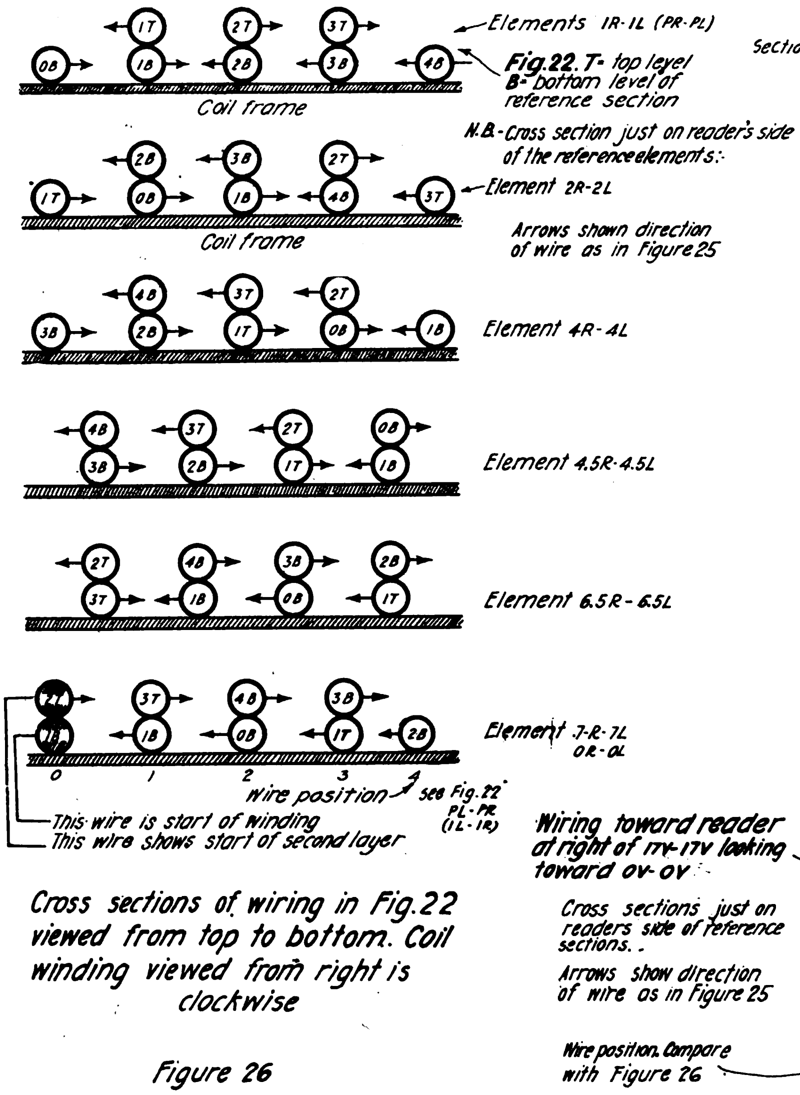
Before the derivation of working formulas is given the simple relations in a swing for odd and even coils with actual wire will be studied, so that pecularities of hand-winding may be allowed for in the wire calculations. Figures 28A and 28B give an idea of the first swing arc with bottom level wires from figures 22 and 23 respectively.

Figure 28A is an even coil; as $m=\frac{p}{v}=8$. In figure 28B, m=9.

Now we see that x, which is the number of "separation-spaces" (H) between wires each 4 units in length, is always half of the value m—the number of "step-circuits" or simply "circuits" in a layer. These circuits are zig-zags and hence are not true turns. This is evident in figure 28A if the bend aob from the succeeding (top) level is taken into consideration. In the case of this figure the width (w) is immediately calculable as equal to 4h+2Δ which gives the extra width for the bending allowance which we shall discuss directly. In the case of figure 28B although there is no bend opposite $\frac{9V}{2}$ at 4.5V, yet there will be one at 5v and the width of the coil is thus 4.5h+2Δ. So the rule is established in the case of both odd and even "step-lattice" windings.

placement between juxtaposed bends of half the advance, as contrasted with the even type of figure 28A where there is no such displacement. The first bending allowance may be, as in figure 29, or 31, a total correction equal to the diameter (d) of the wire. With a very thick wire, as in figure 30B, it must be equal to this diameter where A=radius of wire, if the sinoidal arrangement is followed.

In figure 30B the second bending allowance is the



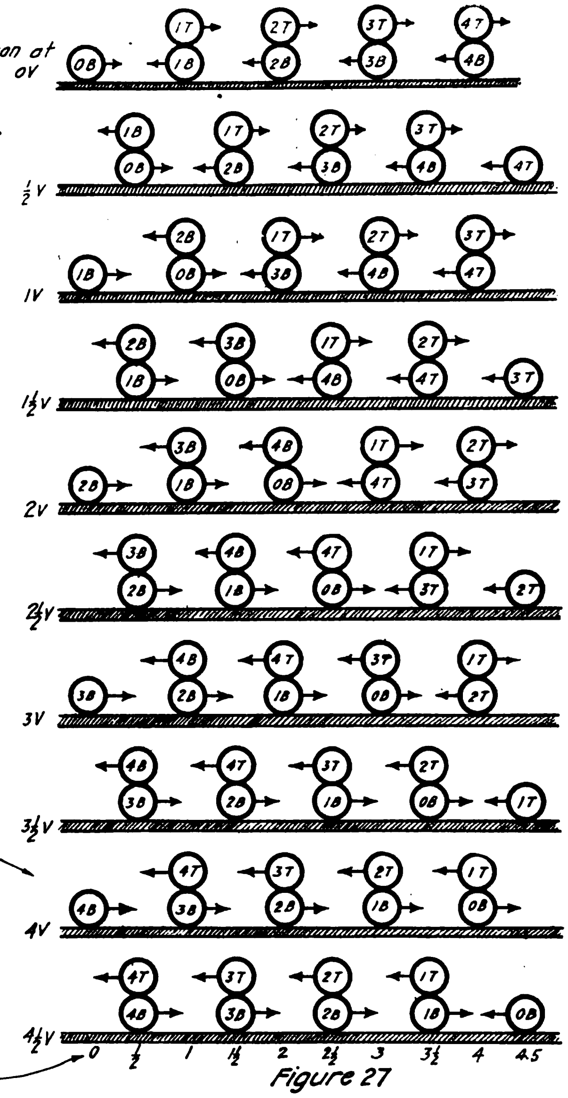


Figure 26—Axial and radial "banking" of figure 22 lattice. Figure 27—Axial and radial "banking" of figure 23 lattice.

ALLOWANCE FOR BENDING

The term "bending" here covers two separate conditions calling for a correction, if only theoretically, in most cases. These factors are, first—bending at the end of a cross-step or cross-spiral so that the wire projects slightly over the face of the coil as shown in figure 28A at 4V. This bending may be imagined as absolutely sudden, being produced by a "fold" in the wire, as in figure 30A where the angles and dimensions are exaggerated for purposes of study. In this case there will only be one allowance made.

Second: The layout of the cross-steps is simple harmonic or almost so; i.e., the axial travel of the wire follows the motion of a pendulum. This complicates the calculation of length of winding, but allows a semi-empirical inductance formula to be derived which would be practically out of the question with the sudden bends or discontinuities shown in all layouts, preceding figure 28A.

Examination of figure 29 shows the "odd" type of coil-winding analyzed in figures 23, 27 and 28B with a dis-

difference between the length K of the path 12321, called the cross-step as computed by an integration and the rectified helical length computed over the pitch-arc 1-1 of the sinusoid. This is expressed by the integral

$$K=12321=\frac{w}{l_{as}}\int_{o}^{l_{as}}\sqrt{l^2_{as}+\pi^2\,w^2\cos^2\frac{X\pi}{l_{as}}}\,.dx$$

When w is small relatively to l_{as} or G, and hence sin G small, the correction is negligible. However, the logical convenience of using a sinusoid instead of an analytically disconnected series of "zigzags" should be remembered when the electrical problems are considered.

The theoretical extreme of bending is shown in figure 30A where everything is exaggerated as much as possible. It is shown here that if h, is the separation between wires of diameter D, with swing-angle of G degrees, and swing equal to S degrees, we have two corrections. The spacing H between wires on a level in an axial direction, with separation h, is h sec G or H=h sec G and the correction for width, 2Δ=h csc G.

In figure 31 the sinoidal character of the curvature with an appreciable diameter of wire is rendered more evident. The double curvature with points of inflexion lying along the midplane M-M is evident.

In figure 32 the advantages of hand-winding a wire like the above are indicated by the shaded cross-steps OR-SL and SL-PR wound around winding-pins shown in cross-section. The swing-angle G is greater than it would have been with the same width (w) in a coil frame. but with the wiring as in figure 31 it has a slightly better time constant, other things being equal.

However, other things are not equal, as the use of winding pins straightens the wire and causes an approach to figure 30A, with practical sizes of wire. Inductively the straight cross-step in figure 30A is less efficient than the sinoidal cross-step of figure 31. There is shown in figure 32 a possible limitation to the spacing and size of winding pins. When these pins—which are of course v degrees apart—touch the wiring on the side away from the coil pins axially, the limit of approach has been reached, unless the very slow and cumbersome method similar to basket or rattan weaving is used of allowing all the winding pins to project full length equal to the depth of the coil (t) throughout the process of winding same. The ordinary hand-winding attachment can be made to raise the pin just before the bend around it is to be formed by an amount equal to the diameter (D) of the wire used.

The coil with tapping-points at the bends, whose winding-pins in large coils may be ½ to 1 inch diameter, has a distinct advantage over one not so wound. The minimum spacing or "advance" between winding-pins will now be considered.

Figure 33 gives for hand-wound lattices the geometrical relations between the width (w) of the coil, the "swing-increment" (θ), the "stretch-angle" (ϕ), the distance (K) between two "following" winding pins —as shown at C and C_2 and M, the minimum distance allowable under semi-mechanical systems of winding these coils.

The wire is shown as if it were in an outside level and stretched around and between the winding pins at C to the left on the lower face of the lattice, and C_2 at the upper face on the right as developed on a plane. The axis of the wire passes through C, the midpoint of K the "pin-step."

If D is the diameter of wire and P and ϕ the diameter and radius of the winding pins, we may draw in the wiring —tangent under tension—to pins at C and C_2 and merely touching the adjacent winding-pin at C_3. This is done by describing a circle around C of radius P+D and drawing a tangent to it from C_2. Perpendiculars to this tangent through C and C_2 give, at points of intersection with circles showing pin diameters, the required points of tangency.

We see how the swing-angle (G) is changed by the addition of the swing-increment (θ) into a new angle, γ, called the "stretch-angle."

By inspection we have the following relations:

$$\phi = \theta + G$$

$$\theta = \sin^{-1} \frac{P+D}{K}$$

$$K = l_{as} \sec G = \sqrt{l_{as}^2 + (w+P)^2}$$

It may be remarked before going any further that figure 33 does not rigorously show the winding of a semi-manually-wound coil, such as is shown schematically at figure 37. The distance between the pins in the outer layer of the latter figure correspond to the length of the arcs a-b, b-c.

In the present treatment we have assumed that the minimum allowable distance M, between say, C_2 and C_3 on a flat development of the coil shown in figure 33 is just enough to clear the wire from adjacent winding-pins. This being so, the distance on the outer layer along the actual surface of the coil is more than enough to clear the wire. This margin becomes greater—as a short analysis will show—the sharper the curvature of the winding surface. Hence in figure 37, if the outer layer has safe distances given by a-b, b-c, etc., the inner layers have corresponding distances such as a_1-b_1, a_{11}-b_{11}, etc., with a greater clearance as the layers approach the bottom of the coils.

The length of wire from Z_1 to Z_2 is called the "stretch" L.

$$L = K \cos \theta + 2 \left(P + \frac{D}{2} \right) \phi$$

$$= K \cos \theta + (P+D) \phi \text{ or approx.}$$

$$= K \cos \theta$$

$$M = (P+D) \csc \phi$$

The above formulas cover the particular additions specifically applying to hand-wound coils where the adjacent pins merely touch, but do not affect adjacent wires as is the case in purely hand-wound coils. This is shown schematically in figure 34, where two wires are shown completely handwound about winding posts 2-6 for one wire and 3-7 for the other. The winding posts are separated of course by the advance, v. The inward bending is bad mechanically, but electrically figure 34 is better than figure 33.

Size of Wire Versus Swing Angle Change

The advantage of rapid radial change in levels, either through thick wire or separation of levels by cylindrical spacers is shown in figure 35.

The ordinates show ΔG the decrement of tangent of the swing-angle as Dx the diameter of any given level increases. If we take three levels as shown with diameters differing by the equal distances a-b and b-c for a certain size wire, we may shift them along OX to ascertain the best value. This is determined by the consideration that the area a-b-c-p_3-p_2-p_1-a is the greatest possible consistent with mechanical considerations. Hence we instantly reject the positions a_1-b_1-c_1 or a_2-b_2-c_2 giving Oa_1 or Oa_2 as the smallest diameters at first level for a lattice of the selected size of wire. The distance a-b-c might be half an inch difference in diameter to be divided among three or more wire diameters; i. e., levels corresponding to same. The curves in figure 35 show that the bigger the coil the larger the wire necessary at a given level to make a given change in the swing-angle at the next level.

The best classifications of general formulas and comparison of results will now be sought, in order to obtain a scientifically arranged systematic tabulation thereof.

Classification of Relationships in Lattice Windings

1st—Electrical properties

2nd—Mechanical and geometrical relationships

Under both these headings we may consider

A—Cross-step lattices

B—Cross-spiral lattices

It is impossible within the limits of this article to consider quantitatively the electrical properties of lattice coils. This will be done in a forthcoming article with tables from data secured under laboratory and practical working conditions.

Structural Classification of Design Factors and Symbols by Definition

There are many varieties of lattice coils to be systematized under the present classification. Hence the liberal use of subscripts is almost compulsory in comparing similar but slightly differing concepts, as for instance d_l the diameter of a level and d_p the diameter of a pattern layer.

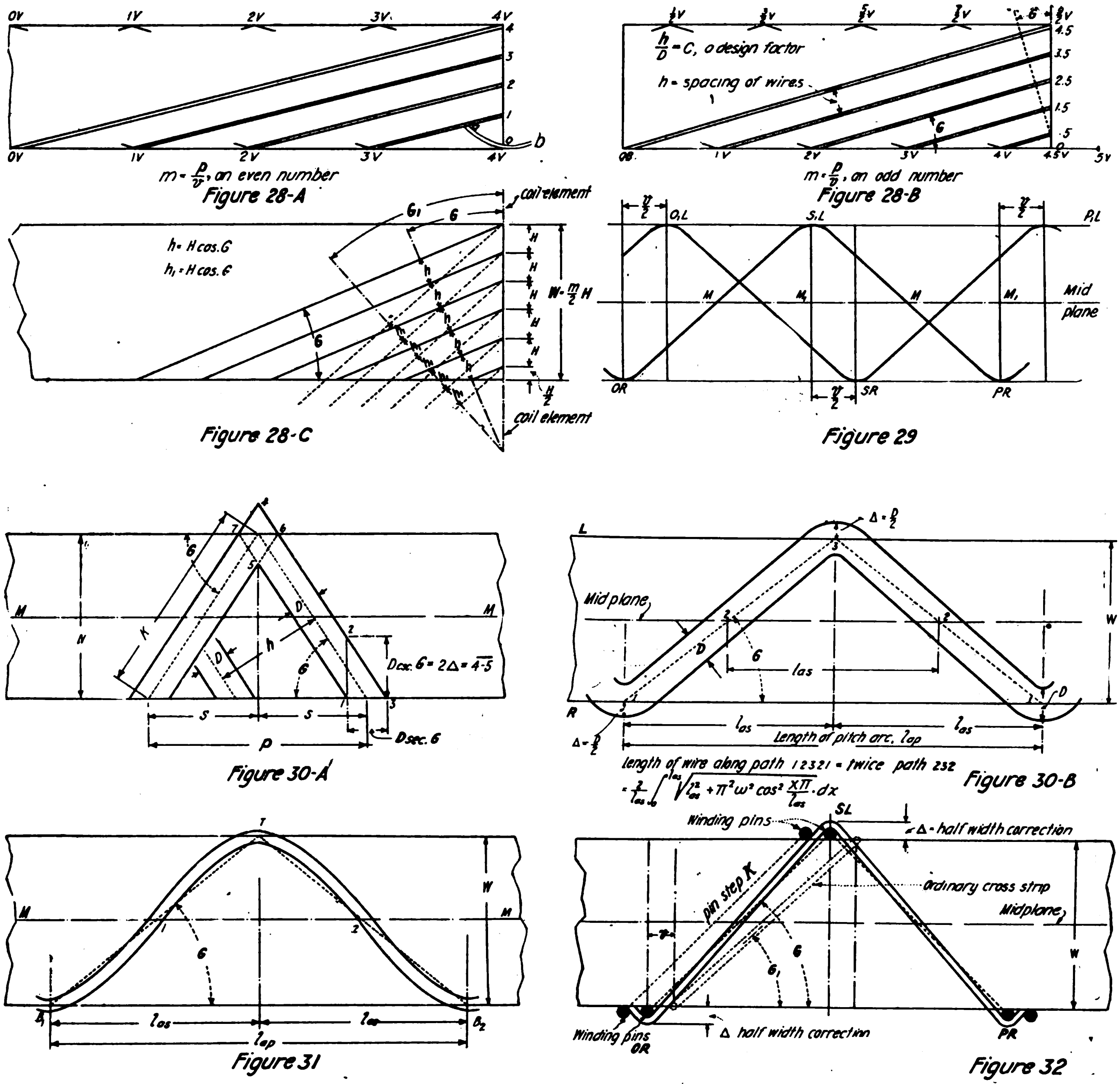


Figure 28A, B, C—Relation of axial separation to wire spacing. Figure 29—"Staggering" of bends in "odd" lattices of figure 23. Figure 30A—Coil width allowance. Figure 30B—Coil width and length relations. Figure 31—Sinoidal vs. straight layout. Figure 32—Handwinding precautions.

It should be noted that the first two levels in a lattice winding determine the "pattern." This pair and every other superposed pair of levels may properly be called "pattern layers," although as shown in figures 17 and 18 the patterns slowly change in dimensions, but not arrangement.

As seen in figure 23 the pattern layer is complete when the winding, or what is the same thing, the advance reaches the first circuit again, as it does here at 9V. When the advance travels 360° to 17V or OV which is the same thing, we have a "basket-layer." One or more baskets make a complete lattice coil, although a basket-layer may be a pattern layer when $p > 360°$; e. g. $p = 372°$.

A partial list of subscripts follows, and by proper combinations of the symbols given it may be extended to any practical construction used in lattice windings.

It should be remembered that a pattern layer in a lattice coil has m turns, denoted by the letter n_y.

SYMBOLS USED AS SUBSCRIPTS	FACTORS IN COIL CONSTRUCTION TO WHICH THE SYMBOLS REFER SPECIFICALLY
b	basket-layer
n	swing-circuit
v	advance
s	step-swing
q	spiral-swing
u	hand-wound
a	arc
x	lattice-level
y	lattice layer or pattern layer
N	multi-wire
z	multi-lattice
e	external
i	internal
m	average
t	total

We read the expression l_{avu}, as length of arc of the advance in a handwound coil. Adding the subscript "e" makes it an external advance arc, and adding "q" would specify that it was a "spiral-swing" advance. This is an extreme case. If LL_b is total length of a basket-layer and we wind two more separate baskets we may write $F_t = LL_{bi} + LL_{bu} + LL_{be}$. A 3-wire bi-lattice has a length shown by F_{3x2s} and if it is a spiral, add "q" as a subscript.

With the subscripts logically classified we may now condense the fundamental lattice elements into a short statement of the minimum number of factors requisite to the design of a lattice coil.

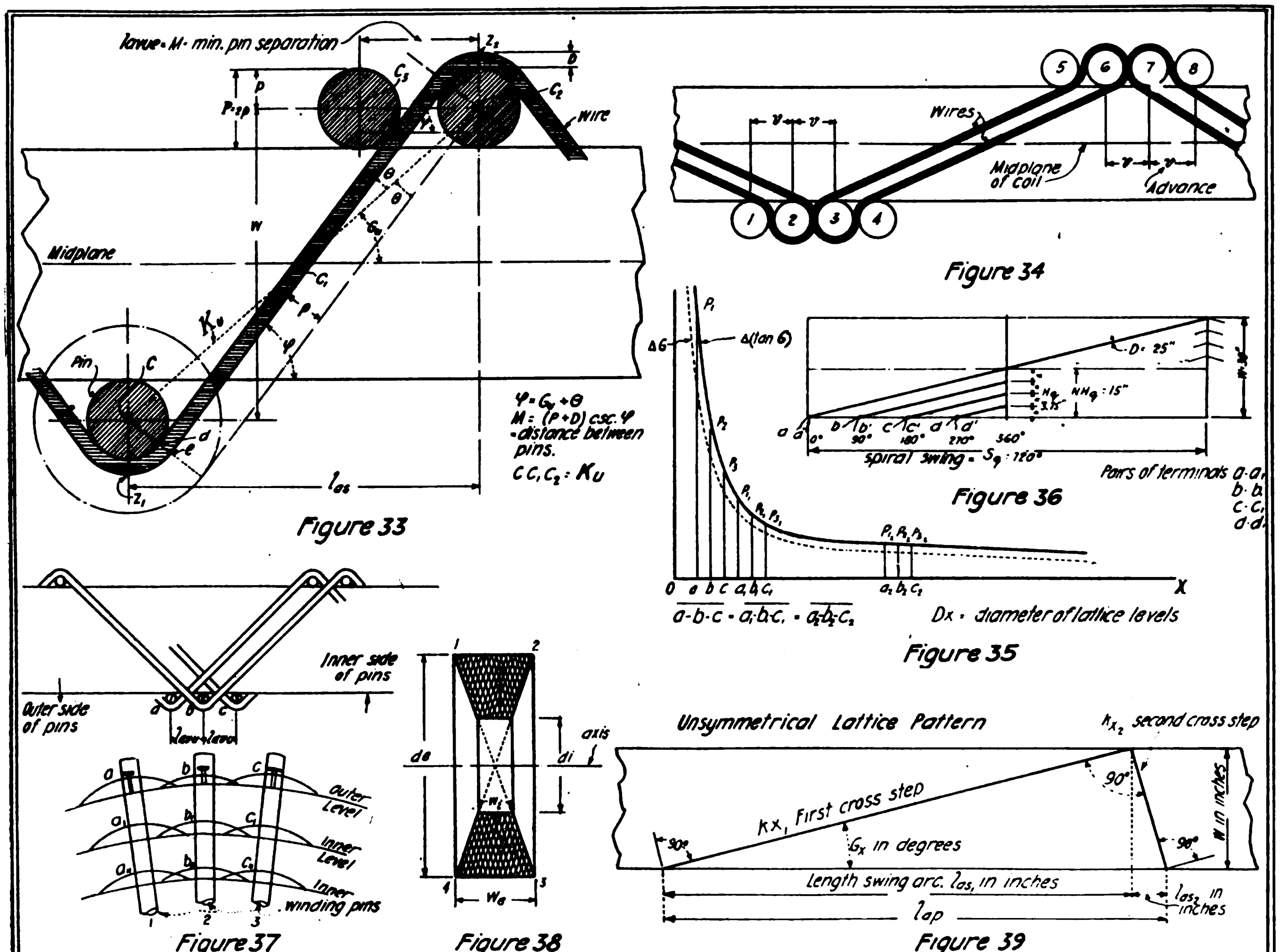
Units of Fundamental Elements

We have been dealing with cross-swing lattices where the swing was either a step or a spiral and where the "back" and "forth" swings were equal. These are owing to the fact that the lattice form depends upon a Diophantine equation satisfied by a class of numbers rather than by definite algebraic values, that 6 quantities can be used without over-determining the problem.

In hand-wound coils at least 6 factors are necessary.

The following symbols are classified as auxiliaries to the above, by definition, and are therefore listed with the suffix "DA" meaning "Defined Auxiliary" symbol.

t is the depth of coil winding in inches (1DA)
c is the ratio of wires on a level to diameter of wire D (2DA)
r_y is ratio of separation of layers to diameter of wire (3DA)



Figures 33 and 34—Minimum pin distance outer handwound layer. Wire twisting. Figure 35—Change in interlayer capacity. Figure 36—Multi-spiral lattice windings. Figure 37—Layout of construction of figure 33. Figures 38 and 39—New lattice constructions.

symmetrical lattices. In figure 39 there is shown an exceptional pattern scheme, an unsymmetrical lattice.

The swing is s degrees in general (1D)
The step-swing may be written s_s degrees or just s (1_sD)
The spiral-swing may be written s_q in degrees (1_qD)
The width of the coil measured between axes of wires at the coil faces, parallel thereto is w inches (2D)
The general diameter of a coil is d inches (3D)
The diameter of wire used is D inches (4D)
The separation of wires shown in figures 28B and 28C is h in inches (5D)
The separation of layers is given by b in inches (6D)

The use of the listing suffix D in the above classification signifies that these factors are determined by definition solely and are primary. The five factors 1D; 2D; 3D; 4D and the number of turns completely determine any machine wound lattice coil. It may be possible,

d_x is the diameter of any level (4DA)
d_y is the diameter of any layer (5DA)
p is the angular pitch in general (6DA)
p_s is the step-angular pitch (6aDA)
p_q is the spiral-angular pitch (6bDA)
m is the number of "swing-circuits" in a layer (7DA)
y is the number of layers in the coil (8DA)
H is the axial spacing of wires in a "level" in general (9DA)
H_s is the step-lattice spacing along the axis as shown in figure 28B (9aDA)
H_q is the spiral-lattice spacing along the axis, called the axial pitch (9bDA)
x is the number of "step-circuits" in a level, measured axially at a bend in a "step-lattice" coil (10DA)
n is the "turns" or "swing-circuits" (11DA)
l is length in general (12DA)
l_{sn} is length of wire in one step-circuit (12aDA)

l_{qn} is length of wire in one spiral-circuit (12bDA)
l_x is length of wire in one level (12cDA)
l_y is length of wire in one layer (12dDA)
F or F_t is length of total wire in coil (13DA)
G is the swing angle (14DA)
k is length of the "cross-swing" in general (15DA)
k_s is length of the "cross-step" (15aDA)
k_q is length of the cross-spiral (15bDA)
k_m is average cross-swing in general (15cDA)
k_{ms} is average cross-step (15dDA)
k_{mq} is average cross-spiral (15eDA)
k_e is cross-swing outer level (15fDA)
k_i is cross-swing inner level (15gDA)
l_{as} is length of swing arc in all lattice coils (16DA)
l_{ap} is length of arc subtending angular pitch (17DA)
r is ratio of radial separation of layers to diameter of wire (18DA)

Defined Auxiliary Factors in Semi-Manual Wound Lattice Coils

These are listed with suffix "HDA" meaning "Hand-wound Defined Auxiliary."

P is diameter of winding-pin (1HDA)
p is radius of same (2HDA)
K is the "pin-step" or distance between pins successively reached by wire (3HDA)
θ is the "swing-increment" or angle by which the effective "swing-angle" G, is changed by the pressure of the winding pins (4HDA)
M is minimum allowable distance between winding-pins (5HDA)

If l_{as}, as calculated from winding, is different from M the vernier action between the two will cause the pins and wire to eventually interfere.

ϕ is the stretch-angle or the new angle made by the wire instead of the swing-angle G when winding-pins are used (6HDA)
L is the "stretch" in inches giving the length of hand-wound wire between "successive" pins (7HDA)

Formulas Used in Design

We are now ready to classify the formulas required for analysis and design, from a structural standpoint solely. There are three classes of formulas:

A—Those immediately following from definitions.
B—Those derived from general principles.
C—Those combined from A and B.

The above letters will be used as suffixes in referring to formulas, and after classification the formulas will be tabulated in accordance with the requirements of various problems, to secure complete design constants in the simplest way. Given five independent initial factors, twelve coils will be evaluated.

Tabulation of Symbols, Factors and Direct Derived Formulas

When s is given there are five fundamentals, viz:

Coil depth, inches, t. (1)
Internal diameter, inches, d_i. (2)
Coil width, inches, w. (3)
Swing, degrees, s. (4)
Wire diameter, inches, D. (5)

General Definitions

$p=2s.$ (1A)
$v=ap-360z$; "a" and "z" must be whole numbers. (2A)
$m=p/v.$ (3A)
$x=m/2.$ (4A)
$\sin G=w/k$; $\sin G_m=w/k_m$; $\sin G_e=w/k_e$, etc. (5A)
$t=2\,D_y$; $y=2t/2D$ etc; if $r=2$ (6A)
$h=cD.$ (7A)
$b=rD.$ (8A)
$n=my.$ (9A)
$d_y=(d_{x1}+d_{x2})/2.$ (10A)
$t=bD_y$ when $r=2$ or generally $t=[r(y-1)+2]D.$ (11A)

General Relations

$t=(d_e-d_i)/2.$ (1B)
$d_m=(d_e+d_i)/2.$ (2B)
$c > 1$ (3B)
$r > 2$ (4B)
$m=p/(ap-360z)$; "a" and "z"=1.2.3 etc. (5B)
$l_n=360\,k/s$; $l_{nm}=360\,k_m/s$; $l_{no}=\frac{360}{s}k_e.$ (6B)
$H=b\sec G$; $h=H\cos G$; $\cos G=h/H.$ (7B)
$w=Hx$; $H=w/x=\frac{2w}{m}.$ (8B)
$G=\sin^{-1}w/k$; $G_e=\sin^{-1}w/k_e$ etc. (9B)
$G_q=\sin^{-1}w/k_q \doteq \sin^{-1}x\,H_q/k_q$; $k=\csc G.$ (10B)
$k=\sqrt{w^2+76s^2\,d^2\,10^{-6}}$; $k_m=\sqrt{w^2+76s^2\,d_w^2\,10^{-6}}.$ (11B)
$G_m=\sin^{-1}w/km.$ (12B)
$G_{qm}\sin^{-1}x\,H_q/k_{qm}.$ (13B)
$l_{as}=\frac{\pi d\,s}{360}$ or $=k\cos G$; $l_{av}=\frac{\pi d\,v}{360}$; $l_{ap}\frac{\pi dp}{360}$ etc. (14B)
$k_q=\sqrt{w^2+76s_q^2\,d^2\,10^{-6}}$;
$k_{qn}=\sqrt{w^2+76s_q\,d_m^2\,10^{-6}}$ (15B)

$$k_m=\frac{w}{G_2-G_1}\int_{G_1}^{G_e}\csc G.dG=\frac{w}{G_e-G_1}\log\left[\csc G-\cot G\right]_{G=G_1}^{G=G_e}$$

$=w\csc(G_o+G_i)/2$ or $w\csc G_m$ when $G < 15°$.
$=(k_e+k_i)/2$ when $G < 15°$.

Resultant Formulas

$F=30\,my\,k_m/s$ (in feet) (1C)
$F=3.14\,my\,d_m\sec G_m+\frac{5v\%}{18}$ (2C)
$\sin G=w/\sqrt{w^2+76s^2d^210^{-6}}$ (3C)

Hand Winding Formulas

G_u=swing angle of "line-step" drawn through centers of "following" winding pins. (7)
K="pin-step" or distance between following pins, sometimes written K_u. (8)

The pin diameter P and the width w are not independent but M must equal l_{avu}, the length of the advance-arc in the hand-wound coil. It is preferable to adjust w, the width to fulfill this requirement.

Dimensions of Inductance Coils

By M. K. Akers

THE need of an accurate, rapid means of determining possible dimensions of a coil for a given inductance is appreciated by all who have such calculations to make and many formulas for this purpose have been devised. A list of these formulas is given in Scientific Paper No. 169 of the Bureau of Standards. Of the formulas given, that of Lorenz's, on page 118, is perhaps the most convenient for ordinary radio calculations.

This formula as given is:

$Ls = A\ N^2\ Q$ centimeters of inductance.

Expressing the dimensions in inches, the formula becomes:

$L = 1.27\ A\ D\ N^2 \times 10^{-6}$ millihenries,

where,

D = diameter of coil in inches,

N = whole number of turns,

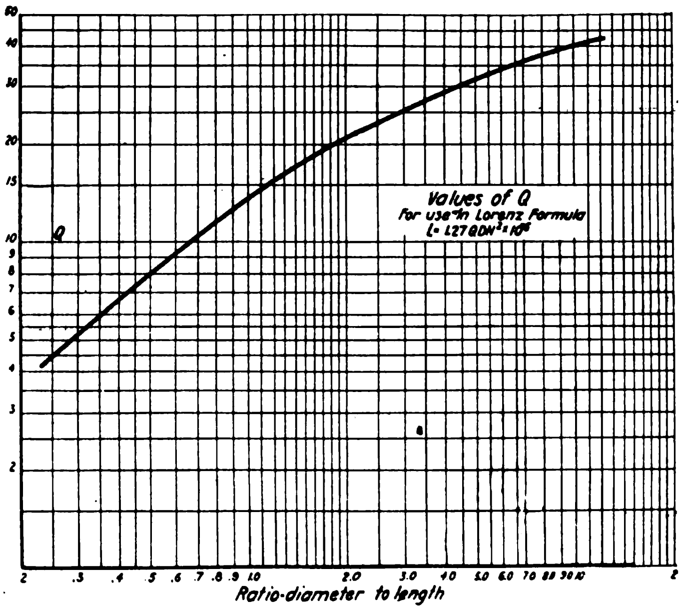


Figure 1—Graphic curve showing ratio of diameter to length.

and Q is a function of the ratio, diameter to length, and is given on the curve.

The problem usually presents itself in the form of: "What will be the proper dimensions for a coil to give an inductance of L millihenries when wound with a wire winding n turns per inch?" By assuming a ratio of diameter to length and taking the corresponding value of Q from the curve, the equation above may be solved. It is liable, however, to result in a diameter D for which no form is available, and to fit it to a given diameter requires a cut-and-try proceeding which is long and tedious. To facilitate these calculations, charts of different sorts have been constructed.

The values in the following table of inductances were taken from one of these charts based on Lorenz's formula. The dimensions given are of about the same order of accuracy as the coil and can be wound without special care. The figures given are for such values of diameter and length that the ratio of diameter to length is approximately 2.5, since this is the condition for maximum inductance for a given length of wire of a given size. If greater accuracy is desired than is given by the table measure the coil and count the turns, after the coil is made. Remember that the length is the overall length of the winding and the diameter is measured to the middle of the wire. The inductance can then be calculated from the formula.

While the figures given are for a single layer coil, they are reasonably accurate for a two-layer coil, provided the diameter is taken as the average of the layers. For a greater number of layers the accuracy decreases, but the figures still give a reasonable approximation of the inductance.

TABLE 1.—DIAMETERS AND LENGTHS OF COILS FOR VARIOUS INDUCTANCES

Inductance Millihenries	Diameter and Length in Inches											
	d		d	l	d	l	d	l	d		d	
	No 6 B & S d. c. c.							No. 8 B & S d. c. c.				
.003	2	1 1/2	2 1/2	1 1/4	3	1	..	..	..	..	..	..
.0035	2	1 5/8	2 1/2	1 3/8	3	1 1/8	..	..	..	..	..	..
.004	2 1/2	1 1/2	3	1 5/16	3 1/2	1	..	..	..	..	..	..
.0045	2 1/2	1 9/16	3	1 1/4	3 1/2	1 1/8	..	..	..	..	..	..
.005	1/2	1 5/8	3	1 3/8	3 1/2	1 5/16	2 1/2	1 1/4	3	1	3 1/2	7/8
.00 5	3	1 11/16	3 1/2	1 1/4	4	1 1/8	2 1/2	1 5/16	3	1 1/16	1/2	15/16
.006	3	1 13/16	3 1/2	1 3/8	4	1 5/16	2 1/2	1 3/8	3	1 7/8	3 1/2	1
.0065	3	1 5/8	3 1/2	1 7/16	4	1 1/4	2 1/2	1 1/2	3	1 5/16	3 1/2	1 1/16
.007	3	1 3/4	3 1/2	1 1/2	4	1 5/16	2 1/2	1 9/16	3	1 1/4	1/2	1 1/8
.0075	3	1 7/8	4	1 3/8	5	1 1/8	2 1/2	1 5/8	3	1 3/8	3 1/2	1 1/8
.008	3	1 15/16	4	1 7/16	5	1 5/16	2 1/2	1 11/16	3	1 3/8	3 1/2.	1 3/16
.0085	3	2	4	1 7/16	5	1 5/16	3	1 7/16	3 1/2	1 1/4	4	1 1/8
.009	3	2 1/16	4	1 1/2	5	1 1/4	3	1 1/2	1/2	1 5/16	4	1 1/8
.0095	3	2 1/8	4	1 9/16	5	1 5/16		No. 12 B & S d c. c.				
.010	3	2 1/4	4	1 5/8	5	1 3/8	2	1 1/2	2 1/2	1 5/16	3	15/16
.015	3	3	4	2 1/8	5	1 1/4	2 1/2	1 1/2	3	1 3/16	3 1/2	1 1/16
.02	4	2 1/4	5	2 1/8	6	1 1/4	3	1 1/2	3 1/2	1 5/16	4	1 1/8
.025	4	3 1/8	5	2 3/8	6	2	3	1 1/4	3 1/2	1 1/2—	4	1 1/4
.03	4	1/2	5	2 1/4	6	2 1/4	3 1/2	1 11/16	4	1 7/16	4 1/2	1 5/16
.035	4	3 7/8	5	3 1/16	6	2 1/2	3 1/2	1 7/8	4	1 5/8	4 1/2	1 7/16
.04	4	4 3/8	5	3 3/8	6	2 1/4	4	1 13/16	4 1/2	1 5/8	5	1 7/16
.045	5	3 5/8	6	3	7	2 1/2	4	1 15/16	4 1/2	1 1/4	5	1 9/16
.05	5	3 7/8	6	3 1/4	7	2 1/4	4	2 1/8	4 1/2	1 7/8	5	1 5/8
.055	5	4 1/4	6	3 1/2	7	2 7/8	4	2 1/4	4 1/2	1 15/16	5	1 1/4
.06	5	4 1/2	6	3 5/8	7	3 1/8	4	2 3/8	4 1/2	2 1/8	5	1 7/8
.065	6	3 7/8	7	3 1/4	8	2 1/4	4 1/2	2 1/4	5	2	5 1/2	1 13/16
.07	6	4 1/8	7	3 1/2	8	3	4 1/2	2 3/8	5	2 1/8	5 1/2	1 7/8
.075	7	3 5/8	8	3 1/8	9	2 1/4	4	2 1/4	5	2 5/16	6	1 15/16
.08	7	3 3/4	8	3 1/4	9	2 7/8	4	2 7/8	5	2 1/4	6	1 7/8
.085	7	4	8	3 1/2	9	3	4	3	5	2 3/8	6	1 15/16
.09	7	4 1/8	8	3 5/8	9	3 1/8	4	3 1/8	5	2 1/2	6	2
.095	7	4 3/8	8	3 3/4	9	3 1/4	5	2 5/8	6	2 1/8	7	1 7/8
	No. 10 B & S d. c. c.							No. 14 B & S d. c c.				
.10	6	2 7/8	7	2 3/8	8	2 1/8	4 1/2	2 5/16	5	1 13/16	5 1/2	1 1/4
.15	7	3 1/8	8	2 3/4	9	2 1/2	5	2 9/16	6	2 1/8	7	1 15/16
.20	7	7/8	8	3 3/8	9	3	5	3 1/8	6	2 5/16	7	2 5/16
.25	8	4	9	3 1/2	10	3 1/8	6	3	7	2 5/16	8	2 1/4
.30	8	4 1/2	9	4	10	3 1/2	6	3 7/16	7	2 7/8	8	2 1/2
.35	8	5	9	4 3/8	10	3 7/8	6	3 7/8	7	3 1/4	8	2 13/16
.40	9	4 7/8	10	4 1/4	11	3 7/8	7	3 1/2	8	3	9	2 11/16
.45	10	4 3/4	11	4 1/2	12	3 7/8	7	3 7/8	8	3 5/16	9	2 13/16
.50	10	5	11	4 1/2	12	4 1/8	7	4 1/8	7	3 1/2	9	1/8
	N 12 B & S d. c. c							No. 20 B & S d. c. c.				
.55	8	5 1/4	9	4 5/8	10	4 1/8	5	2 7/8	6	2 3/8	7	2
.60	9	4 7/8	10	4 3/8	11	4	5	3 1/16	6	2 1/2	7	2 1/8
.65	9	5 1/4	10	4 5/8	11	4 1/4	5	3 5/16	[illegible]	2 5/8	7	2 1/4
.70	10	4 7/8	11	4 1/2	12	4	5	3 3/8	[illegible]	2 1/4	7	2 3/8
.75	10	5 1/8	11	4 5/8	12	4 1/4	6	2 7/8	7	1/2	8	2 13/16
.80	11	4 7/8	12	4 3/8	13	4 1/8	6	3 1/16	7	2 5/8	8	2 5/16
.85	11	5	12	4 1/2	13	[illegible] 1/4	6	3 5/16	7	2 11/16	8	3/8
.90	11	5 1/4	12	4 1/4	13	4 3/8	6	3 5/16	7	2 13/16	8	2 7/16
.95	11	5 1/2	12	4 7/8	13	4 1/2	6	3 1/2	7	2 13/16	8	2 9/16
1.00	11	5 5/8	12	5 1/8	13	4 3/4	6	3 9/16	7	3	8	2 5/8
	No 24 B & S s. c. c.							No. 30 B & S s. c. c.				
1.5	5	2 5/8	6	2 1/8	7	1 7/8	3 1/2	1 7/8	4	1 5/8	1/2	1 3/8
2.0	5	3 1/4	6	2 5/8	7	2 1/4	4	1 13/16	4 1/2	1 11/16	5	1 9/16
2.5	6	3 1/8	7	2 5/8	8	2 3/8	4 1/2	2	5	1 1/4	5 1/2	1 5/8
3.0	6	3 1/2	7	3	8	2 5/8	4 1/2	2 3/8	5	2 1/8	5 1/2	1 7/8
3.5	6	3 7/8	7	3 1/4	8	2 7/8	4 1/2	2 1/2	5	1/4	5 1/2	2
4.0	7	3 5/8		1/8	9	3 3/4	5	2 1/2	5 1/2	2 1/4	6	2
4.5	7	3 7/8	8	3 3/8	9	3	5	2 5/8	6	2 5/16	7	1 7/8
5.0	8	3 5/8	9	3 1/4	10	2 7/8	5	2 7/8	6	2 3/8	7	2
6.	8	4 5/16	9	3 3/4	10	3 5/16	5	3 1/4	6	2 5/8	7	2 1/4
7.0	8	4 1/2	9	4	10	3 5/16	6	3	7	2 1/2	8	2 1/4
8.0	9	4 1/2	10	4	11	3 5/8	6	3 1/4	7	3 1/4	8	2 3/8
9.0	9	4 7/8	10	4 3/8	11	3 7/8	6	3 1/2	7	3	8	2 5/8
	No. 32 B & S s. s. c.											
15	6	3 1/8	7	2 5/8	8	2 3/8	..	..	..	..	..	..
20	7	3 1/4	8	2 13/16	9	2 1/2	..	..	..	..	..	..
25	7	3 3/4	8	3 1/4	9	2 7/8	..	..	..	..	..	..
30	8	3 3/4	9	3 1/4	10	3	..	..	..	..	..	..
35	8	4 1/8	9	3 5/8	10	3 1/4	..	..	..	..	..	..
40	8	4 1/2	9	4	10	3 9/16	..	..	..	..	..	..
45	9	4 3/8	10	3 7/8	11	3 1/2	..	..	..	..	..	..
50	9	4 11/16	10	4 1/8	11	3 3/4	..	..	..	..	..	..
60	10	4 1/4	11	4 1/4	12	3 7/8	..	..	..	..	..	..
70	11	4 3/4	12	4 5/16	13	4	..	..	..	..	..	..
80	11	5 1/4	12	4 3/4	13	4 3/8	..	..	..	..	..	..
90	8	8	9	7	10	6 1/4	11	5 5/8	12	5 1/8	13	4 3/4
100	8	9	9	7 3/4	10	7 1/4	11	6 1/8	12	5 1/2	13	5 1/8
150	8	12 1/8	9	10 1/4	10	9	11	8 1/4	12	7 1/2	13	6 3/4
200	10	11 1/4	11	10	12	9	13	8 3/8	14	7 5/8	15	7 1/8
250	12	10 1/2	13	9 1/4	14	9	15	8 1/4	16	7 3/4	17	7 1/4
300	14	10 1/4	15	9 1/2	16	8 7/8	17	8 1/4	18	7 3/4	20	6 7/8

Table 2 gives the number of turns of wire per inch of length, which may be wound with different sizes of wire with different kinds of insulation. This table is calculated from the diameter of the wires and hence requires close spacing to obtain the figure given.

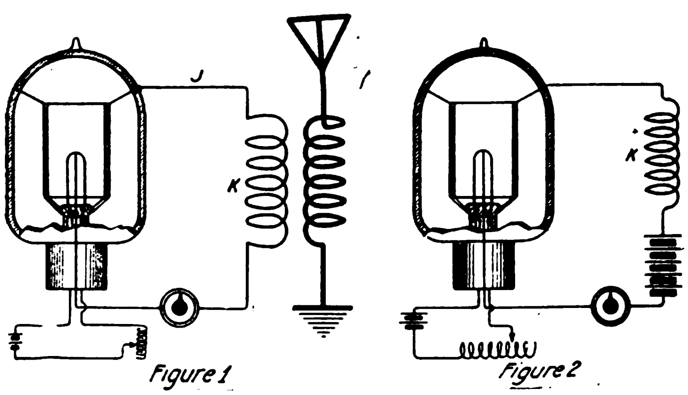
Observe that in the formula, for any given coil dimensions, the only factor which is variable is $N^2 = l^2 n^2$ where l is the length and n is the number of turns per inch. It is consequently possible to calculate the inductance of a coil for other wire than that given in table 1, by multiplying the inductance given in the table by the ratio of the square of the number of turns per inch, from table 2. Thus: Table 1 gives for .01 millihenries, d = 4 inches and l = 1⅝ inches, for No. 6 B & S double cotton covered wire. No. 6 B & S d.c.c. wire winds 5.7 turns per inch. If this coil were wound with No. 20 enameled wire, which winds 29.4 turns per inch, the inductance would be $\left(\frac{29.4}{5.7}\right)^2$ times .01 or .266 millihenries. By this relationship it is possible to interpolate the table and with a simple calculation obtain the inductance of most any coil desired.

TABLE 2.—TURNS OF WIRE PER INCH OF WINDING

B. & S. Gauge No.	Diameter in Inches Bare	Turns Per Inch of Winding				
		Enamel	Single Silk Covered	Single Cotton Covered	Single Cotton and Enamel	Double Cotton Covered
6	.162	...	...	...	...	5.7
7	.144	...	...	...	...	6.4
8	.128	...	...	...	...	7.1
9	.114	...	...	...	...	7.9
10	.102	9.7	...	9.3	9.2	8.8
11	.091	10.8	...	10.4	10.2	9.7
12	.081	12.1	...	11.6	11.4	10.7
13	.072	13.6	...	13.0	12.7	11.9
14	.064	15.2	...	14.5	14.1	13.2
15	.057	17.1	...	16.1	16.	14.7
16	.051	19.1	...	17.9	17.4	16.1
17	.045	21.4	...	19.9	19.3	17.9
18	.040	23.9	...	22.0	21.3	19.6
19	.036	26.7	...	24.2	23.5	21.7
20	.032	30.1	29.4	27.8	26.8	23.8
21	.028	33.9	32.8	30.8	29.8	26.3
22	.025	39.2	36.5	34.0	32.7	28.6
23	.022	42.2	40.7	37.6	36.1	31.2
24	.020	47.2	45.2	41.5	39.6	33.3
25	.018	52.9	50.3	45.7	43.6	....
26	.016	59.5	55.5	50.0	48.0	....
27	.014	66.6	61.7	55.0	52.7	....
28	.013	74.6	68.5	60.3	57.5	....
29	.011	83.3	75.2	65.3	62.5	....
30	.010	93.5	83.3	71.4	68.2	....
31	.0089	103	91.7	77.0	73.1	....
32	.0079	116	100	83.3	79.4	....
33	.0070	130	111	90.1	86.5	....
34	.0063	145	120	97.2	91.7	....
35	.0056	161	131	104	98.0	....
36	.0050	178	143	111	104	....
37	.0039	200	154	...	111	....
38	.0031	222	166	...	117	....

Improved Connections for Two-Element Vacuum Tube

R. A. WEAGANT discloses a method of connection which when used with the two element vacuum tube greatly improves the value of the device as a detector. As is well known, in devices of this kind operating by virtue of an electronic flow between a hot and cold electrode in a vacuum, current will flow upon receipt of a signal, from



Figures showing valve and hookup, one having a local battery.

the hot element or electrode to the cold, since the heated element gives off negative electrons. In the case of devices of this kind now in use, the cold element is made positive with respect to one of the leading in wires of the filament when a signal is received and it is therefore made positive with respect to a relatively cold portion of the filament.

When no signal is being received the filament, if heated, is giving off electrons and the cold element tends to assume the potential of some particular point upon the filament, depending upon the relative location of the hot and cold elements and upon their form.

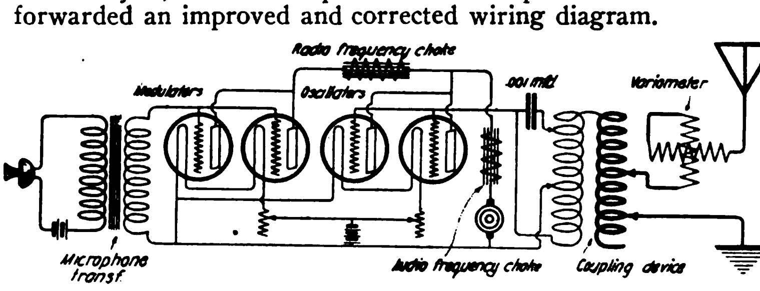
The object of Weagant's invention is to provide means whereby the cold element may be connected with the indicator and a point upon the filament, the potential of which the cold element tends to assume and thus, when a signal is received, the cold element is made positive with respect to this point, which will be a hot point of the filament somewhere between its ends.

Figure 1 shows the valve and an arrangement of associated local and aerial circuits. Figure 2 shows a modification in which a battery is used in the local circuit.

The vacuum chamber includes a hot element and a cold element with electrical connections extending to points outside the chamber; the cold element may be a cylinder of metal. The filament which may be of metal like tungsten, or of carbon is connected by leads to a battery. A regulating resistance is included in the circuit as a means for adjusting the emf. The local circuit *j* includes the secondary coil of an inductorium *k*, the primary of which is in a grounded aerial wire. One terminal of the telephone is connected in circuit through coil *k* to the cold electrode, the other terminal being connected directly to a predetermined point *x* in the heated element. This point *x* is preferably one of the hottest in the filament, or a point, the potential of which the cold element tends to assume when no signals are being received. In figure 2 there is shown a battery in series with the coil *k*. The connection of the terminal of the indicator directly to the hot point in the filament results in indications of greatly increased volume and strength.

"25-Mile Radio Phone"

MR. C. R. LEUTZ, author of an article on the above subject, which was printed in the April issue has forwarded an improved and corrected wiring diagram.



A Negative Resistance for Atmospheric Reduction

PROF. M. I. PUPIN and Edwin H. Armstrong have recently disclosed a method for the production of a negative resistance reaction by means of a system of circuits containing a local source of electrical power with means for controlling it, and the application of this negative resistance reaction to the compensation of the resistance reaction of electrical conductors, in order to make them responsive to sustained electrical waves of a predetermined frequency, and *not* responsive to electromotive forces of a disturbing character.

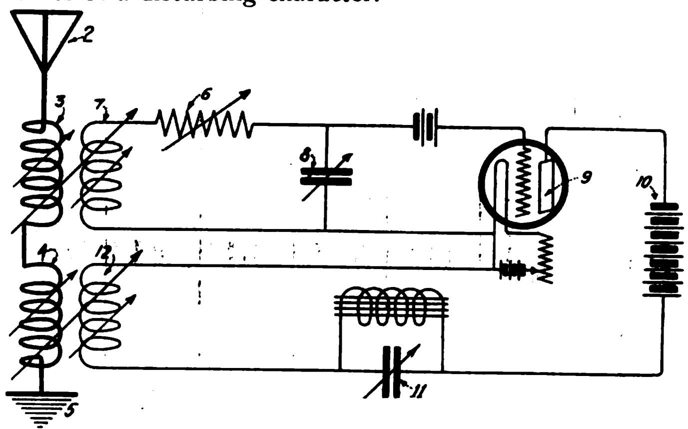


Figure 1—Circuit for producing negative resistance reaction

The apparatus described here is, briefly stated, a new form of resistance compensator. Figure 1 illustrates a system for producing this negative resistance reaction, and figures 2A and 2B show curves of its resistance and reactance characteristics for various frequencies. Figure 3 shows a method of applying the resistance compensator to reduce the effective resistance of a conductor. Figure 4 shows a system of magnifying the negative resistance reaction produced by the system of figure 1 by means of a magnifying shunt placed around the main conductor of the compensator, and figure 5 illustrates the resistance and reactance characteristics obtained with a shunted compensator. Figure 6 illustrates the method of applying the shunted compensator to the tuning of a conductor. Figure 7 represents a compensator consisting of a number of parts connected in cascade system for the purpose of producing very large values of negative resistance. The characteristics of this system are illustrated by the curves of figure 8, and figure 9 illustrates the application of the resistance compensator to the wireless antenna.

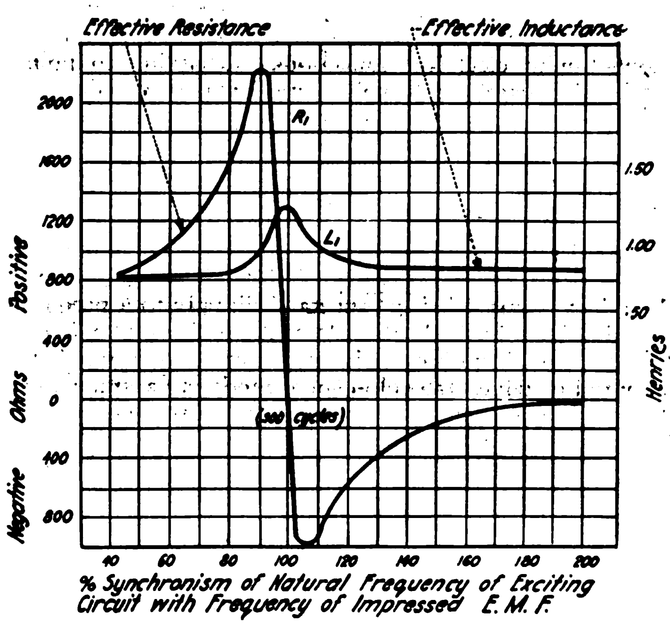


Figure 2A—Graph showing resistance and reactance characteristics

In the particular arrangement illustrated in figure 1 a three-element vacuum tube is coupled with the main conductor on the input side by means of the "exciting" circuit 6, 7, 8, and on the output side by the "energizing" circuit 9, 10, 11, 12. The external impulses are conveyed

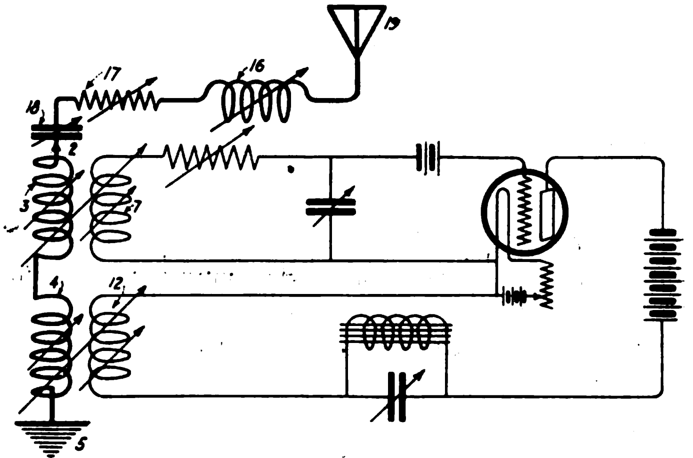


Figure 3—Method of applying resistance compensator to reduce effective resistance of a conductor

to the tube by the exciting circuit. By adjusting the constants of the exciting circuit with respect to the frequency of the incoming waves the excitation of the tube is regulated. The "energizing circuit" contains a battery which maintains a direct current between filament and plate.

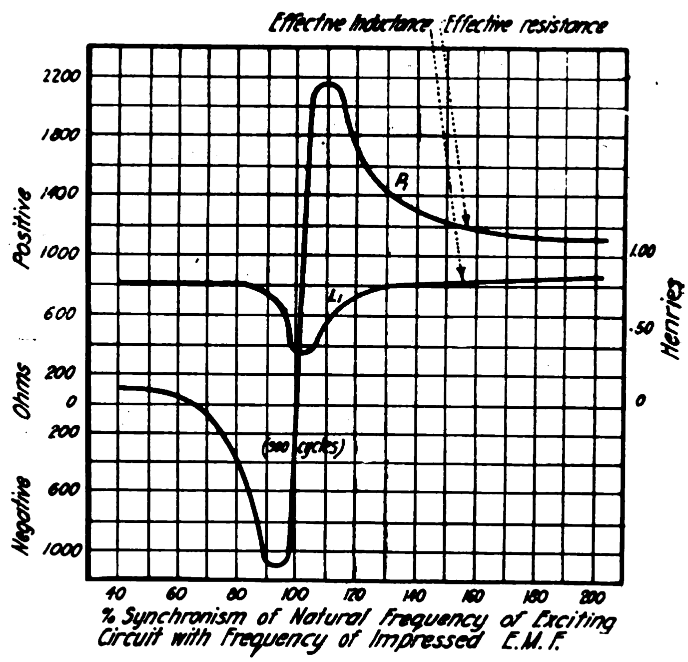


Figure 2B—A modification of figure 2A

The incoming waves vary the potential of the grid, and thereby the direct current. This variation produces an electromotive force in the main conductor by mutual induction between the windings of the transformer 4 and 12, whereby energy is transferred from the battery to the main circuit. It is this transfer of energy which manifests itself through a reaction between the points 2 and 5 of the main circuit, which has all the properties of a negative resistance reaction.

It will be seen that in the arrangements described results have been produced by operations that are generically similar to those of the induction motor resistance compensator, in which the primary circuit of the induction motor receives the incoming waves and produces thereby the magnetic excitation, whereas the rotating secondary by its electromagnetic reactions transfers, by expenditure of mechanical energy, electrical energy to the primary and thereby produces in it a negative resistance reaction. The amount of the negative resistance reaction produced by the means employed in the present instance depends upon the relation of the constants of both the exciting

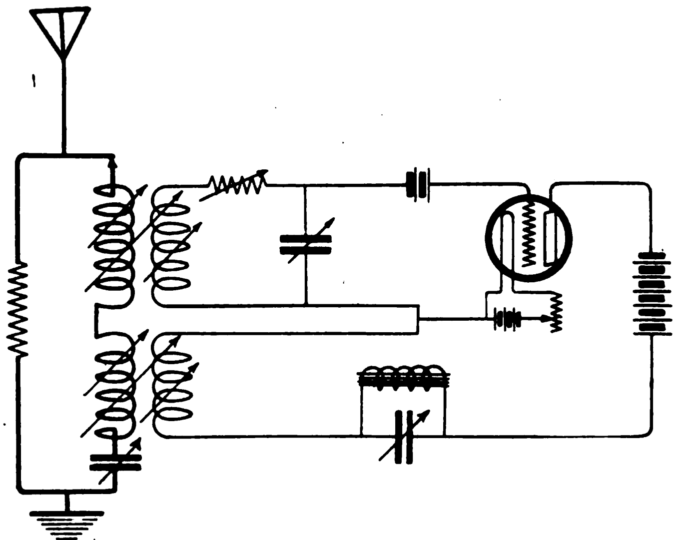


Figure 4—System of magnifying negative resistance reaction

and energizing circuits to the frequency of the incoming waves, and for the purpose of adjusting these constants, variable inductances and capacities and a variable resistance are employed. In other words, these circuits are capable of tuning.

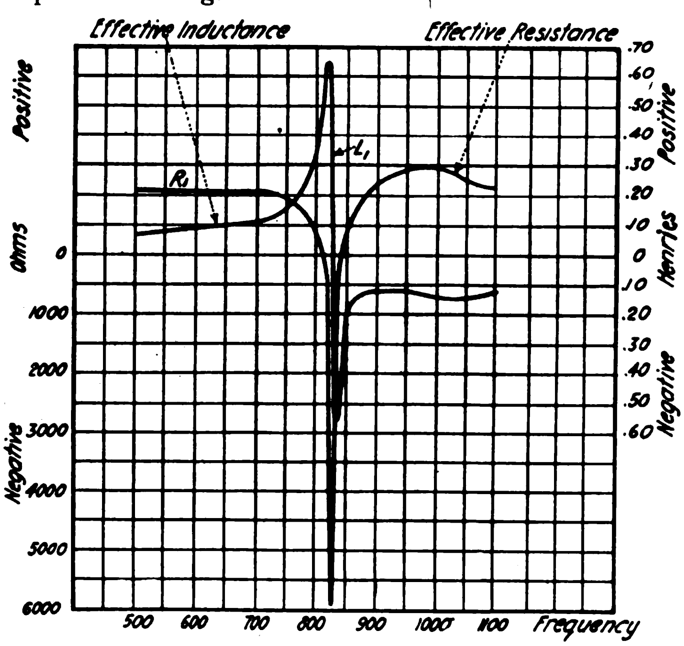


Figure 5—Resistance and reactance characteristics obtained with a shunted Compensator

The effective resistance and the effective inductance of the system of figure 1 between the points 2 and 5 of the main circuit, as measured by a Wheatstone bridge employing an alternating e.m.f. of suitable frequency, may be either as in figure 2A or 2B, depending upon the polarity of connection of the two transformers 3, 7 and 4, 12. In figure 2A, the maximum negative resistance in the main conductor is developed at a frequency above the frequency for which the exciting circuit, when taken by itself, is non-reactive.

The negative resistance reaction in the main conductor is produced in the system of figure 1, by the following operations: A current in the main conductor produces in the exciting circuit an e.m.f. which, through the medium of the grid condenser, charges the grid. The charged grid produces a variation in the amplitude of the direct current flowing through the exciting or plate circuit. This current variation then induces an e.m.f. in the main conductor. The phase relation between the current in the main conductor and this e.m.f. determines the reactions which are produced in the main conductor. If the e.m.f. thus produced in the main conductor is so constituted in phase that one of its two components is in the same phase with the current in the main conductor, then a resultant negative resistance reaction between 2 and 5 appears when this e.m.f. component is greater than the effective positive resistance reaction of the coils 3 and 4. The value of this negative resistance reaction depends only upon the amount of current variation produced by the action of the grid, and upon the electromagnetic coupling between the main circuit and its secondaries. The law in accordance with which this value of the negative resistance reaction may be varied, and given

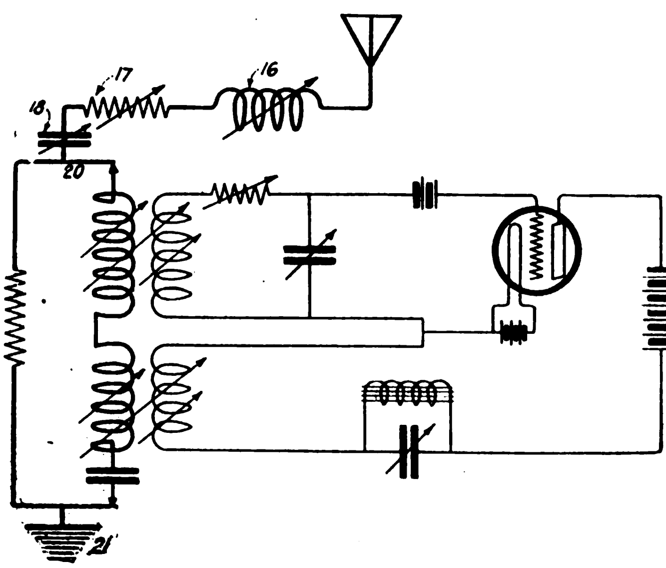


Figure 6—Shunted compensator applied to the tuning of a conductor

any assigned limit, is discovered by connecting the terminal 2, 5 of the main circuit of figure 1 into an arm of a Wheatstone bridge employing alternating e.m.f. of suitable frequency and intensity. The curves of figures 2A and 2B, are the result of a study of this kind. In these figures the ordinates of curve R_1 represent the effective resistance, and of curve L_1 the effective inductance between the terminals 2 and 5 for various frequencies. It will be seen that these curves are in their main features similar to those which may be obtained with the induction motor compensator. No exact general mathematical formula can be given which will express the relation between the effective resistance and the effective reactance of the main conductor of the electromagnetic constants of the various parts of the system and the impressed frequency. But an experimental study by means of the Wheatstone bridge enables one to construct easily an empirical formula for any particular case.

To apply this negative resistance reaction to the compensation of the resistance reaction of an electrical conductor, we proceed in the manner indicated in figure 3. Here 16, 17, 18 is a conductor containing resistance, inductance and capacity and which is to be tuned to the frequency of an impressed simple harmonic e.m.f. The main conductor of the resistance compensator is placed in series with the conductor 16, 17, 18, and the exciting circuit adjusted to produce negative resistance between the points 2 and 5 at the frequency for which the conductor as a whole (19 to 5) is to be made selective. The value of the negative resistance between 2 and 5 is adjusted to be slightly less than the positive resistance of the whole conductor so that the resultant effective resistance of the conductor is very much reduced for the correct frequency. The negative resistance may be varied by adjusting the coupling between 4 and 12 or 3 and 7, or by varying the power of the vacuum tube to vary the local direct current, or by varying the value of the resistance in the circuit. As the main function of the resistance is to control the steepness of the resistance curve R_1 in figures 2A and 2B in the vicinity of their negative maxima and thereby vary the sharpness of tuning of the system, it is better to vary one of the couplings to obtain the required variation in the negative resistance. The reaction of the main conductor is adjusted to zero for the same frequency by means of the inductance or the condenser.

For the right frequency, therefore, the conductor 19, 5

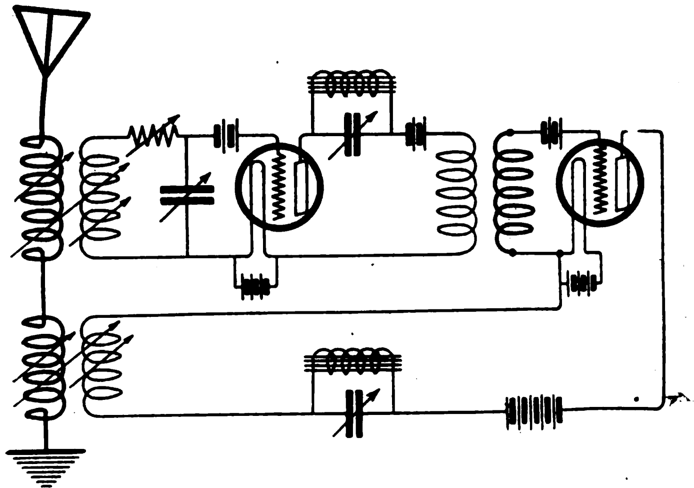


Figure 7—Cascade system of producing very large values of negative resistance

has zero reactance, and an effective resistance which is only a small fraction of the resistance added to it, but for all other frequencies both the resistance and the reactance are relatively very large. The amount of positive resistance that can be added in this way is limited by the capacity of the resistance compensator and by nothing else.

The arrangement lends itself to the magnification of the resistance reaction by means of a shunt or by other means of potential magnification by transformation. This may be done by the arrangement represented in figure 4. In this arrangement, which is the counterpart of the arrangement of figure 3, a non-inductive shunt containing resistance is placed across the conductor in which the negative resistance is produced. This conductor is provided with a series condenser for the purpose of adjusting the effective reactance of the conductor. When the shunt positive resistance is made slightly greater than the shunted negative resistance, a large multiplication of the original negative resistance is obtained in the manner previously explained. A shunt of 1,200 ohms placed across the conductor having the characteristic of figure 2A gives a multiplication of about six times. The characteristic resistance and reactance curves are shown in figure 5.

To apply the shunted vacuum tube system for the purpose of compensating the resistance reaction of a conductor, the conductor 20, 21 is connected in series with the conductor 16, 17, 18, as illustrated in figure 6. The adjustments of resistance and reactance of the main conductor are made in the manner previously described for the simple resistance compensator.

Another method of producing a high negative resistance is by means of a resistance compensator consisting of several vacuum tubes and their appurtenances in cascade, as in figure 7. Two are shown here, but any number may be used providing due regard is paid to the proper adjustment of the phase of the mutual inductance

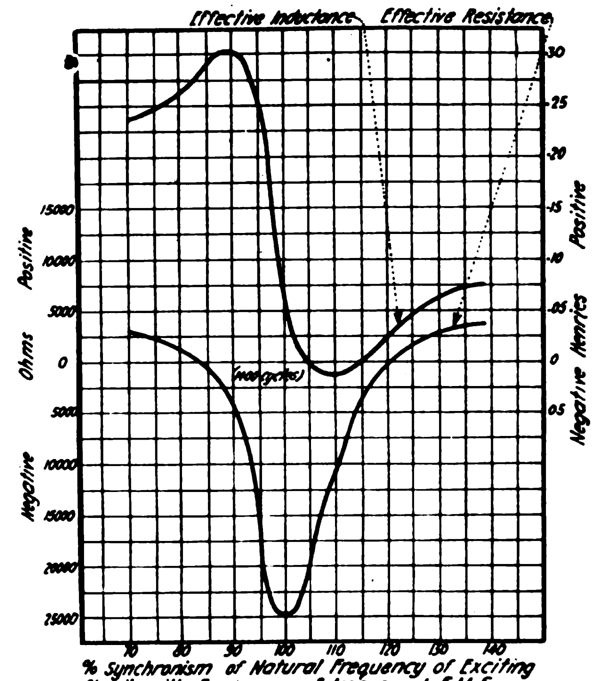


Figure 8—Curve showing characteristics of circuit shown in figure 7

reaction between the energizing circuit and the main conductor. The characteristics of the particular arrangement of figure 7 are illustrated by the curves of figure 8.

In all these applications the arrangement for producing

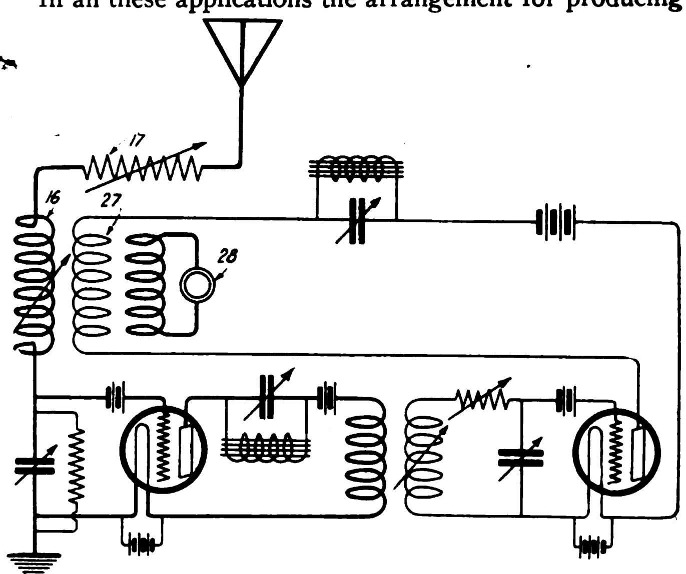


Figure 9—Application of the resistance compensator to the wireless antenna

negative resistance should preferably be such that the full value of the negative resistance cannot be produced instantaneously; that is, a certain definite length of time should elapse after the arrival of the initial impulse of a train of waves before the transient electrical state has passed into the stationary state in which the full maximum value of negative resistance is established. This length of time is determined by the duration of the transient state of the exciting circuit, and may be regulated by the suitable adjustment of the resistance of this circuit which determines the rate of damping of its free oscillation.

(*Continued on page* 28)

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

Description and Design of a Small Transmitter Unit

By D. R. Clemons

WHERE radio is congested, a low-powered addition to the higher-powered transmitter proves of great value.

It occurred to me that a small "inter-fleet" set would prove valuable when used in conjunction with the main set. A twelve-volt storage battery is the source of power ordinarily available in the station and the field.

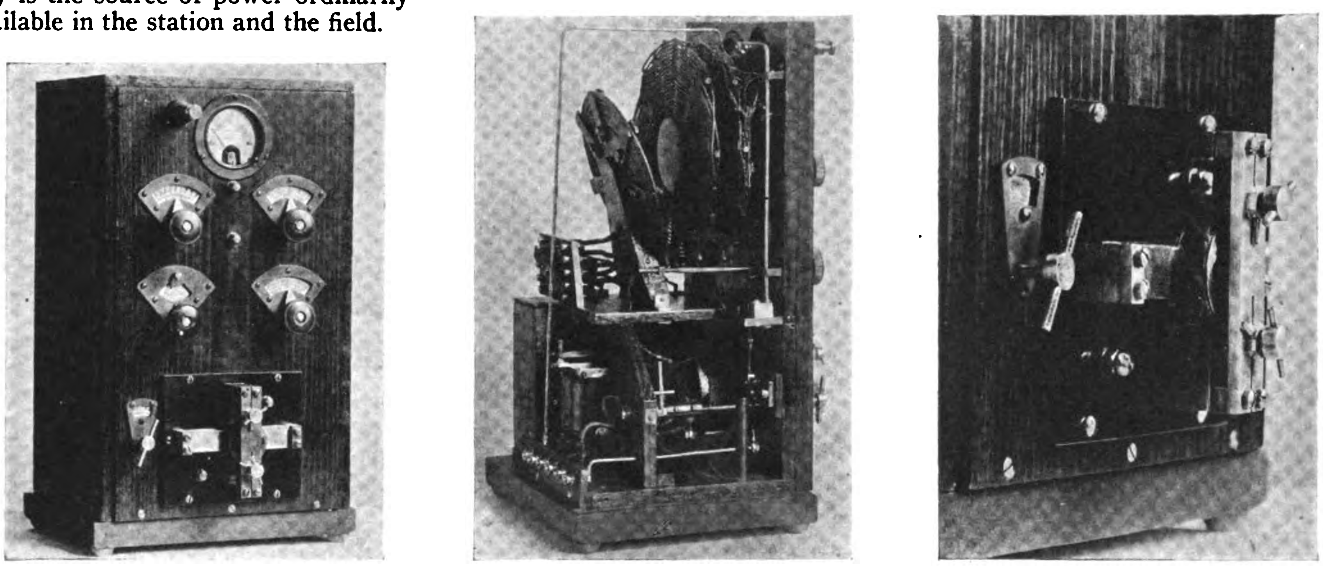
A large electro-magnet is mounted behind the vibrator panel shown in figure 3. An inductance and capacity is shunted across the contacts, as shown by the diagram in figure 4.

In making contact, a powerful magnet field is established and attracts the vibrator which moves toward the magnet, finally separating the contacts. At the instant of contact separation, the field collapses and induces a potential in the same direction as the original current flow. At this instant the potential is very great and jumps the increasing gap, thus charging and discharging the capacity through the primary inductance. This impulse in the primary induces oscillations in the secondary system.

The primary pulsation is aperiodic, and for this reason need not have the exact oscillatory constant of the emitted wave—in fact, increased current is pronounced where there is slight dissonance. The character of the primary impulse depends somewhat upon gap adjustment, and with a long "make" and quick "break" the wave is more uniformly established.

The following instruments are included in the cabinet: A send-receive switch, buzzer exciter, power relay, condenser battery, primary inductance, secondary inductance, variometer and hot-wire ammeter. All of these are arranged as shown in figures 1 and 2.

A relay having high resistance winding breaks the primary current, and is mounted in the rear of the set, figure 2. Its windings are in shunt to the power mains, and are operated by a light telegraph key in series with the windings. A .05 mfd. condenser shunts the heavy contacts to prevent arcing.



Figures 1, 2, 3—Various views of the complete transmitter unit

A low-powered transmitter should be thoroughly efficient, well designed, simple and — depending upon power available in the station or field—portable. It is also true that many stations do not have the facilities for operating power transformers. With these points as objectives, the following set was constructed. Its performance has been so satisfactory that it is a valuable addition to any progressive station.

The complete set is illustrated in figures 1 and 2. Low tension primary currents are used, thus simplifying insulation problems.

The entire transmitter is mounted in an oak cabinet measuring 16½ x 10 x 8½ inches depth, and weighs twenty-six pounds complete. The well known buzzer type of primary excitation is used, employing the hook-up shown in figure 4 and is designed to operate on 200, 300, 600, 1200 and 2400 meters wavelength.

When on the receive position, a knife switch opens the power circuit.

Four sections of the primary condenser are used for the several wave lengths. Waxed paper* is used as separating sheets. A small case contains the condenser units shown in figure 2.

Figure 2 shows the primary inductance mounted between rubber strips, and consists of six turns of cable tapped for correct values of inductance. Its relation to the secondary is variable; a knob driving a threaded rod adjusts the angular position.

Two flat spirals of stagger wound inductances are employed in the secondary system. Eleven radial rods are placed about the core, and through

* Mica would be better.— Ed.

them the windings are arranged as shown in figure 2, number 18 DC. wire being used for this purpose. This forms a very efficient arrangement. Taps are taken to the wave change switch of five points mounted between the coils and panel. The outermost ten turns of the second spiral are insulated from the inner turns by several turns of cotton braid wound between the groups. Taps are taken from each of the ten turns, and are controlled by the variometer switch of figures 1 and 2. The variometer has a range of one hundred fifty meters in nine steps, providing ample correction for changes incidental to different antennae. Secondary adjustment switches are mounted on the rear of the panel controls, being brought through as shown in figure 1.

Figure 2 shows the primary wave adjustment switch, altering both capacity and inductance values for the several waves. A lead comes from the antenna and passes directly to a brass block carrying a double spring. The double spring makes contact with the variometer terminal stud when transmitting. An eccentric cam on the antenna switch operates a lever and arm, making contact with the double spring, lifts it away from the stud, and provides a circuit to the receiver when thrown to the receive position. Power is also off when the switch is in this position.

Ordinarily a constructor chooses different arrangements than those set forth in descriptive articles; therefore, only the more important details will be given here.

Figures 1 and 3 shows the vibrator which is mounted on a Formica panel 5½ x 4⅝ x ¼ inches having core aperture and screw holes drilled as shown in figure 13. Figures 7 to 13 show the different parts of the vibrator.

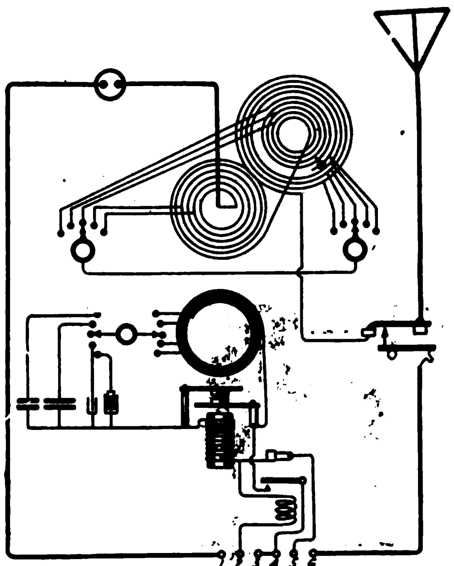


Figure 4—Hookup of buzzer type of primary excitation

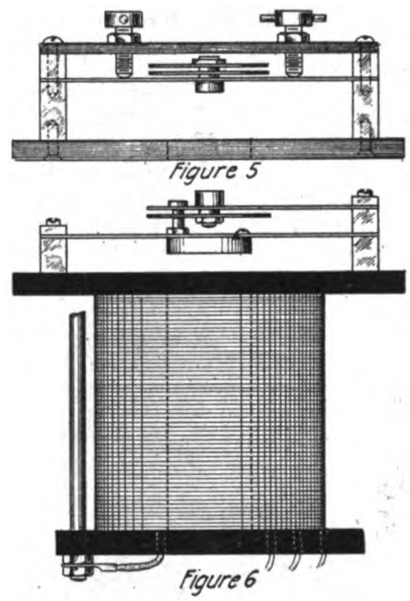
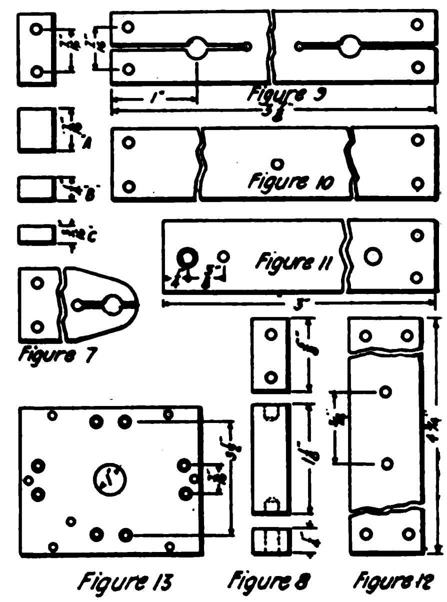


Figure 5, 6—Coil and vibrator



Figures show the various parts of the vibrator

Two sets of parts shown in figure 7 are required; these carry the moving springs and contact shown in figure 6. Two sets of parts as shown in figure 8 carry the stationary contact as shown in figure 5. These standards are cut from ⅜ x ¾ inch brass bar.

Where machine screws are to engage the stock, 8/32 threads are used. Round head machine screws pass through these smaller spacers, clamping the moving springs to the standards shown in figures 5 and 6.

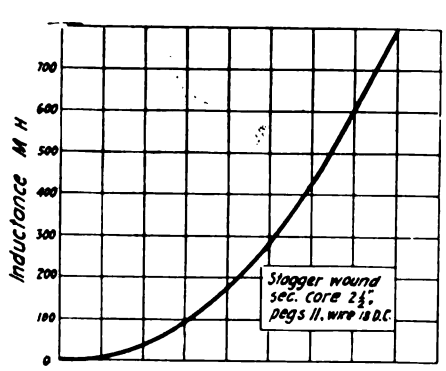


Figure 14—Graph showing action of coil

Two 10/24 adjustment screws pass through the brass piece shown in figure 9, which is of ⅛ x ¾ inch stock. These adjust the stationary contact as shown in figures 3 and 5.

Phosphor bronze strips of 22 gauge are used for springs, and are cut to the dimensions given in figures 10, 11, 12. The stationary contact is carried on the strip shown in figure 10, and the movable contact is carried on figure 11. An iron armature is carried on the strip shown at figure 12, and acts upon the moving contact by a projecting stud shown in figure 6.

The core is of soft iron wires three inches long, and is bundled to a diameter of one inch. Two pounds of number 18 double cotton wire is wound into a coil 2⅝ inches long. Tie rods clamp the magnet coil between the panel and circular wooden disc and also provide leads to the vibrator parts.

Hardened silver contacts ¼ inch in diameter are used. Two radiators are carried upon the stock of each contact.

Figures 1 and 3 show the assembled vibrator; the coil and disc are shown in figure 2.

Four sections of condenser are used: .1, .5, .011, and .004 mfd. each. Paper dielectric is used, each sheet measures 4 by 5 inches. Papers are of good bond thoroughly impregnated by dipping into a hot mixture of 3 parts paraffin, 2 parts beeswax, and 1 part rosin. One hundred and eighty sheets were used, separating one hundred sheets of foil having effective area of 3½ by 4½ inches each. Each section is tapped, and the units are clamped in the wooden case provided with a hard rubber top.

Low tension ignition cable is used for the primary inductance. The secondary system is wound in two flat spirals. A section of rolling-pin 2¾ inches long and 2½ inches in diameter is used for the core mounting. Eleven 3/16 inch dowel pins are set radially into holes in the core. Two coils require two radial groups. No. 18 double cotton wire is wound through the pins, using the stagger system of winding. The coils are wound to a diameter of eight inches. The last ten turns of the second coil are insulated from the interior turns and tapped to the variometer switch—several turns of cotton twine being wound between the groups.

As the constructor would design to

suit his antenna and chosen wavelengths, I have included an inductance curve for this type of coil. By using the constants of one's antenna with the desired wave, the required inductance and turn required will be found.

All indicating dials shown in figures 1 and 3 are cut from 1/8 inch hard rubber battery jars. Scales with numerals are instrument drawn and covered by celluloid sheets of the same dimensions as the rubber plate—readings showing through the openings as illustrated. This forms a very attractive and cheap way of using indicators.

This transmitter draws 15 to 25 watts on contact, responding evenly to transmissions at high rates of speed without fluctuation of tone or signal strength. The pitch is about two hundred per sec. On an antenna having a natural period of 170 meters and a resistance of 33 ohms at 600 meters, the current is 0.6 ampere. When employing a capacity and directive loop, the current is 1.4 ampere with a resistance of 6 ohms. A 12 volt storage battery is used as a source of power.

Audion Circuits Galore

By E. T. Jones

THE average amateur is forced to pull his circuits and receiving apparatus apart every time it is desired to change circuits, as, for instance, from an ordinary detector circuit to that of an Armstrong regenerative circuit. In doing this he generally loses much time and the connections which were of sufficient lengths to take care of one circuit will not fit for the next. This results in the waste of much copper wire for leads. Also, in time it will tell on the apparatus.

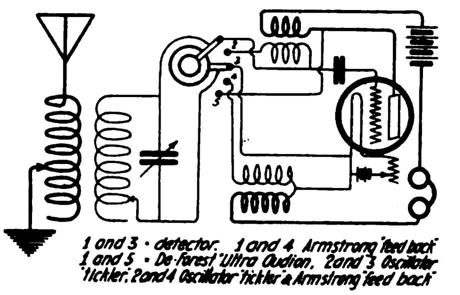


Figure 1—Original hookup

figure 4. This is the Armstrong feed back circuit. Bringing the contact arm from No. 4 to No. 5 and permitting the other to remain on No. 1 gives the circuit shown in figure 5. This is the De Forest ultra-audion circuit which can be used to great advantage in the reception of long wave undamped waves.

Next the usual oscillating "tickler" circuit is brought into play by placing one of the contact arms on point No. 2 and the other on point No. 3. Take a glance at figure 6 and see for yourself.

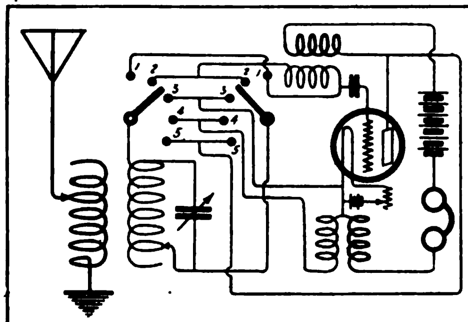


Figure 2

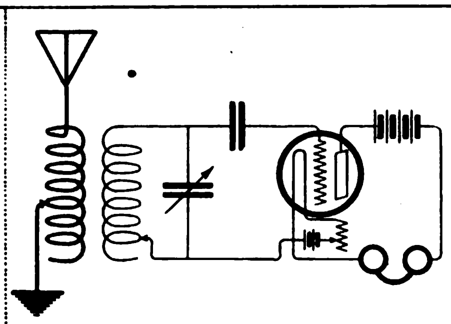


Figure 3

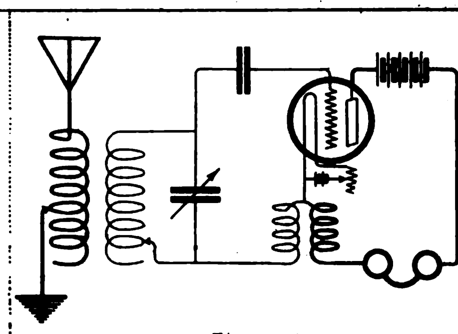


Figure 4

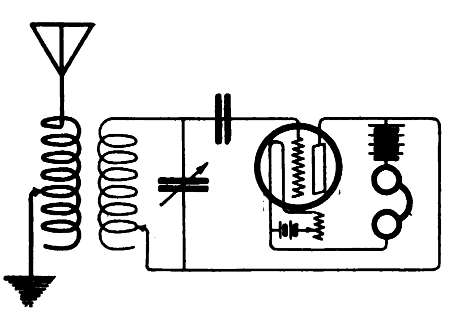


Figure 5

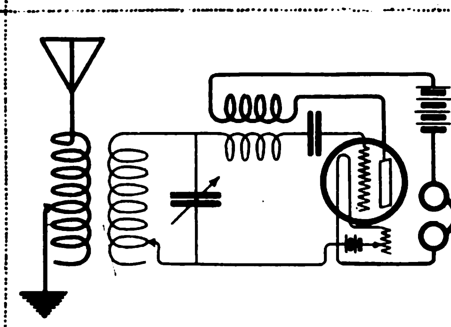


Figure 6

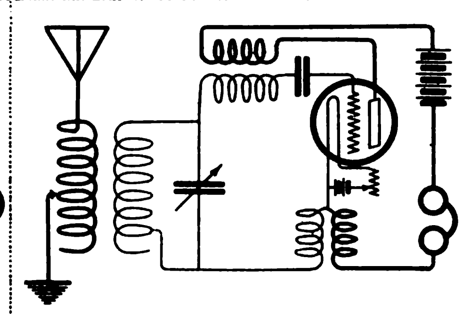


Figure 7

Various circuits secured by manipulating figure 1

Experimenters, who live up to their name, tire of one circuit and prefer another—variety is the spice of life. Those desiring to have a circuit comprising numerous other circuits, need only follow the diagram given in figure 1. The switch shown in this circuit of connections is not so easily constructed and for that reason figure 2 shows how two ordinary rotary switches can be employed to the same advantage. The two switch arms are connected to the secondary terminals of the receiver. The five contact points of each switch are made common in pairs. This, of course, permits the same adjustment as the switch shown in figure 1, but is more cumbersome and occupies considerable more panel space.

By placing the switch arms on contacts No. 1 and No. 3 the circuit shown in figure 3 is obtained. This is an ordinary detector connection. Connections made with contact points No. 1 and No. 4 give the circuit shown in

If an over anxious experimenter hits a hard bulb which refuses to oscillate, place the switch arm contacts on points No. 2 and No. 4 and have a double feed back system, the oscillation "tickler" and Armstrong "feed back" circuits are then possible. See figure 7.

This scheme should bring joy to the heart of any really enthusiastic "dabbler" and, as stated in the beginning of this article, will economize time, give variety and save the apparatus.

Direct Coupled Radio Receiving Sets

By R. Newell Turner—5 BP

IT is not generally known that direct coupled receiving sets possess so many good qualities that they are well worth the attention and consideration of amateurs. Their construction requires less material, and, therefore, less money. They are very sensitive and surprisingly selective when properly handled, tuning being much more easily and quickly accomplished than when an inductive coupling is used, and when used with a Marconi V.T. and honey-comb coils you can have a receiving set in a minimum space at a minimum price that will give maximum results. Because a single coil hook-up is more efficient than a coupled hook-up when used as a radiator, a telephone transmitter placed in the ground lead will enable one to radiophone two miles or more with but a single V.T.

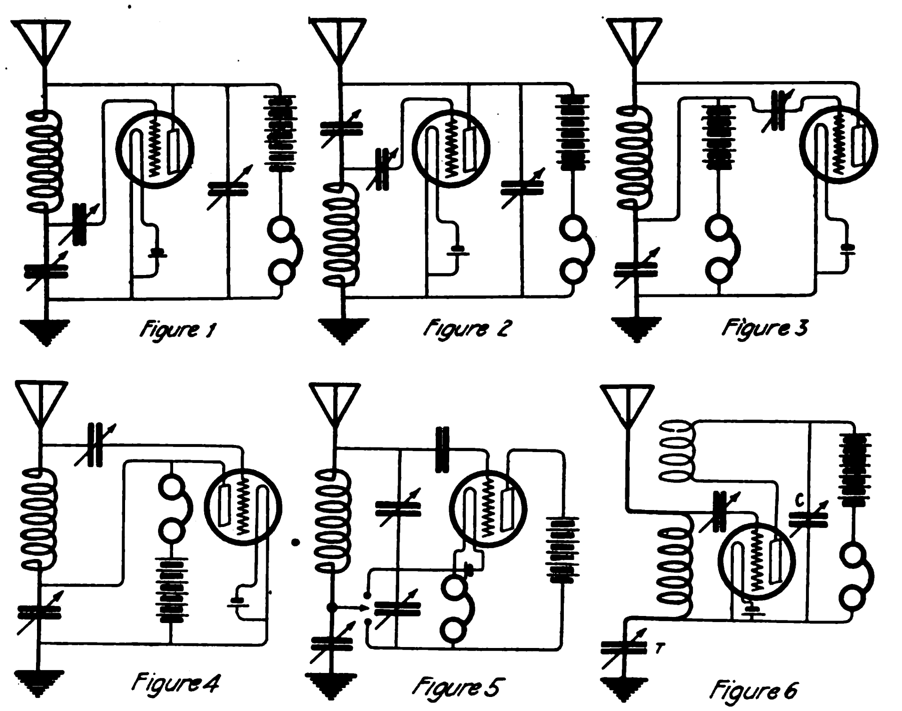
In a series of experiments carried out by Arden Hooks at his station, 5BB, over twenty hook-ups were tried, every one of which was a direct connected circuit using only one coil, except when a second coil was employed as a tickler. For the reader's consideration the six best circuits are given here.

No. 1 is an excellent oscillator, tuning being very sharp, but when receiving spark signals regeneration is not so easily controlled as with some of the other circuits. No. 2 seems at times slightly more sensitive than No. 1 but it is not so good an oscillator. No. 3 is a good oscillator and is sensitive, but requires more A and B battery than either of the circuits No. 1 and No. 2. No. 4 requires less A and B battery than the other circuits and is the best oscillator of all the circuits tried. One prominent radio engineer states that with this circuit a single Marconi V.T. has brought in several trans-oceanic stations. Of all the circuits tried employing a capacity feedback No. 5 was far superior to the rest. Arc signals are strong and clear; spark signals are strong but the circuit is better for the reception of undamped waves.

Experiments with several circuits using a tickler coil were made. The majority of these circuits were good but just one is given, No. 6, which proved to be the best all-round hook-up that is possible with a direct coupling.

This circuit was used extensively by the Navy during the war and it is readily understood why when the circuit is known to be very sensitive and selective; and an excellent oscillator with easy control of oscillations and regeneration without affecting the wave length in the antenna circuit. It is a circuit that can be adjusted in a minimum time to meet the most exacting requirements. With this Navy uni-control circuit practically all the U. S. coast stations have been copied at Kountze, Texas, on 600 meters and several amateurs have been read from 800 to 1,000 miles distant which is good work using only one Marconi V.T.

The condenser T should be connected so that it can be placed in parallel with the inductance P if it should be desired to cover a greater range of wave length. The tuning, however, will be much broader than when it is left in series with the antenna circuit. This variable tuning condenser should have at least .001 mfd. capacity and for very long wave lengths a greater capacity is desirable.



Various hookups for directly coupled receiving sets.

The variable C bridging the phones and B battery should be .002 mfd. and more capacity is required at times, but .0005 mfd. is entirely sufficient for the grid variable condenser. A variable condenser bridging the tickler coil was found to be an advantage when receiving arc signals, but it is best set at zero when damped waves are being received.

I believe that the trend of the times will bring into more general use these uni-control receiving sets which in a large measure will eliminate complications.

A Negative Resistance for Atmospheric Reduction

(*Continued from page* 24)

To apply the resistance compensator to the reduction of atmospheric disturbances the preferred arrangement is as shown in figure 9, wherein a resistance compensator containing several three-element tubes is arranged to produce in the antenna a high negative resistance reaction. The first tube and its appurtenances are connected to the antenna by means of a condenser which is located at the base of the antenna and is shunted by a resistance which constitutes a leakage path for electrostatic charges accumulating on the antenna. The particular advantage of this connection is that the condenser is shielded by the high resistance 17 and the inductance 16 from pulses of short duration which are unable to develop any appreciable reaction across the condenser and thereby excite the compensator. The second tube of the resistance compensator is connected to the antenna through the transformer 16, 27, and a detecting device, 28, is inductively associated with the coil 27.

Further Data on Oil-Dielectric Condensers

By L. Bartholomew

IN an article describing an oil-dielectric condenser for transmitting which appeared in the May issue of The Wireless Age, several points have since been discovered which will improve the construction considerably.

Due to electrostatic stress between adjacent plates, trouble was experienced with buckling of the plates after a period of use, and the use of No. 16 or 18 gauge aluminum sheeting was found to be advisable.

Also, for a medium low-toned rotary spark gap, the peak potentials developed by the average wireless transformer are greatly in excess of the secondary voltage rating, as calculated by formula. Hence a greater spacing than 3/16" becomes necessary for high-powered transformers, and a 5/16" spacing was tried with success on 20,000 volts.

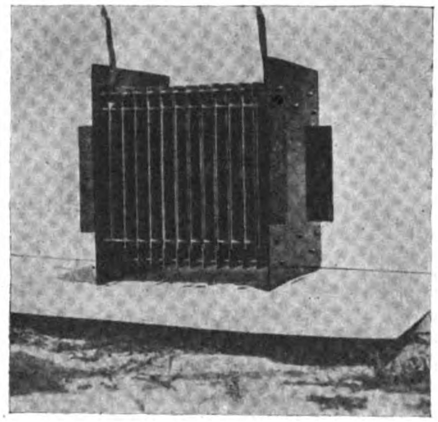


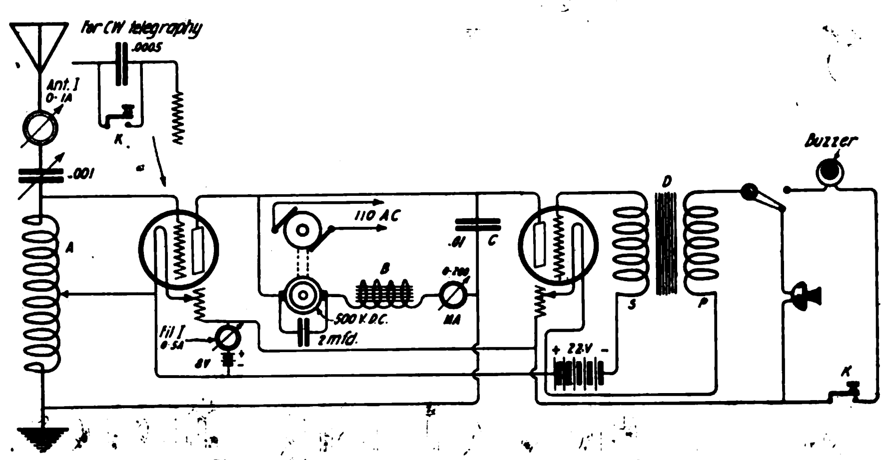
Figure 1—The oil-dielectric condenser built by the writer

A photograph of the oil-condenser built by the writer according to these specifications accompanies this article. It will be noted that bakelite end plates are used, with wooden jambs projecting to prevent the condenser slipping and touching the sides of the metal container.

Two of these condensers are in service at station 6LC, and all troubles from breakdown have disappeared.

A Substitute Circuit Diagram

THE accompanying circuit diagram is to be substituted for figure 3 of the article entitled "A Laboratory Radiophone" by Mr. Allen H. Wood, Jr., which appeared on page 27 in the September issue. Due to an omission the circuit, as it was previously published, would not be workable as the plate circuit of the modulator tube was short circuited. The diagram published herewith corrects the error. The audio frequency choke coil should be wound with 2,000 turns of No. 30 enameled wire and the microphone transformer primary is wound with 300 turns of No. 22; the secondary with 6,000 turns of No. 40. These details are necessary to secure practical operation of the radiophone.



Circuit diagram used in the laboratory radiophone

Second District Call Letters of Amateur Stations

(*Continued from September* Wireless Age)

Letters.	Power.	Name and address.
2UM	250	G. F. Mudgett, 698 East 22d St., Brooklyn, N. Y.
2UN	1000	Myron G. Pawley, 513 2d Ave., Asbury Park, N. J.
2UO	880	B. W. Heyer, 45 N. Fullerton Ave., Montclair, N. J.
2UP	800	C. H. Phelps, Jr., 310 West 92d St., New York City.
2UQ	500	Eugene D. Hallett, 86 Prospect St., Rutherford, N. J.
2US	500	Wm. H. Hannah, 70 Plymouth St., Montclair, N. J.
2UT	210	J. J. Taylor, 23 Lowell Rd., Schenectady, N. Y.
2UU	500	J. V. Candido, 584 East 26th St., New York City.
2UV	50	Geo. E. Oliver, 140 West 26th St., Bayonne, N. J.
2UX	48	M. W. Woodman, N. Y. University, New York City.
2VA	500	F. M. Schussel, 702 Hudson St., Hoboken, N. J.
2VB	50	L. B. Jamison, 195 West Lawrence St., Albany, N. Y.
2VC	10	Richard H. Van Camp, 713 Grove St., Point Pleasant, N. J.
2VD	480	M. Loos, 150 Franklin Pl., Flushing, N. Y.
2VF	50	Edward Koch, Jr., 168 Willis Ave., Bronx.
2VG	25	B. Goldman, 330 East 80th St., New York City.
2VH	36	Paul Hans, 1814 Grand Concourse, New York City.
2VJ	50	F. Jaeger, 513 East 138th St., New York City.
2VL	800	V. H. Lamarche, 18 Reckless Pl., Red Bank, N. J.
2VM	1000	P. T. Brown, 1808 Grand Concourse, New York.
2VN	50	R. McCoy, Jr., 141 55th St., Brooklyn.
2VO	36	H. Burvis, Jr., 500 West 173d St., New York City.
2VP	250	Henry Bartsch, Box 426, Marlboro, N. Y.
2VQ	500	Justus, J. Agnoli, 16 Purvis St., Long Island City.
2VR	375	S. Carpenter, 15 Charles St., Roosevelt, Long Island.
2VS	50	H. W. Schaefer, 349 East 65th St., New York City.
2VU	500	J. F. Campbell, 317 Clifton Ave., Newark, N. J.
2VV	500	C. G. Schaum, 551 West 172d St., New York City.
2VW	375	C. W. Vollmer, 944 Washington Ave., New York City.
2VX	500	G. W. McCarthy, 1012 Sutter Ave., Brooklyn.
2VY	12	R. Carlisle, 139th St. and Amsterdam Ave., New York City.
2WA	500	John K. Keers, 224 81st St., Brooklyn.
2WB	500	H. J. Fogetti, 7421 Narrows Ave., Brooklyn, N. Y.
2WC	120	Stephen W. Carey, 3d, Luddington Rd., West Orange, N. J.
2WD	500	H. L. Demuth, 82 Wadsworth Ave., New York City.
2WE	36	A. R. Heydon, 403 Decatur St., Brooklyn, N. Y.
2WF	60	R. F. Weinacht, 366 Amsterdam Ave., New York City.
2WG	500	Walter J. Garvey, 162 East 184th St., New York City.
2WH	250	Wm. H. Anderson, 41 Palisade Ave., Garfield, N. J.
2WI	250	R. N. Anderson, 353 Warburton Ave., Yonkers, N. Y.
2WJ	500	G. P. West, Railroad Ave., Sayville, N. Y.
2WK	12	C. Jos. Caggiano, 245 Pacific St., Brooklyn.
2WL	250	Walter C. Houghton, 135 Ward Pl., South Orange, N. J.
2WM	495	Wm. Leyh, 1867 Himrod St., Brooklyn.
2WO	500	R. F. Guy, 17 Maple Court, Brooklyn.
2WP	1000	Chas. O. Spannaus, 25 Saratoga Ave., Yonkers, N. Y.
2WQ	225	A. Koerner, 203 East 104th St., New York City.
2WR	12	A. G. Wester, Jr., 1075 Chancellor Ave., Hilton, N. J.
2WS	360	H. W. Sievering, 54 Nairn Pl., Newark, N. J.
2WT	750	John K. McKenna, 134 Shonnard Terrace, Yonkers, N. Y.
2WU	250	F. Wm. Boettcher, 437 Irving Ave., Brooklyn.
2WV	50	W. Wilson, 42 Hathaway Ave., Deal Beach, N. Y.
2WW	50	W. W. Stein, 48 West Van Vechten St., Albany, N. Y.
2WX	500	W. W. Allin, 37 North Spring St., Elizabeth, N. J.
2WY	50	Myron R. MacLeod, 530 Fifth St., Brooklyn.
2WZ	250	D. C. Keefe, 660 East 23d St., Brooklyn, N. Y.
2AAH	10	B. Cadmus, 500 West 122d St., New York City.
2AAY	50	S. J. Miller, 124 Hillside Ave., Orange, N. J.
2ABA	500	DeWitt L. Parker, 178 State St., Brooklyn.
2ABB	100	Wm. T. Hall, 267 Spring St., Ridgewood, N. J.
2ABE	600	G. P. Smith, 208 West 133d St., New York City.
2ABF	100	W. H. Oatman, 180 Broad St., Ridgewood, N. J.
2ABG	100	Frank G. Krebs, 16 Lincoln Ave., Arverne, Long Island.
2ABI	220	Robt. Blickenderfer, 1891 Daly Ave., New York City.
2ABJ	25	N. Sauberman, 789 East 163d St., New York City.
2ABK	25	Robt. Hertzberg, 894 Union Ave., New York City.
2ABM	945	Fred'k A. Parsons, 754 Beck St., New York City.
2ABN	220	Clifford H. Brockway, 1019 East 179th St., New York City.
2ABP	24	Donald M. Plumb, 546 West 146th St., New York City.
2ABQ	11	Jas. B. Murphy, 121 Colonie St., Albany, N. Y.
2ABS	500	H. F. Meyer, 87 Clifton Terrace, Weehawken, N. J.
2PA	660	J. H. Woolley, 1743 Montgomery Ave., New York City.

Torpedo Controlled by Airplane

By Edward T. Jones

THOUSANDS of dollars have been spent by the Government in investigation of various systems and methods of controlling torpedoes in such a way as to bring them in contact with the enemy craft whether anchored or under steam. One method proposed was to install a wireless receiving apparatus on the torpedo and by manipulating the wireless transmitting apparatus aboard one of the battleships in a predetermined manner, the torpedo was to be guided safely to its mark. The disadvantage of this system is that it permits the enemy to control the torpedo after it has come near its goal. Certainly the radio apparatus at the ship controlling the torpedo loses control after it has passed half the distance between the vessel and its target—the enemy's vessel. It has been claimed, however, that this disadvantageous feature has been entirely eliminated, but no data is at hand.

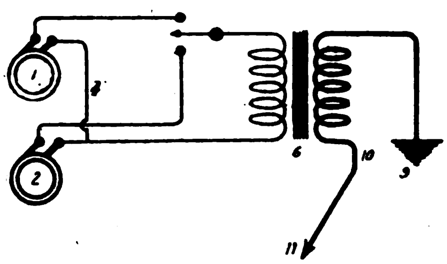


Figure 1—Circuit diagram of hookup on airplane

A method which seems to meet all requirements has been perfected by Earl C. Hanson. He makes use of a wireless receiving system installed on the torpedo, but differing from the usual system in that it works on the principle of audio frequencies. Radio waves do not interfere or actuate the apparatus employed at the receiving station aboard the torpedo, whether at a distance or very close to the enemy's vessel. This is a great improvement over systems previously tried.

In this system the torpedo is fitted with an antenna at the end of which is fastened a balloon, kite, or ship, which, maintains the antenna a considerable distance in the air. That portion of the antenna protruding out of the torpedo nearest the water line is heavily insulated, the remainder, beginning at some reasonable distance above the water line, can be made of bare copper wire. The airplane flies over the torpedo, the pilot making observations from time to time of the missile's progress, by watching the searchlight at night or the balloon in the daytime. Whenever the pilot of the airplane desires to change the direction of the torpedo's progress, he flies the airplane into the vicinity of the torpedo so that the trailing wire of the airplane is somewhere in the neighborhood of the torpedo's antenna. If the two antennae are each several hundred feet long, it is not necessary that the airplane approach closer than several hundred feet.

A description of the apparatus employed aboard the airplane and the torpedo will be necessary to make it clear just how the torpedo is controlled.

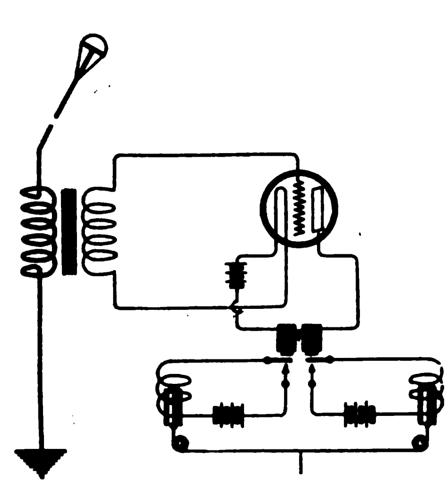


Figure 2—Diagram of circuit used on board the torpedo

By referring to figure 1, it will be seen that the airplane is provided with a pair of audio frequency generators, the generator 1 generating a frequency twice that of generator 2. One of the brushes of each generator is connected to a common wire 4, which in turn is connected to the primary of a transformer 6, this transformer having an iron core and a secondary, one terminal of which is grounded at 9, on the airplane frame and the other terminal 10, being connected to the trailing wire 11, which may be of considerable length. The other brushes of the generators are connected to a switch by means of which either of the generators can be cut into the circuit with the primary of the audio frequency transformer 6.

The apparatus installed aboard the torpedo is shown in figure 2, an antenna suspended by the balloon insulated at its lower portion near the torpedo but well above the water line passing through the hull of the torpedo and is connected to the primary of the audio frequency transformer 1. The other terminal of the primary is connected to the ground, that is, the hull of the torpedo which is in contact with the water providing a good ground. The secondary windings of this transformer go to the vacuum tube amplifier bulb, where the currents impressed upon the antenna are increased sufficiently to actuate the mechanism steering the vessel. The output side of the amplifier circuit is brought to two *vibrating relays*, the armatures of which are composed of tuned reeds and only respond to certain frequencies. It is plain, therefore, that the circuit which controls the rudder of the torpedo is only actuated by certain impulses or frequencies. When one of the generators of, say high frequency, is cut in on the airplane, the right hand magnet on the torpedo is actuated and actuates the reed, which in turn controls the movement of the torpedo. However, if it is desired to have the craft go in a different direction, the lower frequency generator is cut into the circuit controlling the left hand magnet.

This is indeed a very ingenious method of controlling torpedoes and will no doubt receive consideration from various interested angles.

Some Pointers on Reconstruction

By Ernest G. Underwood

(FIRST PRIZE, $10.00.)

GO back about four or five years if you would appreciate the improvement in amateur apparatus. Most of the amateurs, especially of the limited pocket-book fraternity, to which I belonged, were then content to use the crystal detector. The vacuum tube, just coming out, meant a storage battery, which was of course out of the question. Flashlight batteries were another item of expense. The vacuum tube itself was expensive and very delicate, with a filament that burned only a short time. Considering all things, galena or one of the other crystals suited our needs exactly. The old loose coupler, a variable condenser, which we showed with pride to everyone who visited our station, a pair of 2000-ohm phones, a detector and fixed condenser completed the outfit. Surprising results were obtained with this outfit when connected to an antenna of moderate size.

I repeatedly copied Key West, Florida (NAR), during the winter with an antenna only 40 feet high and 60 feet long, the distance being around 2,200 miles. Of course, this could only be done when conditions were good. One who has been in the game any length of time cannot help but remember with pleasure the old days before the war, when, sitting in the small radio shack with two or three other fellows visiting you and the tobacco smoke thick enough to cut with a knife, the thrill of hearing some faint spark report: "S. S. —— San Francisco for Hong Kong, 1,900 miles West of San Francisco at 8 P. M., all well," then old "KPA" (Seattle, Wash.) would come swinging in calling some Jap up in the Northern Passage. Then the famous old rotary at "KPH" would come pounding in like a ton of bricks, OK'ing for the position message you just copied. Just after we entered the war I liked to listen to this famous old rotary. It made one feel as though some friend was right near. All of the old timers missed that old rotary when the Navy took the station over and put in the quenched gap and at the same time quenched the amateur by the general order to dismantle.

Now that things are reopened let us take a night off and visit some of the post-war stations. We find them probably located in the same shed or room, but different in many respects. The receiving apparatus is entirely different and the transmitting apparatus is much more compact and neater than before the war. The receiving equipment will impress you by the absence of the old loose-coupler; in its place is a modern panel receiver, with its neat appearing scales and knobs. Beside the receiver is an instrument unknown before the war, an amplifier. There seems to be no limit to what you can hear.

Now for the pointers: The first thing we encounter is our antenna. How many antennae in use by amateurs are correctly put up and correctly insulated for the electrical strains they are supposed to stand? The average amateur erects his masts and places his antenna in position in the quickest possible time, never stopping for a moment to think about insulation. The experimenter will spend a neat sum on transmitting and receiving equipment, then turn right around and promptly throw about half of the transmitted and received energy away, due to re-radiation and absorption by improperly insulated guy wires. Poor insulation of the antenna in general also contributes to the big total of radiation losses.

Usually two poles are erected, with a small pulley at the top of each pole, a small hemp rope being used for the halyards. A few wires to hold up the poles complete the rigging. If the guy wires do happen to be insulated, the chances are that the insulators are placed as near the top of the pole as possible and another set as near the guy anchors as possible. The antenna probably consists of four wires spaced two feet apart with porcelain cleat insulators separating the wires from the spreaders. A piece of broom stick serves as a strain insulator. A great many antennae have no soldered joints, and if the joints are soldered the chances are they are not firmly soldered.

The improvements in construction are as easy to do right as wrong.

The first thing to consider is the loss in the guy wires due to the unbroken lengths of wire between the guy wire insulators which re-radiate and absorb energy. These losses can be reduced to a minimum by correctly insulating the guy wires. The guy wires before the poles are erected should be broken up into short lengths of not more than 15 feet by the insertion of insulators. For the average amateur station wooden insulators will serve the purpose and are strong enough for all ordinary purposes. Make these insulators not less than 12 inches in length by 1½ inches square. Place the holes for fastening the guy wires 1¼ or 1½ inches from each end of the insulator. After placing these insulators in the guy wires you will have no single length of wire of sufficient length to absorb any great amount of energy and re-radiation will stop. The pulley at the top of each mast should be of sufficient size to prevent any undue wear and tear on the halyard at that point. If at all possible, ¼ inch flexible steel cable should be used for the halyard, but in lieu of it ½ inch hemp, well tarred will serve. Smaller sizes of rope can be used but are very unreliable and are not worth the trouble they will certainly cause sooner or later. To insulate the halyards from the spreaders the 18 inch Electrose strain insulators are ideal for this purpose. The individual antenna wires should be insulated from the spreader by the use of Electrose or bakelite insulators. As to the size of wire to use in the antenna proper, it is largely a matter of expense. If you can afford it, 7-18 phoshor bronze antenna wire is the best. Smaller sizes of wire will do just as well, however. The antenna wires should not be placed closer than 3 feet. For amateur work 6 or 8 wires in the flat top and lead-in are to be preferred. At the far end of the antenna all wires should be carefully soldered to a jumper, shorting them.

The lead-in wires should be soldered to the flat top wires so they will not work loose. A jumper should be soldered to each lead-in wire and in turn soldered to the flat top wire and curved so that a round corner is made between the lead-in wire and the flat top wire. This will cut down the high frequency resistance caused by the square corner if this is not done. The lead-in should consist of the same number of wires as the flat top.

Another point where energy is lost in the average amateur station is at the lead-in insulator. Some wonderful substitutes have been invented by various amateurs, but nothing can beat a good Electrose or porcelain lead-in insulator. The conductor going through the lead-in insulator should be large enough to equal the carrying capacity of the antenna lead-in. They are expensive but will well repay the investment. The first cost is the only cost. A good lead-in insulator adds a great deal to the appearance of the station.

The average amateur antenna switch is well made and serves the purpose for which it is made. But let me caution you to watch out where you place the high frequency leads, if you use the switch to transfer from transmitting to receiving. Keep the high frequency leads at least 6 inches from the top of the table and from the walls. Do not run the leads through porcelain tubes. If a support is necessary use a piece of bakelite or an Electrose supporting insulator. Copper tubing makes an ideal conductor for the high frequency leads within the station. The tubing will bend easily and will also stay in place after it is bent. When neatly bent and nicely polished the appearance of the operating room is increased a great deal.

The receiving apparatus draws our attention next. There is little to say to the amateur who has one of the receivers made by a reliable company—but watch the leads when connecting up the apparatus.

To those who are building, or thinking of building, their own set I might give a few pointers. If you are making one of the variometer type regenerative receivers for 200-meter work, you can make tuning a great deal easier and cut down the distortion effect of the hand when tuning by placing a copper plate on the rear side of the bakelite panel. It can be easily fastened to the panel. Care should be taken to see that no wires or other parts touch the copper plate as it is to be connected to the ground. If you want to go further, a thin copper case can be made to completely enclose the receiver. Connect this case to the ground. The effects of the body and hands are entirely eliminated by this method.

In using amplifiers up to three steps, audio-frequency amplification is to be preferred. The steel core type audio-frequency amplifying transformers are the best for this purpose. Also, while not generally done, a great deal of improvement in the working of the amplifier will result if a separate set of "B" batteries are used for the plate circuits of each bulb. One "A" battery can, of course, be used for all the bulbs, providing it is of sufficient capacity.

In connecting up receiving apparatus it is well not to use wire smaller than No. 14 stranded copper wire. For making the interior connections of receivers No. 14 solid bare copper wire with empire cloth tubing for insulation is preferred.

Keep a careful check on your "B"

batteries. If flashlight batteries are used, test them often so that any defective battery may be removed. If defective batteries are allowed to remain in the circuit the effective voltage will be reduced. Noises in the receivers, too, will be caused by the defective cell, or group of cells. The flashlight batteries should be soldered together so that no loose connections will cause unnecessary noises in the receivers.

The "A" battery rheostats should be kept clean and the contact with the resistance wire should be firm but not tight enough to wear the wire. Dirty resistance wire on rheostats where the contact is made will cause noises in the receivers.

Loose and dirty contacts on the inductance switches will affect the tuning and strength of signals. Special care should be taken to keep the dead end switches working properly and to keep the contacts clean and tight.

If mica condensers are used in the plate and grid circuits of the receiver it will pay you to buy the best condensers obtainable; cheap ones will break down and cause no end of trouble which will be hard to find and remedy.

A careful inspection of all switches and connections should be frequently made to insure the maximum operating efficiency of the receiver. The telephone receivers recommended by most amateurs are the mica diaphragm type.

The transmitter next claims our attention. There are so many amateurs who own and operate transmitters that are very successful that perhaps my suggestions will appeal to only a few. The transformer is the first instrument of the transmitter to consider. It may be made at home if desired. With reasonable care used in its construction it will do good work. The mica condenser is best, the only objection to this type of condenser is the excessive first cost. A substitute is an oil immersed glass plate condenser, in which a good grade of oil must be used.

The spark gap is one of the most talked of parts of a transmitter. It is also one of the most important. I prefer the low-toned spark that is produced by a rotary of 16 points on a 10 inch bakelite disc enclosed in a perfectly air tight chamber. To obtain the best tone that can be obtained from a low frequency source of power this gap is run by an induction motor of sufficient power to turn the disc easily. So in getting a motor for your rotary it will pay you to obtain one that will float on the line even with the load of the rotary wheel. If the points on the rotary wheel are exactly spaced and the motor floats on the line, a tone as near synchronous as it is possible to obtain without a synchronous motor or a rotary attached to the shaft of a motor generator will be the result. The quenched gap is coming into favor for use on low frequency supply sources for amateur transmitters and will run the rotary a close race.

The oscillation transformer should be well made and amply insulated. The hinged pancake type seems to have the preference over other types. This type permits careful tuning to be done and is easily placed to the best advantage.

A good ground system means real work. Anyone planning to install a real ground should figure on this part of the job. In my estimation the best ground is the buried counterpoise type. In addition, connections are made to all water pipes. A good many trenches about 12 or 14 inches deep are dug radiating in all directions under the antenna. No. 12 bare copper wire is buried in these trenches. The wires are bunched together at one point and lead into the operating room. About twice as much wire is buried as there is in the antenna proper. Copper and zinc plates buried several feet under ground also make good grounds providing they are large enough.

The addition of a wavemeter to the station equipment will enable the operator to keep his transmitter carefully tuned and working to the best advantage.

One more suggestion. It is my last. Let us keep amateur radio on the same basis tomorrow as it is today. Let us keep in the public eye enough to have the public realize that we are not a bunch of kids playing with some toy. Make them realize that our hobby is just as dear to us as a baseball game or a golf match is to the busy business men—for the fact is that many business men find their recreation as amateur radio enthusiasts.

This Month's Prize

The attention of readers is called to the fact that only one prize is awarded for this month's contest. That is because only one manuscript was received. It is the first time this has happened, and it seems without apparent reason, for surely thousands of our readers have good ideas on the popular subjects we select each month. Come to life. We are distributing very handy sums of money each month—regular space rates for the winning articles, and prize money in addition! Those stifling hot dog-days are gone, but the opportunity for earning the price of that greatly desired piece of equipment still remains. Get in on these contests. THE EDITOR.

The Monthly Service Bulletin of the

National Amateur Wireless Association

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

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Headquarters, 64 Broad Street, New York

Doings of the Clubs

THE Springfield (Mass.) Radio Association has completed the installation of a receiving set, and has adopted two definite aims: first, to raise enough money by October first to install a complete ½ kilowatt transmitting station; and, secondly, to have every member a Government licensed operator by December first. To secure the latter aim, code instruction classes have been organized which will meet on Wednesday and Friday nights besides the regular meeting night on Tuesday. The classes will meet in the club rooms at 19 Orleans Street, Springfield, Mass., and any amateur who wishes to join should do so at once.

A new club has just been launched in New York City in the lower east side district. The organization meeting was held on September 12th, at the home of Abraham Zeitchick, who invites all nearby amateurs to communicate with him at 340 East 8th Street, New York City.

The Bedford Radio Club, of Brooklyn, would like to get in touch with amateurs to devise ways and means of getting the most out of wireless work in way of working together and arranging sociable times and visits and outings to places of common interest.

The Bedford Radio Club is planning a 3-months' course in wireless instruction for beginners.

All who are interested can apply to the club's secretary, James Corcoran, 420 Gates Avenue, Brooklyn, N. Y.

The Essex County Radio Association, of Salem, Mass., certainly has been active during the past two months.

A radio telephone exhibition for Fraternity Lodge I. O. O. F. of Salem was given on July 4th and the association held a dance by radio telephone on July 5th using two complete continuous wave sets.

A demonstration for the Lynn Chamber of Commerce was arranged for their annual outing at Idlewood

There Were Two Answers to this Question

One meant that you were due for a jolt. The other meant that you would have no regrets.

Here's the Story—

FOR more than a year—the Publishing Board of the Wireless Press has been fighting to keep up the quality of The Wireless Age and to hold the price at the old level. Believe me, it has been some battle.

Along with all other publishers, we have seen our bills busting the altitude record month after month. We have been hopeful each time that they would start a tail-spin toward normal, but nothing doing. Costs have just kept on climbing.

The other day we reached the point where something had to be done. We had to consider that you want the same "high test" matter in The Wireless Age that you have always enjoyed. So we couldn't save in that direction. We couldn't buy paper or illustration or printing any cheaper and give you what you want.

There was only one thing to do. To ask you to help—help by paying a few more cents a copy for The Wireless Age. We know you will be willing to do it to keep the magazine at the top of the ladder of quality, where it has perched so long.

The Board asked me to break the news. I said "O. K.," with reservations: PROVIDED I could call your attention to the fact that while the price is to be raised from $2.00 to $2.50 a year (only 25 per cent.) our increases in expense run from 70 per cent. for printing to 200 per cent. and more for paper, and PROVIDED that our readers have

One Last Chance

to enter or renew their subscriptions at the old rate. I felt that you were entitled to this in return for your loyal support in the past.

BOOK LIST

Practical Wireless Telegraphy—Bucher	$2.25
Vacuum Tubes in Wireless Comm.—Bucher	$2.25
Wireless Experimenters' Manual—Bucher	$2.25
How to Pass U. S. Govt. Wireless License Examinations—Bucher	.75
How to Conduct a Radio Club—Bucher	.75
Radio Telephony—Goldsmith	2.50
Radio Instruments and Measurements	1.75
Practical Amateur Wireless Stations (Compiled by Editor of Wireless Age)	.75
Practical Aviation—Maj. J. A. White	2.25
Signal Corps Manual—Maj. J. A. White	2.25
1920 Year Book of Wireless Tel. & Tel.	3.75
Manual of Radio Tel. & Tel.—Robison	2.50
Elementary Principles of Wireless Telegraphy—R. D. Bangay. Part 1	1.75
Part 2	1.75
Both	3.25
The Thermionic Valve and its Development in Radio Tel. & Tel.—Fleming	5.00
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Principles of Radio Engineering—Lauer & Brown	3.50
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Wireless Telegraphists Pocketbook of Notes, Formulae and Calculations—Fleming	3.25
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Wireless Teleg. & Telephony—Dowsett	3.50

Last Chance Offer

Effective October 5, 1920, the price of The WIRELESS AGE will be increased to $2.50 per year (postage outside U. S. 50c. extra.) Single copy price 25c.

If your order is postmarked on or before that date we will accept your new or renewal subscription for one year at $2.00 (50c. extra outside U. S.) Books ordered with subscriptions will be sent postpaid. Be sure your order is mailed before October 5, 1920.

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Lake on August 4th with receiving set and loud speakers on the side of the lake with the audience and the transmitting set on the opposite side of the lake.

Another radio dance is being planned for October when Governor Coolidge, Republican nominee for Vice-President, will address the audience by wireless telephone.

The association has three live sections now and are forming two more which will finish the organizing in Essex County.

Prize Contest Announcement

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

"REMOTE CONTROL TRANSMITTERS FOR AMATEUR USE."

Closing date, November 1, 1920.

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

Prize Winning Articles Will Appear in the January Issue.

Many amateur operators, seriously handicapped by the great volume of sound produced by the non-synchronous rotary gap, have devised several means of overcoming the situation. Best among them seems to be the "Remote Control of Transmitters." The receiving apparatus and key are placed in the house in a comfortable location while the transmitter proper is often located in the attic, cellar, or in some cases entirely outside the house in a small shed built to protect it and operated by a remote control antennae switch. We are particularly interested in this remote control switch and the method of installing such a transmitting station.

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

All manuscripts should be addressed to the Contest Editor of The Wireless Age

Some Essentials of Radio Operating

By S. F. McCartney

THE radio amateur is now standing on precarious ground. His first care should therefore be to keep strictly within the limits prescribed by the authorities, for if he does not, more severe restrictions or even actual suppression may be his portion. Every little while there is an intimation that the amateur is now on trial. We must so conduct ourselves that the verdict shall not be "guilty." To this end construct your plant so that it will be nearly a physical impossibility to emit a wave of over 200 meters. Do not put up an aerial that is too long and then resort to the "condenser in series" dodge. The inspector would hardly be satisfied. He would fear that it might get out of series when he had left! It is rather remarkable that the authorities do not prescribe the maximum dimensions of the aerial and all other transmitting equipment.

Radio is an art that exhibits many vagaries; local conditions seem to have great influence. A practice that is effective in one locality may be disappointing in another. This being the case, it seems inexpedient to give advice as to what particular form of instrument to buy or what refinement of circuit to use. Informative matter in books and magazines is so plentiful and so widely circulated that it is not necessary to give many instructions as to details unless one has a new and vital discovery to announce, and it is feared that none of us have. Get the best that your reading and observation recommend to you. Get just what you need and no more. Do not make your operating table a wilderness of wires. Let the leads be short and well separated. Then when you have good equipment use it intelligently. Study good text books and know the fundamentals of the art you are practicing. Be satisfied with nothing but the best that is in your set. I recall in particular two stations that I have seen. One almost made the beholder suspect that the owner was starting a museum, and yet that inferior-looking set was heard many hundreds of miles away. What was the secret of this success? Simply this, I think, that the operator did the very best with what he had. Then the set was in the basement within three feet of the ground. This latter fact should be well noted. The other outfit that I have in mind promised great ranges at first sight; everything was new and bright. The station was located on the second floor. This situation, of course, was not so unfavorable, but alas! Wires were running wildly about everywhere except on the floor. One naturally fell to wondering where they went and whether they ever got back. This amateur was never charged with interference by stations very far away.

Perhaps the most neglected part of the amateur wireless station is the ground connection — in fact, a first class ground is expensive and somewhat difficult to install. As is well known, the ground system and consequently the station itself should be situated directly under the aerial, and the set as near the ground as it can be got. There is no such thing as getting too much ground connection. Dig and dig and dig. Bury all metal plates you can, copper if possible. Do not merely connect them in series, but run insulated leads from a central point to each plate. Here and there we find an exceptionally efficient transmitting station. The reason is sometimes obscure. It may lie in favorable location, but is more likely to be found in the perfect ground system.

What a multitude of radio sins is covered by the vacuum valve detector! We can use inferior aerials, transmitters and receiving timers, and defective grounds, and still, in spite of freak equipment, we can receive fairly well. The popular attitude seems to be: "Let the valve do it" It is so much easier to buy a few valves than to attend to the dull, prosaic details of radio.

Speaking of the receiving side: Is the most sensitive receiver always the best? The commercial companies do not think so. If the amateur can hear another amateur 1000 miles away, he presumably can hear the hundreds that are located between, as the wave length and power of the intermediate stations cannot vary much.

But let us assume that the amateur has a well equipped station and is ready to transmit. A certain young man had a fairly efficient radio set, but he realized that he was not accomplishing much, so, having instruments in mind, he asked, "What more do I need?" The answer he got was, "The code!" A good many operators need the code, and they are not all amateurs either. First class senders are scarce. Not everyone can be a good fast sender, but everyone can be a good slow one if a determined effort is made in the beginning. Make the dash so pronounced that no one could mistake your a for an i. This is especially necessary when combatting static and other interference. Make each letter clear and distinct and do not ignore spacing. Do not splutter and "fall down." Know just what you are going to say before you begin a sentence. This can be accomplished only by clear, definite thinking. How often we hear operators repeat some punctuation mark over and over again while they are thinking what to say next. One should never forget that in radio there is but one public highway.

Things greatly needed in radio transmission are consideration for others and good judgment. In every station should be placed, printed in large letters, the expressive slang saying: "There are others." The great war seems to have done much to exterminate the "air hog," but the species is not yet entirely extinct. We all know the enthusiast who appears to sleep with his hand on the key, and we have reason to regret that he awakes so often. Then there are those industrious young men who send their practice signals out into the ether. The grand jury should sit on those budding operators. Of course as long as there are thousands of stations using nearly the same wave length and power there will be much interference, no matter how good the judgment the operators exercise. Perhaps in time some genius will bring forth a far-reaching and revolutionary discovery that will change all this, but at present we soon reach the limits of tuning. If your set is adjustable enough, why not cut the wave length down below 200 meter sometimes? Of course, power should always be cut down to the lowest quantity that will cover the distance it is desired to work.

It should be not difficult to make an improvement in the conditions affecting the handling of formal traffic. Some central authority should set aside a certain period for the transmission of messages by amateurs. During this period all conversations with the ubiquitous "Old Man" should cease. While this old gentleman is getting the rest he so well deserves, the ether would be comparatively at rest, and traffic conditions very much improved. But what authority could establish this proposed division of working hours? There can be but one answer: The Government. It is not likely, however, that the radio authorities care how much the amateurs hinder one another as long as they do not interfere with the commercial stations, and so it is probable that all they would be willing to do would be to issue a request with a statement of the necessity for it. Surely such a request from that source would be pretty generally complied with. If any one were selfish enough to ignore such a reasonable regulation, his fellow workers in the radio art could ostracize him and thus reform him.

So the problem of how to handle radio traffic with the least delay and in terference begins when the wires are raised and the ground plates buried. Very selective receiving sets must be used in order to take advantage of what little variation there is in the length and character of the emitted waves of the great number of amateur stations in the country. Send good, plain, well spaced "stuff;" set apart a period for genuine message work, and frown upon him who does not respect it; and never forget that there is a great opportunity in the radio field for the application of the Golden Rule.

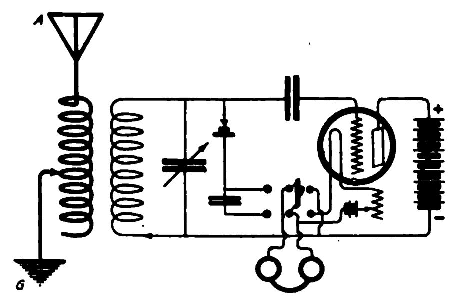
Queries Answered

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.

L. E. W., New York City:
I would suggest that you try some other type of modulating system instead of the one described, such as a transmitter in the ground circuit shunted by four to six turns of wire. Data for such a system can be found in "The Wireless Experimenter's Manual" by E. E. Bucher, which you can obtain from the Wireless Press, 326 Broadway, New York City.

* * *

C. M. G., Kansas City, Mo.:
Below you will find a wiring diagram suitable to your needs.



The various types of vacuum tubes on the market are designed to fulfill certain requirements which depend upon the type of service required.

* * *

E. R. B., San Francisco, Cal.:
Your letter does not state which diagram you are referring to in Vacuum Tubes by E. E. Bucher.

If you refer to the long wave sets, the primary and secondary tuning condensers are .001 mfd. capacity. The grid condenser .0005 and the bridging condenser .001 mfd. capacity. If you refer to short wave sets, .0005 mfd. capacity can be used throughout.

The radio frequency transformers are of the Federal type, made by the Federal Telegraph and Telephone Company, Buffalo, N. Y.

The primary inductance is wound with number 22 or 24 B. & S. and the secondary number 26 or 28 B. & S. The regenerative coils are wound with number 26 B. & S.

* * *

N. E. W., Whitewater, Wis.:

I suggest that you write directly to the manufacturers for the information and diagram of the Mignon RW4 receiver.

* * *

C. D. P., Gypsum, Colo.:

See answer number two, C. M. G., Kansas City, Mo., in this issue.

The distance you would be able to receive depends upon the local conditions surrounding your station and the power of the transmitting station. Roughly, you ought to be able to cover about 250 miles on 200 meters, 500 miles on 600 meters from 2 kw. transmitters and about 1500 on long wave stations of the NAA type. All the above distances are figured on conditions being very good and are night ranges.

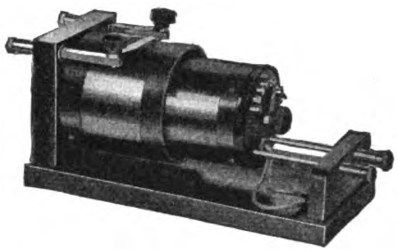
Yes, you can use 110 V. A. Co. reduced to about six volts but some system of smoothing out the current fluctuation is needed. E. E. Bucher describes such a method in "Vacuum Tubes."

Yes, you may use a six-volt, 30-ampere storage battery instead of a four-volt battery if you insert a 6 to 10 ohm battery rheostat in series.

The battery as described in the clipping attached to your letter will give service longer than ordinary dry cells but a storage battery is recommended.

NEW SHORT WAVE COUPLER No. 747

Comes up to the CHAMBERS' usual High Standard. Especially adapted to long distance Amateur work. Tunes to 800 meters. Does away with the dead-end effect so common when large couplers are used for short wave reception.

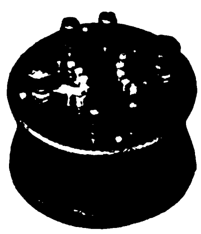


Mahogany finished woodwork. Brass metal parts. Has new slider feature. Secondary has six taps. Wound with Red Enameled Wire, or, secondary with Green Silk if so ordered. Measurements over all, length 12 inches, width 4¼ inches, height 5 inches.

PRICE - - $10.00

F. B. CHAMBERS & CO.,
2046 ARCH STREET - - PHILA., PA.

HOOK 'ER TO YER BULB



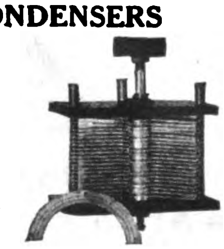
The Most Wonderful Tuner in the World for $15.00. It weighs but two pounds—size about 4½ x 4½ x 3". It has a primary and secondary coil only and receives all arc signals from 5000 M to 20000 M. It will not work with a crystal detector. The wiring diagram is in the bottom of each tuner. Do not remove top of tuner or you will destroy it—the coils are waxed in and leads are short. Tests all over the world show this tuner will receive efficiently arc signals on the smallest aerial. We recommend a single wire 25' high by 40' long. Three variable condensers and an audion are needed for the circuit.

Don't take our word for it—write us for name of nearest Amateur using one. Add Parcel Post.

NAA—ARLINGTON TUNER—5000 M

This tuner is same size as above tuner only it has a tickler coil and uses the straight audion hook up with tickler in series with phones. It is the only spark tuner that gets NAA on a small aerial without any variable manual coupling. This tuner also gets arc signals at 5000 meters and records easily wireless phone talk from 600 to 5000 meters. Priced at $15.00 plus Parcel Post.

KNOCKED DOWN OR ASSEMBLED CONDENSERS



Which kind do you want? Made for panel mounting and are complete with scale, pointer and knob. Used all over the world. No. C. O. D. orders, add Parcel Post. Buy from your local dealer or send us his name if he can't supply you.

Formica tops and bases. Movable plates are now held by nuts and not clamped with washer as formerly.

11 Plate K.D.	$1.80	11 Plate assembled	$2.75
21 " "	2.25	21 " "	3.25
41 " "	3.20	41 " "	4.25

THE UNIVERSAL CONDENSER

The only fool proof, complete assembled condenser in the world that will fit any cabinet, and take the place of any and all the condensers that you may be using. **It has a Continuously Variable Capacity from .0025 to .001 MF.** Studs are so mounted as to prevent any leakage and to fit any holes you may have already drilled in your panels. Size 3 x 3 x 1" and shipping weight one pound. Priced at $2.50 and add Parcel Post.

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'REMEMBER' We carry an immense stock and can make immediate delivery.

Power Transformers (New type)

Acme 250 Watt mounted	$16.00
Acme 250 Watt unmounted	13.00
Acme 500 Watt mounted	22.00
Acme 500 Watt unmounted	18.00
Acme 1000 Watt mounted	33.00
Acme 1000 Watt unmounted	28.00

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

Continuous Wave Power Transformers

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

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

Modulation Transformers.

Acme A-3 unmounted	$4.50
Acme A-3 semi-mounted	5.00
Acme A-3 mounted	7.00

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

Dubilier Condensers.

Type	Watts	Cap.	Volt.	Price
D-100	250	.007	10000	$19.00
D-101	500	.007	14000	30.00
D-102	1000	.007	21.000	45.00
D-103	1000	.007	25.000	50,00
D-150		.0024	8.000	5.00

Suitable for C. W. and spark coil transmitters.

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Quenched Gaps.

Amrad Type G-1	1 K. W.	$29.75
Amrad Type G-2	½ K. W.	18.85
Amrad Type G-3	¼ K. W.	13.50

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

Telephones.

Brown 4000 Ohm (Imported from England) Supersensitive	$20.00
Baldwin Type E, latest model	18.50
Baldwin Type C Navy standard	16.50
Murdock 55's 2000 Ohm complete	4.50
Murdock 55's 3000 Ohm complete	5.50

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Honey-Comb Coils

LITZENDRAHT WIRE. (While they last.)

LL-75	330-1030 meters	$1.60
LL-100	450-1460 "	1.70
LL-150	660-2200 "	2.00
LL-200	930-2850 "	2.10
LL-250	1300-4000 "	2.30
LL-300	1550-4800 "	2.50
LL-400	2050-6300 "	2.80
LL-600	4000-12000 "	3.00
LL-750	5000-15000 "	3.20
LL-1000	6200-19000 "	3.50
LL-1250	7000-21000 "	3.90

NOTE:—These are the genuine DeForest litz coils.

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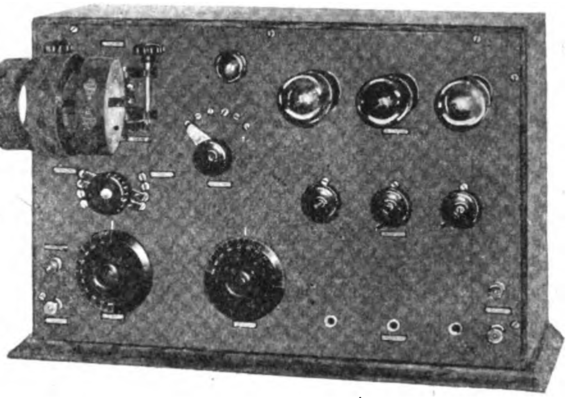

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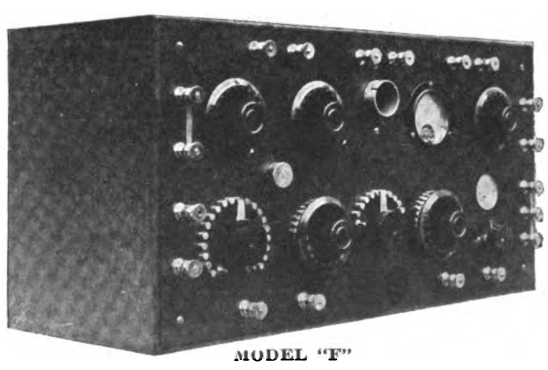

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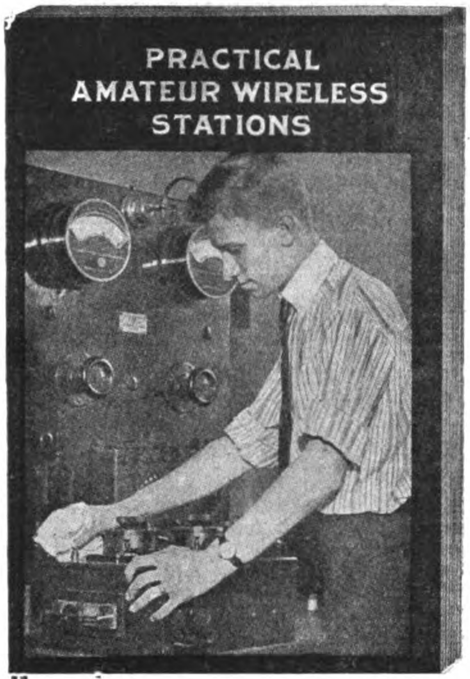

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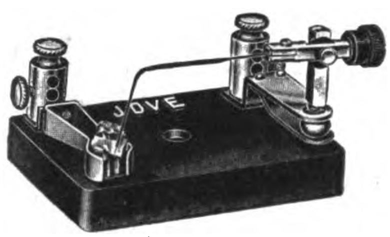

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