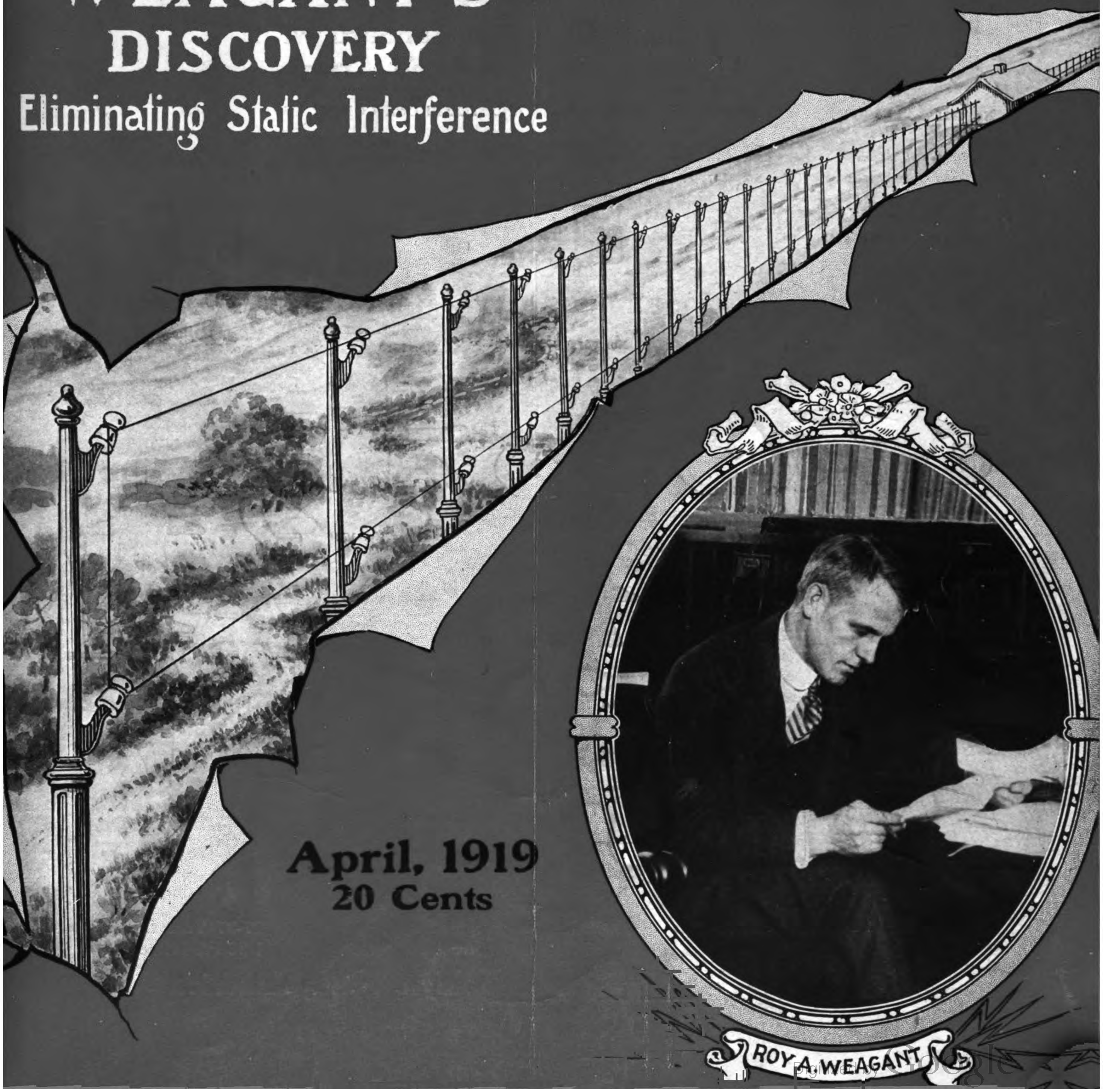
The WIRELESS AGE

Volume 6 Number 7

WEAGANT'S DISCOVERY

Eliminating Static Interference



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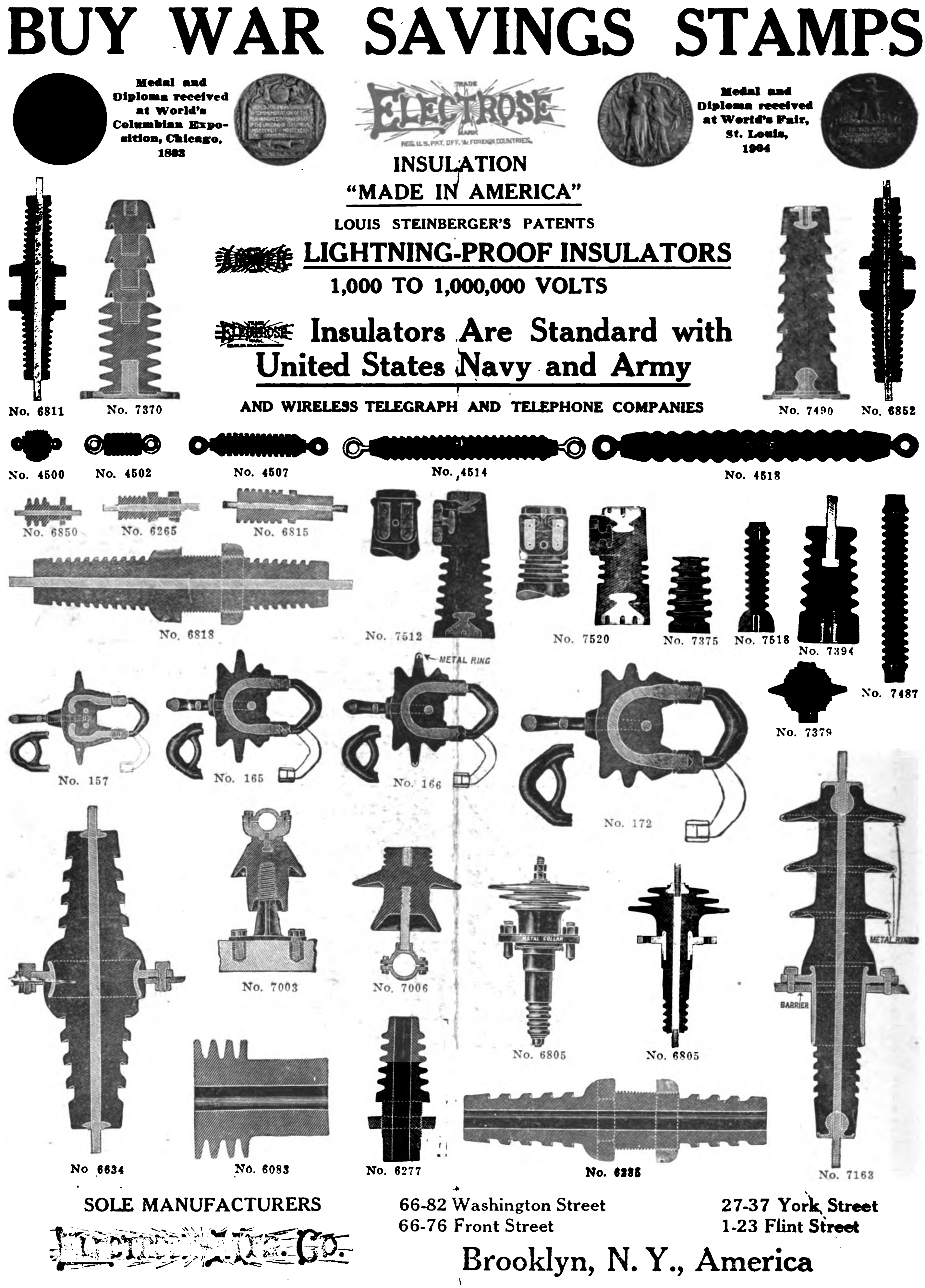
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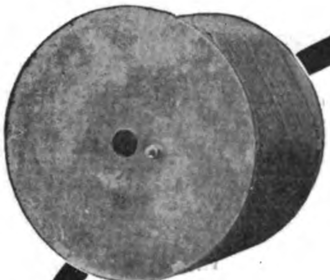

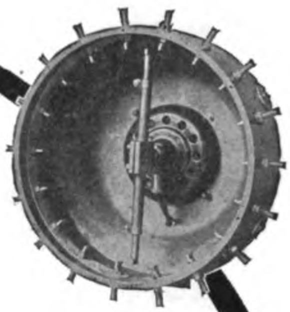

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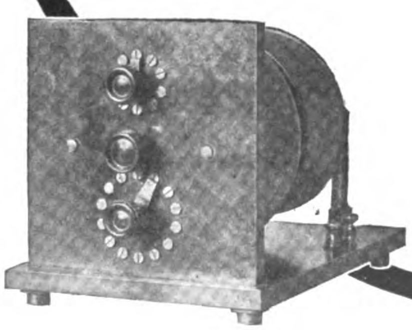

WESTINGHOUSE ELECTRIC

The Wireless Age

Edited by J. ANDREW WHITE — E. E. BUCHER, Technical Editor

Vol. 6 — Contents for April, 1919 — No. 7

Index of Equipment

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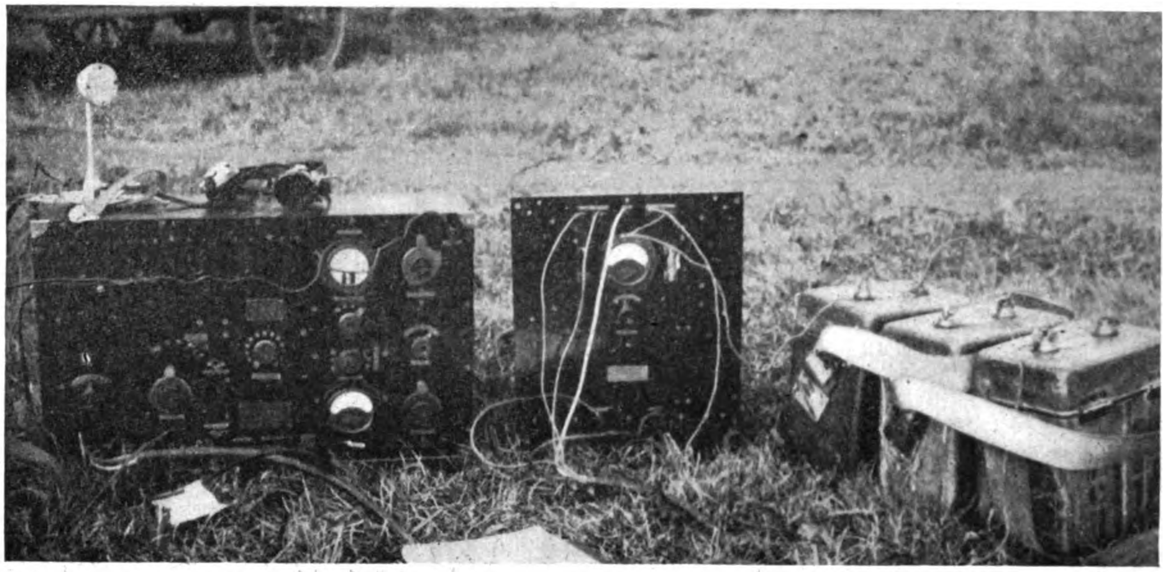
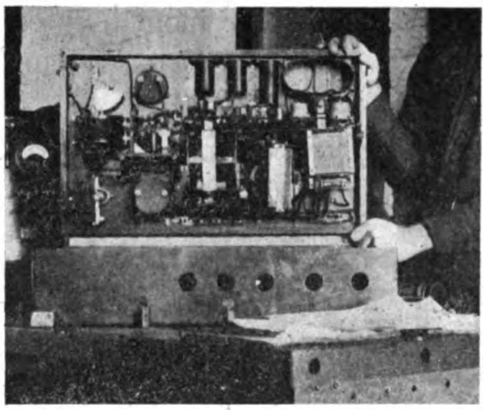


THE ARMY RADIO-PHONE

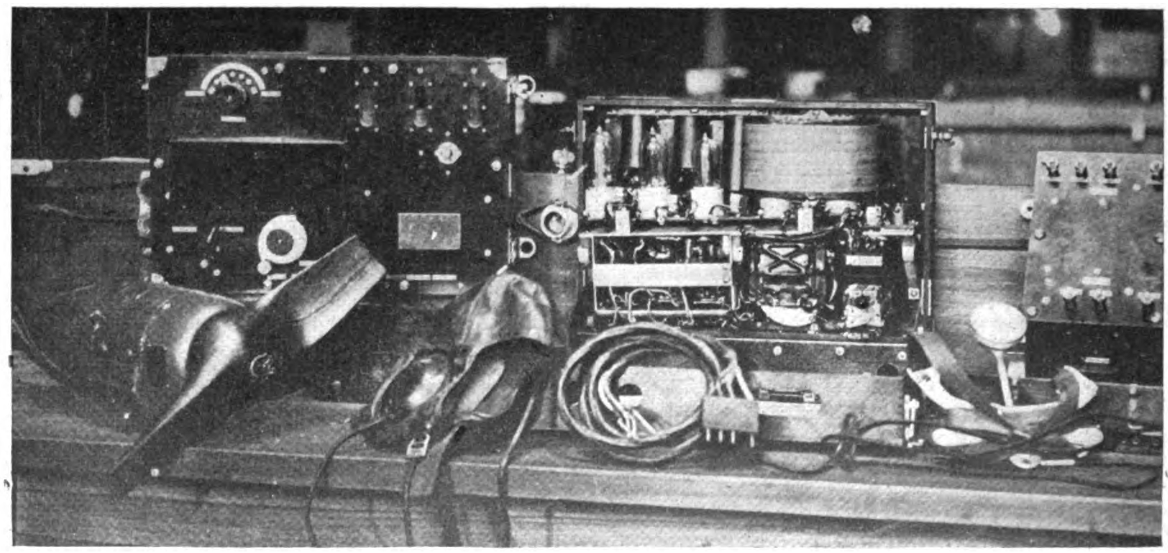
Of undoubtedly great interest to those who did not get the opportunity to work with Signal Corps apparatus are the three illustrations on this page. Above is the radiotelephone ground set; to the right may be seen its three 4-volt storage batteries; in the center, the panel and 300-volt dynamotor; the head 'phones and transmitter are on the top of the set and the automatic relay control button lies in on the ground.



Interior of the radiophone set illustrated above, showing the arrangements without the vacuum tubes; the dynamotor for supplying positive potential for plates may be seen to the left

AIRCRAFT WIRELESS 'PHONE

The airplane radio telephone set: In the left foreground is the wind-driven generator; alongside is the aviator's helmet with 'phones enclosed in soft rubber; to the left rear is the set containing both sending and receiving equipment with two-step amplifier; alongside, set with interior in view, showing bulbs; there are two transmitting bulbs inside the coil; at the extreme right is the transmitter, leaning against the interplane set used for telephone conversation between the pilot and observer.



VOL. 6. No. 7 APRIL, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Weagant's Disclosure of His Static Discoveries Converts Skeptics

CONTROVERSIAL opinions, which followed the preliminary public announcement in November that Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company of America, has solved the problem of eliminating static interference, were noticeably absent when he disclosed the secrets of his discovery on March 5th. The skeptics were converted after hearing his paper, "Reception Through Strays and Interference," delivered before a joint meeting of the Institute of Radio Engineers and the New York Electrical Society at the Engineering Societies Building in New York.

The meeting was attended by eminent scientific figures from all parts of the country and the auditorium was filled. The Weagant paper, which was illustrated with stereopticon designs, consumed in its reading nearly two hours. He was given a hearty round of applause at the conclusion of his address, at the end of which Prof. Michael I. Pupin of Columbia University, an early critic of Weagant's claims, arose from a front seat to acknowledge the discovery and invention which had hitherto been targets for his skepticism.

"We have here a momentous step in advancing the art of telephony," he said. "It is a marked improvement in the problem of getting rid of static, a great step. It should be hailed with delight by electrical scientists."

American-Built Lafayette Station Sold to France

THE sale of the great Lafayette wireless station at Bordeaux to the French Government at a price of approximately $4,000,000, and many hitherto unpublished facts of American naval activities in the war were announced here today by Assistant Secretary Roosevelt, who arrived at Boston with President Wilson on the George Washington on February 24th.

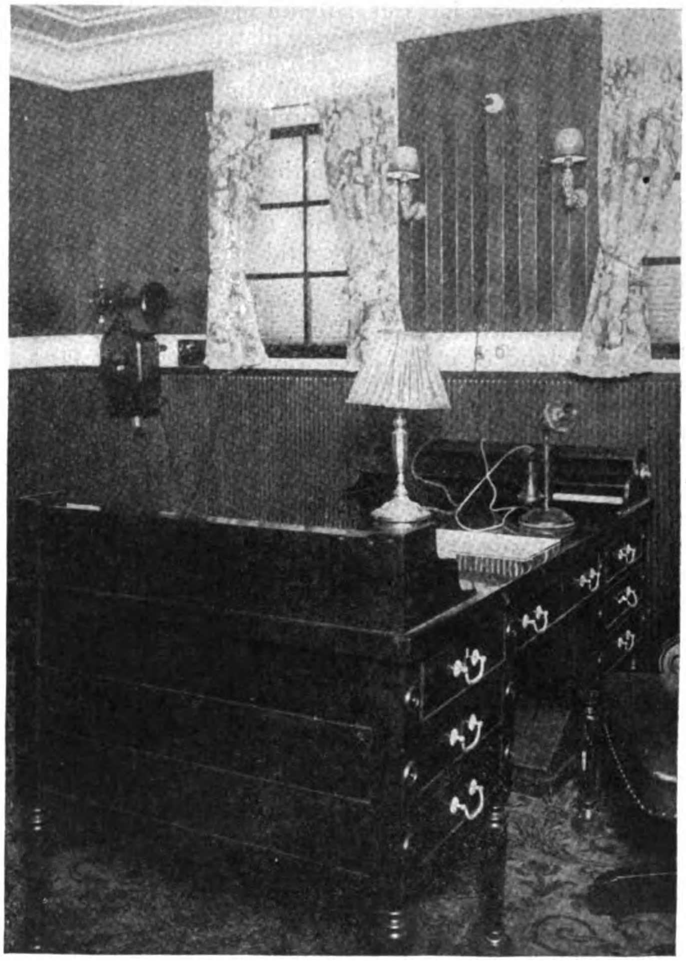
"The great Lafayette radio station near Bordeaux was intended to insure communication between Washington and the army and navy in case the cable system was put out of commission or interfered with by German submarines," Mr. Roosevelt said. "It has eight towers, and could communicate with the United States day and night. It was built by the navy. I arranged with the French Government that we shall complete the station, which is two-thirds finished, and they will then take it over at what it costs us, about 22,000,000 francs."

Ten Wireless Stations for Scandinavian Countries

IT is announced in Lloyd's List and Shipping Gazette that a large radio telegraph station has recently been erected at Karlsborg, in Sweden.

The station has a radius of 5,000 kilometers (about 3,100 miles), and will thus be able to communicate directly with America.

In addition to the Gottenborg and Karlskrona stations three others are being built in Sweden—at Boden, Hernosand and Vaxholm, near Stockholm. The station at Karlsborg has two masts, each 210 meters high. The aerials between the masts consist of six wires 450



Telephone equipment installed in the President's room on board the steamship George Washington

meters long. The electric current is supplied from the Trollhattan hydroelectric power station, and is converted at the station to a periodicity of 15,000.

In Norway the Stavanger station is nearly finished. It will communicate with America, where the Marconi Company has built a sister station. Its radius will be equal to that of Karlsborg.

Rundemand station, near Bergen, with a radius of 800 to 1,100 kilometers, has been in use some time, and Tryvand station, near Christiania, will be ready in the near future.

Radio Devices for Mapping Arctic Regions

AN important contribution toward the success of the Roosevelt Aerial Arctic Expedition, to be headed by Captain Robert A. Bartlett, was announced at the thirteenth annual dinner of the Aero Club of America. John Hays Hammond, Jr., stated that he has devised a system by which maps of the Arctic regions may be made with unprecedented speed and accuracy through the use of radio devices.

Mr. Hammond, in his address, said in part:

"The war has contributed three important scientific developments for the purpose of exploration—first, the aeroplane; second, the application of radio signaling to aircraft; and, third, the development of aerial photography.

"I have devised a system, the main principles of which are extremely simple, embodying these three technical developments in a system of aerial surveying, utilizing which it should be possible for vast tracts of territory to be mapped with accuracy and speed never before attained in mapping.

"It is hoped by the Aero Club to apply this system in the exploration of the Polar basin, a vast territory, concerning which man has but little knowledge. We hope to achieve by the use of these new instrumentalities the results in a few months which before would have required years of the enduring and almost superhuman struggle which characterized Admiral Peary's extraordinary achievements."

Mr. Hammond then explained that a number of radio direction-finding bases would be established on a base line from Mackenzie Bay to Cape Columbia. The airplanes used for exploration would be equipped with radio transmitters.

Then the aviator, at a rate of eighty miles an hour, will fly over the regions. By various tests he will distinguish land from ice floes, and once he finds land he will fly along its contour, encircling it. His signals will be picked up by the finders along the base line, keeping check on his movements.

A photograph is taken from the machine at each signal. These pictures all attached will show a progressive outline of the coast and can be checked up by the chart made at the base line stations.

Patriotism and Profits Revealed in American Marconi Report

IN the annual report of the Marconi Wireless Telegraph Company of America the operations for the fiscal year show, before allowing for reserves, a net income of $998,358.14 as compared with $780,592.44 for the year 1917.

The net profits for the year, after utilizing $286,516.37 for reserves, amounted to $711,841.77 as against $617,772.69 in 1917, or an increase of 15.23 per cent. This amount has been added to the surplus, increasing that account, after payment of $499,975.00—1918 dividend—to $1,631,415.78 at December 31, 1918, and the reserves set aside at that date for depreciation amount to $629,176.27 additional.

The directors call attention to the dividend of 5% per annum which was paid August 1, 1918, and to the declaration of another dividend of 5% per annum payable July 1, 1919, to stockholders of record June 1, 1919.

Noting that the company continued in 1918 its whole-hearted efforts to cooperate with the government in every way possible, in the conduct of the war, the report observes:

"Of approximately 1,200 male employees on its roll, 456 were numbered in the stars of its service flag, and seven were called upon to make the supreme sacrifice for their country." Mention is made of the official recognition of the company's war service expressed by Commander S. C. Hooper, of the Navy Department, which The Wireless Age published in its earlier account of the hearings on government ownership of wireless. The testimony of the Marconi officials before the House Committee is made a supplement to the report, with a caution to stockholders to remain on the alert and to protest against any new attempts to pass measures destructive to the business of the company.

Sound Transmission by Rays of Light Reported from London

A COPYRIGHT dispatch from London to the Press Publishing Co., stated under date of March 8th, that the London Daily Express understands that wireless telephony by the use of light rays has been discovered and successfully experimented with by a young doctor of physics at University College of London. A message sent by the new wireless telephone is, in effect, a spoken heliograph, and wherever it has been practicable to send a Morse code heliogram by flashes it will be possible, when the invention is developed, to send spoken words. The experiments were carried out for the Admiralty during the war. Mr. Balfour, then First Lord of the Admiralty, and Admiral Beatty, sitting in a flagship in the Firth of Forth, were able to talk over the light ray telephone direct to the Admiralty and receive messages back. Later the apparatus was placed in submarines and used with success.

Hammond's Wireless Controlled Craft Approved

ARMY and navy experts have reported favorably on the device of John Hays Hammond, Jr., for radio control of surface craft to be sent laden with explosives against enemy ships. They predict similar results with submerged craft showing above water only wireless antennæ.

Before finally deciding on the purchase of the patents for $750,000, the board desires further experiment with the submerged craft and a change in law for the experiments is necessary to permit building so as to make success certain before purchase.

Construction of the submerged craft which will be about 80 feet long, by 7 feet in diameter, will take two years, according to Mr. Hammond, who told the committee he has spent ten years and $400,000 on his invention.

"There is no question whatever as to the ability to control with great accuracy the torpedo or carrier, whatever kind it is," said a letter to Major-Gen. F. W. Coe, a member of the board, "so long as it is a surface vessel or has any antennae above the water, by direct radio waves, either from shore or from airplane.

"The board had before it also, and considered, the ability of the enemy to interfere with the control of the vessel by radio energy. Mr. Hammond's claims are that no interference can be had with the craft outside a radius of 100 to 250 yards from the source of the energy; that is, from the radio plant of a battleship, for example.

"Within such a radius a certain interference from a powerful wireless station is possible, but that interference with the apparatus only operates to keep the torpedo on a fixed course on which it may be running."

With a shore station having a height of eighty feet above sea level radio control of the craft has been demonstrated to the board up to a distance of about seven miles.

"A surface launch with the apparatus on it," said Gen. Coe, relating demonstrations before the board, "was controlled from both the shore and from an airplane, the means of control in each case being the same. The board also witnessed the dropping of depth charges from the stern of the boat while it was proceeding on any desired course."

Gen. Coe said he had run the craft "all around vessels coming into the harbor at will," and at close ranges there would be no difficulty in ramming a vessel from shore.

Mr. Hammond said an aviator after four hours training on control was able from a height of 9,000 feet and a distance of six or seven miles to exercise absolute control over the high speed boat.

Overseas Radiophone Talks a Certainty

CONVERSATIONS by wireless with Europe were predicted for the near future in a newspaper interview given by Edward J. Nally, vice president and general manager of the Marconi Wireless Telegraph Company of America, who returned on March 9th on the Dutch liner Nieuw Amsterdam, after spending five weeks in France and Belgium arranging for the resumption of the normal flow of commercial wireless and for the installation of the recently developed system of radio telephony.

"The scientists of Europe are greatly impressed and enthused with the discovery by Roy A. Weagant, which eliminates the static troubles that hitherto have been the bane of wireless communication in bad weather," Mr. Nally said.

"In the not very distant future you will be able not only to use your telephone to call up a friend in Chicago or San Francisco and converse by wireless, but the radio telephone soon will be developed to a point permitting similar talks from America to Europe.

"It is now possible to use the telephone you have at home in connection with the wireless, thereby cutting down, as the installation of wireless apparatus on telephone systems grows, the need for more telephone trunk lines, and thus doing away with an increase in the material used in construction of telephone trunk lines."

Congressman Believes Wireless Development Has Doomed Wire Systems

ALL the telegraph and telephone poles, wires and instruments will amount to "scrap" in a year if the progress now being made in wireless communication continues, Representative Steenerson, of Minnesota, ranking Republican member of the House Postoffice Committee, predicted on January 30th.

"Radio communication is the coming thing," Mr. Steenerson said. "It is making such rapid strides that before the end of the year the average American will not be bothering much about the transmission of an ordinary message over an ordinary telegraph or telephone wire or as to whether the ordinary telephone or telegraph wire is owned or controlled by governmental or private interests."

Congressman Steenerson declined to comment upon the report that most of the telegraph and telephone companies would be glad to turn over their properties —which they now estimate to be worth about a billion dollars—to the government, if they would be permitted to invest their capital in wireless communication which they are said to regard as certain to supplant present methods.

Testimony given before the House Merchant Marine Committee as to the possibility of radio communication replacing present methods, Mr. Steenerson added, bore out his argument that "there was no reason for anybody to become unduly excited over the question of government ownership of wires."

"It will mean," he said, "that the properties of the Western Union Company and the American Telegraph and Telephone Company, as well as that of the Postal Company, will change so in form as to represent systems not at all comparable with their present ones."

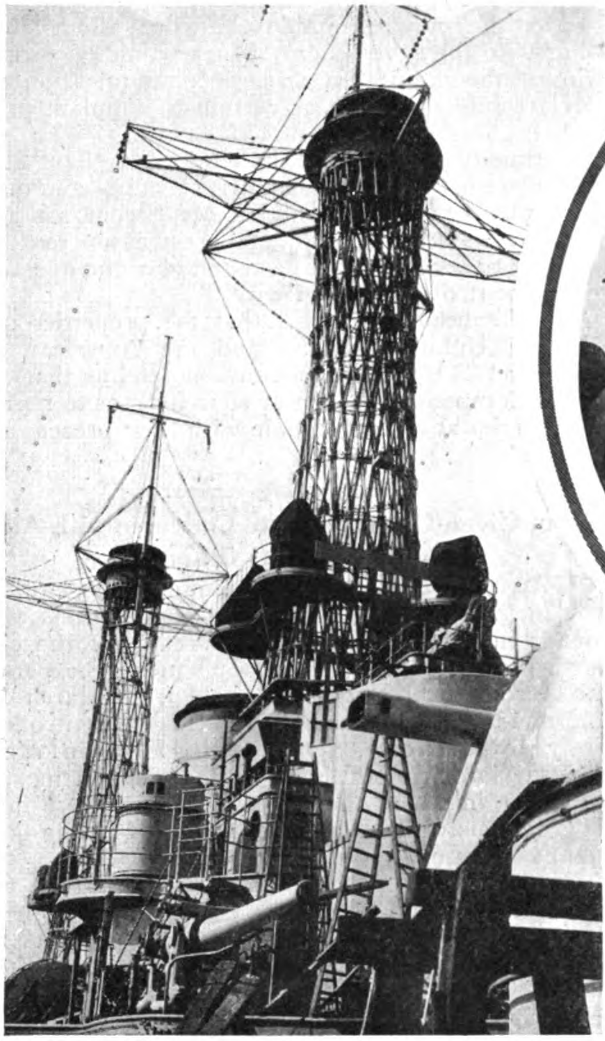
Public Given Opportunity to Converse with Aircraft by Wireless 'Phone

NEW YORKERS had the unique privilege of listening to wireless telephone conversations with a squadron of airplanes which soared over the city in battle formation each afternoon during the period of the Aeronautical Exposition, held from March 1st to March 15th. The squadron flights were controlled entirely by wireless telephones installed in Madison Square Garden and the 69th Regiment Armory, the buildings in which the aircraft exhibits were housed. The demonstration was an official part of the government's feature at the exposition.

The novel feature was the privilege given to the general public to wear flying headgear and helmets during the period when formation flying was under way. Visitors were permitted to converse with the squadron commander, and also listen to the orders given from the ground, and from the squadron commander to the rest of his pilots.

Andrew A. Allan of Canadian Marconi Company, Dead in Montreal

THE loss of a pioneer in commercial wireless was recorded when Andrew Alexander Allan, a member of the well-known shipping family of Montreal, died on February 11th, in that city. He was the son of the late Andrew A. Allan, founder of the Montreal Ocean Steamship Company, whose vessels were operated as the Allan Line of steamships. He was born in Montreal June 15, 1860, and was educated at Rugby, England, and by private tutor. For almost his entire business life he was identified with the Allan Line. He was also connected with several other large corporations, having been, up to a few weeks before his death, the president and a director of the Marconi Wireless Telegraph Company of Canada, the shipping Federation of Canada, and the Dominion Dry Dock Company.



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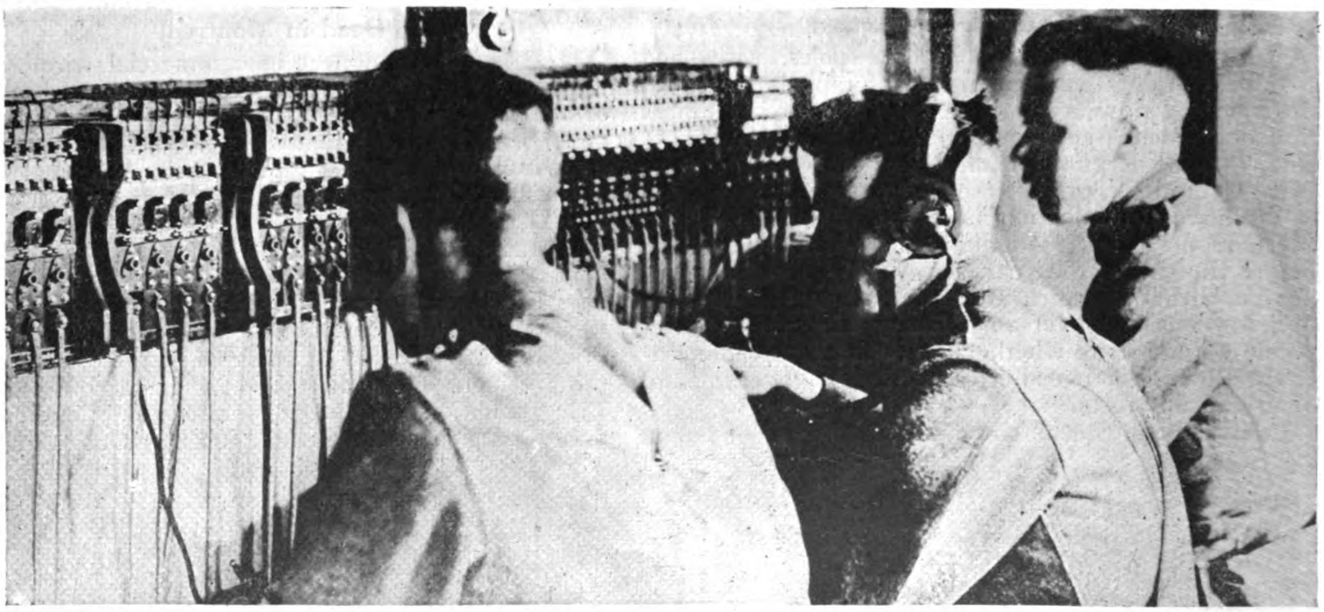
Army and Navy Methods

An interesting arrangement of wireless aerials to obtain extra capacity may be noted in the view of the U. S. S. Idaho, on the left; in addition to the usual double triangular form of antennae on hexagonal spreaders, festoons of ring-spread wires are draped from the masts. In the circle above are two of the army's wounded, one-armed heroes, mastering buzzer communication



Work of the former 1st Bn. Signal Corps, Pennsylvania militia, is illustrated by the above photo of a telephone and telegraph exchange in Abeele, Belgium, during the latter part of August. Left to right, the men are: Privates H. G. Smith, E. K. Daly and H. R. Shaw, all of Company C, Hdqrs. 108th Regt. Infantry, 27th Division

Weagant's Anti-Static Invention

Details of a Great Discovery Which Has Revolutionized Long Distance Wireless Communication

An abstract of a paper read before a joint meeting of the New York Electrical Society and the Institute of Radio Engineers at a monthly meeting, Wednesday, March 5, 1919.
In Two Instalments.

PART I

Reported by Elmer E. Bucher
Director of Instruction, Marconi Institute

TO a large and enthusiastic audience composed of radio engineers and scientists of prominence, at a joint meeting of the Institute of Radio Engineers and the New York Electrical Society, held March 5, 1919, Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Co. of America, delivered a paper describing in detail his apparatus for the elimination of the great bug-bear of transoceanic wireless communication—static interference.

So quiet had the details of Weagant's great discovery been kept that few in the audience had the slightest inkling of the fundamental principles upon which the operation of his system is based. And so convincing was the explanation given by the speaker that even the most skeptical were compelled to admit that the discovery was not the result of speculation in theory, but was the outcome of a progressive series of orderly, scientific investigations founded on sound scientific principles.

In the subsequent discussion of the paper, one of the first to laud the inventor was Dr. Michael Ivadorsky Pupin, world famous scientist, who remarked that whatever may be our opinion of the theory advanced supporting a seemingly vertical propagation of static, the outstanding fact remained that Mr. Weagant had demonstrated beyond all doubt that his apparatus was a practical operative proposition and, after all, this was the all-important thing to be considered.

He congratulated the inventor on the success attained and remarked that the discovery was one great stepping stone toward the final solution of the ideal wireless system. He hoped that radio engineers would now give their attention to the development of an amplifier which would permit transoceanic communication with very small powers, for, as he jocularly remarked, the average college professor with his limited pocketbook could not accustom himself to think in terms of 200 kw. radio frequency alternators and enormous receiving aerials such as now are employed! He felt, however, that the commercial success of transoceanic communication is now assured.

David Sarnoff, Commercial Manager of the Marconi Company, brought out the fact that for the first time in the history of electrical communication we are enabled to establish a telephonic service between countries separated by the oceans, noting that in the some 60 years of the practical applications of electrical signaling, no solution of the problem had even been suggested. He also threw an interesting sidelight on the inventor's ideas regarding nature and its laws, declaring that Mr. Weagant once remarked that he could not conceive that Mother Nature, having given to mankind such a priceless boon as wireless communication, would deliberately put into force another unsolvable law which would destroy its usefulness. Mr. Weagant had held to this belief firmly, and his subsequent success would seem to indicate that his discovery had initially more of the nature of an inspiration than had ordinary scientific achievements.

G. H. Clark, Expert Radio Aide, U. S. N., who had been assigned to the U. S. Navy Department to witness the experiments of Weagant, testified to the indefatigableness of the inventor, ascribing his success to stubborn persistence and willingness to abandon a mere theory in favor of an experimentally demonstrated fact. He stated that he was amazed at the results secured in the very earliest experiments, which he was privileged to witness, and that, concerning the ability of the Weagant system to weed out static, there could be no doubt.

F. N. Waterman, who has been closely associated with Weagant from the inception of the invention, praised the inventor for his daring in attacking a problem of such magnitude and declared that it was the ability of Weagant to recognize the fallacies of all previous systems purporting to eliminate static that enabled him to evolve a practical method of wireless reception of wonderful, commercial and scientific value. He recounted in a most interesting manner the results of early experiments, and the many obstacles and discouragements met with and overcome.

He stated that after complete success had been attained, it was almost uncanny to pick up a telephone receiver, at a long distance radio receiving station, in which the crashes of atmospheric electricity were so loud that it was next to impossible to detect the wireless signal, and then to simply throw a switch and note the static disturbances disappear to a degree that required a trained ear to hear them; and simultaneously to note the wireless signal so increased in intensity as to make it easily readable.

E. F. W. Alexanderson, of radio frequency alternator fame, said that when it was first mentioned that a hitherto unknown law of nature had been uncovered, he was somewhat skeptical regarding it, but now it was plainly to be seen that the speaker of the evening had made a discovery which gave practical results.

Previous to the meeting much speculation had existed regarding the newly observed law of nature disclosed by Weagant's experiments, and while the speaker plainly asserted that his theory regarding the origin of a particular type of static may yet call for some revision, the reported results of his researches, in a large measure, justified, in the judgment of those present, the belief that Weagant had observed and made practical use of a hitherto unknown static phenomenon.

Classification of Static or Strays

As a beginning, Mr. Weagant first classified strays after the well known method of Eccles, pointing out from his observations the distinction between the types that represented genuine obstacles to transoceanic communication and those which caused but occasional interference and could therefore be ignored. Static disturbances due to local lightning and snowstorms were ignored, for the reason that these types are of so infrequent occurrence as to be of negligible importance; but there remained the three types, termed, "grinders," "clicks" and "hissing." The last named, which are due to an actual discharge from the aerial to the earth, give no trouble in the ungrounded aerials used in the Weagant system. Of the remaining two types, "grinders" and "clicks," the former were found to constitute the major source of difficulty.

Some Fallacious Ideas Exposed

The success of Weagant's endeavors to eliminate from the receiver the most troublesome forms of atmospheric electricity may be attributed primarily to his clear recognition of the limitations of all so-called static elimination previously evolved.

Take, as an example, the well known receiving circuit in figure 1. His experiments and observations revealed that the static currents induced in the aerial system, A, L-2, L-3, E had the *frequency* and the *damping* of the antenna circuit itself, no matter what frequency of oscillation to which it happened to be adjusted. It therefore became evident that if one were to separate, by any sort of a device, the static currents in the antenna system from the signal currents, he would be confronted with the proposition of separating two currents of the same frequency in the same circuit.

Experimenters, heretofore, had tried to get rid of static interference by detuning the antenna circuit, by differentially combining two radio frequency receiving circuits, by differential connection of two detectors of different characteristics, by differentially combining two audio frequency circuits, as in DeGroot's method, and finally by the use of the Dieckmann shield.

The hoped-for results in detuning the antenna circuit could not be realized because such detuning did not reduce the intensity of the static signal, but simply changed its frequency. The loss, in the transfer of static energy to the secondary circuit when tuned to the frequency of the incoming signal, is exactly the same as the loss in intensity experienced by the signal currents through detuning the antenna. This, of course, does not improve conditions in the slightest, for it reduces the static and the wireless signal in the same ratio.

Some improvement has resulted from the use of loose couplings between the primary and secondary circuits, provided there is a marked difference between the damping of the signal and static currents; but the relief was by no means sufficient to be of any considerable value when working over great distances.

The "interference preventer" next came in for well deserved criticism and was proven by Weagant to be ineffective. As many of our readers are aware, Fessenden coupled, differentially, the two legs of a branched aerial, or the primary circuits of two separate aerials, to a common detector circuit as shown in figure 2. He concluded that if one branch, say A, be tuned to a transmitting station and the other branch, B, be detuned, static currents of equal intensity would be induced in both sides and would be annulled, and that, as the signal in one branch had little or no opposition from the other branch, it would be heard. He assumed the static currents to be forced oscillations and, therefore, that their frequency and intensity were unaffected by an amount of detuning that would *greatly affect* the signal. This, as Weagant clearly pointed out, is an absolute fallacy.

The fact is, that when one branch of the antenna circuit is detuned, the frequency of the static signals changes accordingly, leaving static currents of one frequency in one branch, and of different frequency in the other branch. It is, obviously, not possible to *balance out two opposing E.M.F.'s of different frequency*. Moreover, the detuning of one branch affects the intensity of both the signal and static currents in the secondary circuit in the manner just explained.

It is important to note here that two opposing E.M.F.'s can completely neutralize each other *only* when they have the *same frequency, the same wave form, and opposite phase*. And in the case of damped oscillations, in addition to these requirements, the dampings of the two E.M.F.'s must be identical. The writer feels assured that readers will at once recognize that the steps by which Mr. Weagant eventually arrived at the result attained in his receiving system, constitute one of the most original applications of engineering principles ever made in radio telegraphy.

Continuing, Mr. Weagant said that if any experimenter had secured worth-while results by means of a differential audio frequency circuit, such results have been due to the looseness of coupling involved in the circuits under test. He pointed out also that the effectiveness of balanced detector circuits is due solely to the protection against loud crashes afforded to the ear of the operator. Re-

Points of Interest Disclosed by Weagant's Experiments

The static currents induced in a receiving aerial by static "waves" are of the same frequency and of the same damping as the complete receiving system.

When the oscillation frequency of the antenna circuit is altered by local tuning, the frequency of the static currents changes in accordance.

For that reason, the differentially connected, branched aerial system proposed by Fessenden is ineffective in reducing static; for when one branch is detuned to the wireless signal, static currents of different frequency exist in the two different branches. Obviously, two currents of opposite phase but of different frequency cannot be made to neutralize one another.

Mr. Weagant's researches prove that all forms of static eliminators utilizing differentially connected audio or radio frequency circuits, are of little or no value for continuous long distance wireless reception.

The dominant type of static waves, called "grinders," apparently is propagated vertically in respect to the earth. Therefore the static "waves" resulting therefrom are at right angles to the wireless waves. By the use of properly disposed aerials advantage can be taken of this phenomenon to separate the static and the signal currents.

Two closed circuit loop antennae, spaced ½ wave length from center to center, the planes of which are in the path of a passing wave, will be acted upon simultaneously by the vertically propagated static waves, but at different times by the horizontally propagated wireless waves.

Hence, when both loops are correctly coupled to a common receiving set, the static currents will be in phase and may be neutralized. The signal waves will be out of phase and will not neutralize, but will add their E.M.F.'s vectorially.

By proper adjustment of the phases of the currents in one loop, in Weagant's antennae system, uni-directional reception is possible, signals of maximum intensity being secured from waves arriving at one end of the loops, while interference from the other end of the loops may be annulled.

Underground or surface-ground aerials act as ordinary closed circuit loops erected above earth. By reason of the capacity effects between the ends of the aerials and the earth, a return path for the induced currents is afforded, which effectively closes the circuit.

The greater the capacity per unit length between the underground or surface-ground aerial and the true underlying earth, the shorter is the maximum length which can be used to advantage. This accounts for the fact that approximately 2500 feet is the maximum length that can be employed for underground aerials placed under brackish water.

garding the Dieckmann shield and the ability of the combination system to reduce static, as described by De-Groot, the speaker declared that he could see no basis

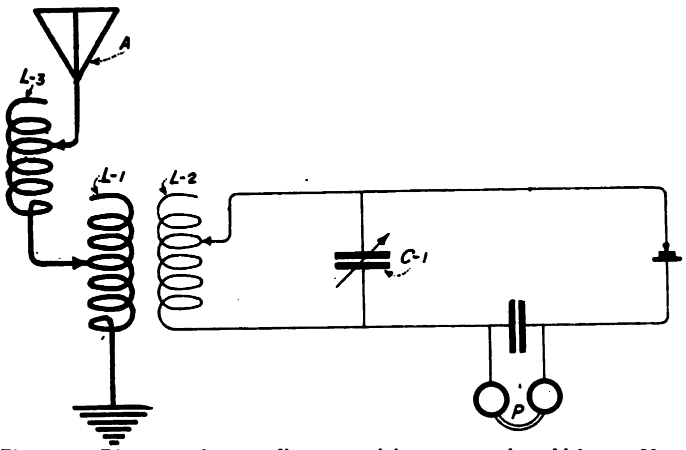


Figure 1—Diagram of an ordinary receiving system in which, as Mr. Weagant points out, the frequency and damping of the static currents are the same as that of the complete receiving system itself. As a consequence, when the oscillation frequency of the antenna circuit is changed by local tuning, the frequency of the static currents change accordingly

therein for differentiating between static and signals, and that investigation had proved that the problem of screening out any electromagnetic wave of any sort, either signal or static, cannot be solved by that method.

For experimental observations Mr. Weagant constructed various forms of aerials, including the horizontal linear—underground and surface-ground aerials. Some of these were found to appreciably reduce static, but the general characteristics of the underground type proved, under experimental investigation, to be entirely different from theories recently advanced. Mr. Weagant's deductions in respect to this aerial will be stated further on.

Some Important Observations Regarding Static

In an effort to determine, by means of the Marconi-Bellini-Tosi direction finder (shown in figure 3), whether or not static was horizontally directed; that is, if it originated from any particular direction at certain hours, Mr. C. H. Taylor, a Marconi engineer, carried out a series of experiments at Belmar, N. J., with apparatus designed for the reception of long waves over great distances. Experiments were also carried on by Mr. Weagant, at Belmar, and simultaneously at another station erected at the Marconi factory at Aldene, N. J.

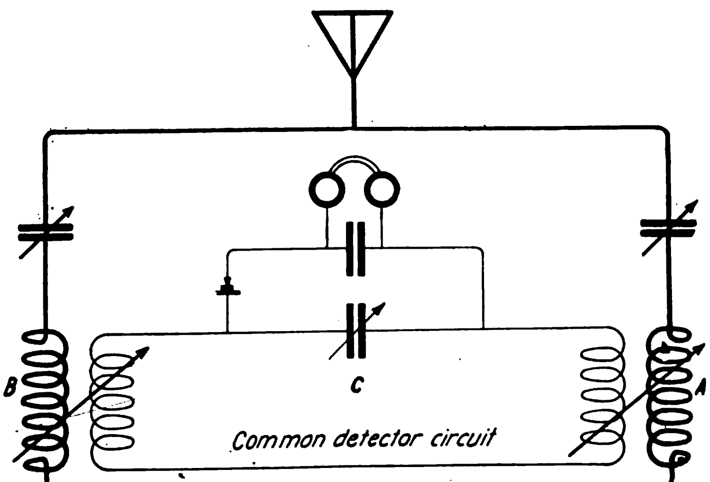


Figure 2—Circuits of the "interference preventer," which Mr. Weagant proves to be ineffective in reducing static. When one branch, say A, is detuned to the wireless signal, the frequency of the static currents change accordingly; hence, static currents of one frequency flow in one branch and of another frequency in the second branch. It is obvious that two currents of different frequencies cannot be made to neutralize each other

These tests seemed to indicate conclusively that the dominant type of static—"grinders"—apparently came from no definite direction, but *gave an equality of disturbances from all points of the compass.*

A further check on this observation was made by rotating a closed circuit loop (see figure 4) connected to a receiving set, about the vertical axis, A. The loop showed equality of disturbances regardless of the direction of the plane of the loop.

These experiments, as Mr. Weagant said, indicated that if static disturbances of the "grinders" type were propagated horizontally, they must come from different directions, and so rapidly that the observer would have no opportunity to manipulate his apparatus with sufficient rapidity enough to determine their direction.

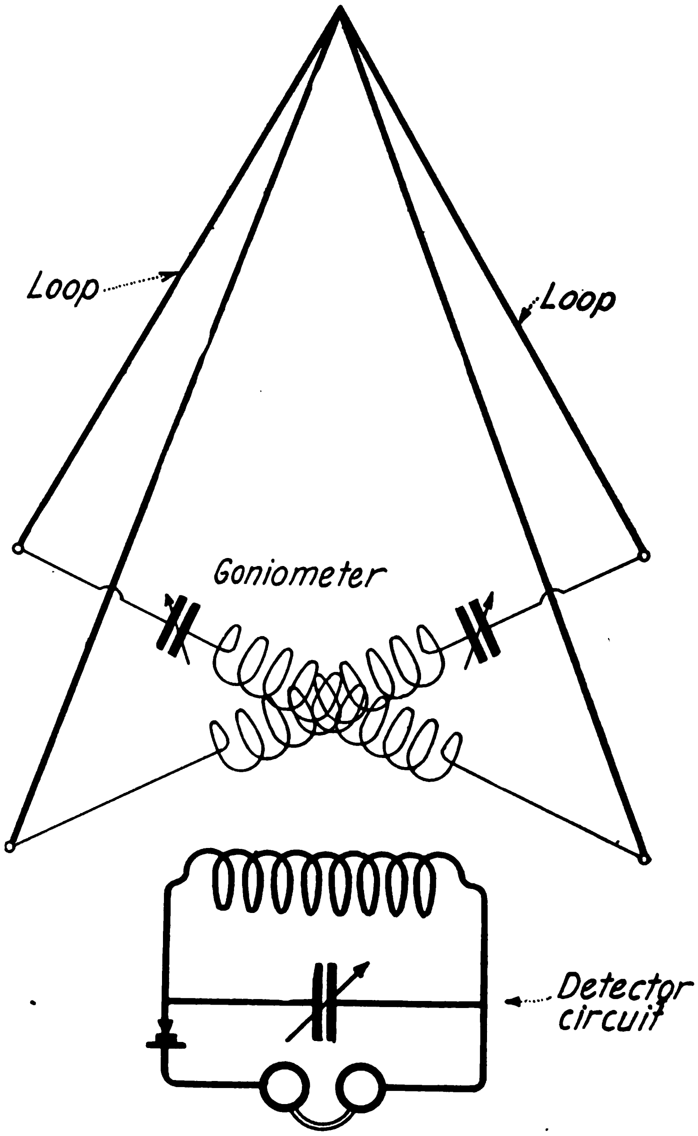


Figure 3—Fundamental circuits of the Marconi-Bellini-Tosi radio goniometer with which experiments were conducted at Belmar, N. J., by C. H. Taylor and R. Weagant to determine whether static signals emanated from any particular direction. The investigation proved that the dominant type of static called "grinders" apparently came from no definite direction but gave an equality of disturbances from all points of the compass

Weagant's Great Discovery

It then occurred to Mr. Weagant that these static disturbances might be propagated *vertically*, instead of horizontally, and if so the *direction of propagation would be at right angles to the direction of the advancing wireless wave.* If that could be definitely proven, then advantage might be taken of the difference in direction to separate the static from the signal currents flowing in the antenna

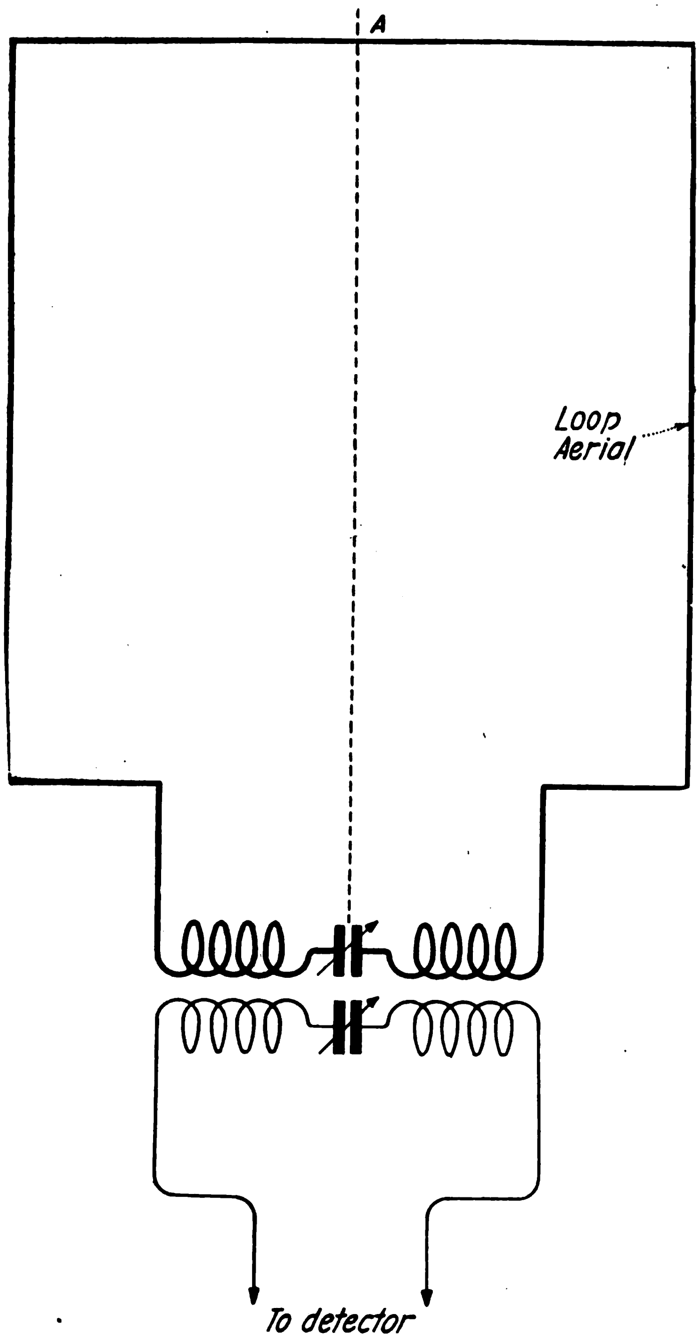


Figure 4—Loop aerial used by Weagant to check up the observations made with the apparatus in figure 3. The loop was rotated on the axis A to determine the line of direction of the static waves. The experiment proved that these waves came from no definite direction

circuit. This was the fundamental working hypothesis on which the Weagant system is based.

A series of experiments to verify the hypothesis then followed.

Observations on Two Loops, the Planes of Which Are Perpendicular

For one thing it was found that when two loops, the planes of which were perpendicular, were connected to a common receiving apparatus, as in figure 5, the static currents *could not be balanced out.* The experiment justified the assumption that *electromagnetic waves responsible for static currents are heterogeneously polarized;* that is, the axes of the oscillators producing them assumed all possible angles in space; and the highly damped waves resulting therefrom are propagated in a direction perpendicular to the earth's surface.

In other words, to the unscientific mind, these static waves may be described as an electric shower which acts upon an aerial, perpendicularly to the earth.

An Early Form of Weagant's Static Eliminator

To determine the correctness of the hypothesis that static is propagated vertically and to ascertain if it were possible on this assumption to devise a system whereby the static currents could be balanced out while the signal was retained, Mr. Weagant erected at Belmar, N. J., the aerials and apparatus shown in figure 6. Two closed loops A and B, each consisting of a single turn of wire 400 feet high with a base line of 1,000 feet, were spaced 5,000 feet from center to center. Two wires, brought from each loop to a receiving station located at the center, were supported on ten-foot poles, 6 feet apart. These leads were connected to the primary coils of a goniometer of the type used in direction finders; the secondary coil was connected to a sensitive oscillation detector. It was this apparatus that permitted the reception of transatlantic signals through static interference of great intensity, whereas without it, it was impossible to distinguish the wireless signal.

The connections to the receiving tuner and detector are shown in figure 6, where loop A has the loading coils L-1 and L-2, the resistances R-1 and R-2, and the coil,

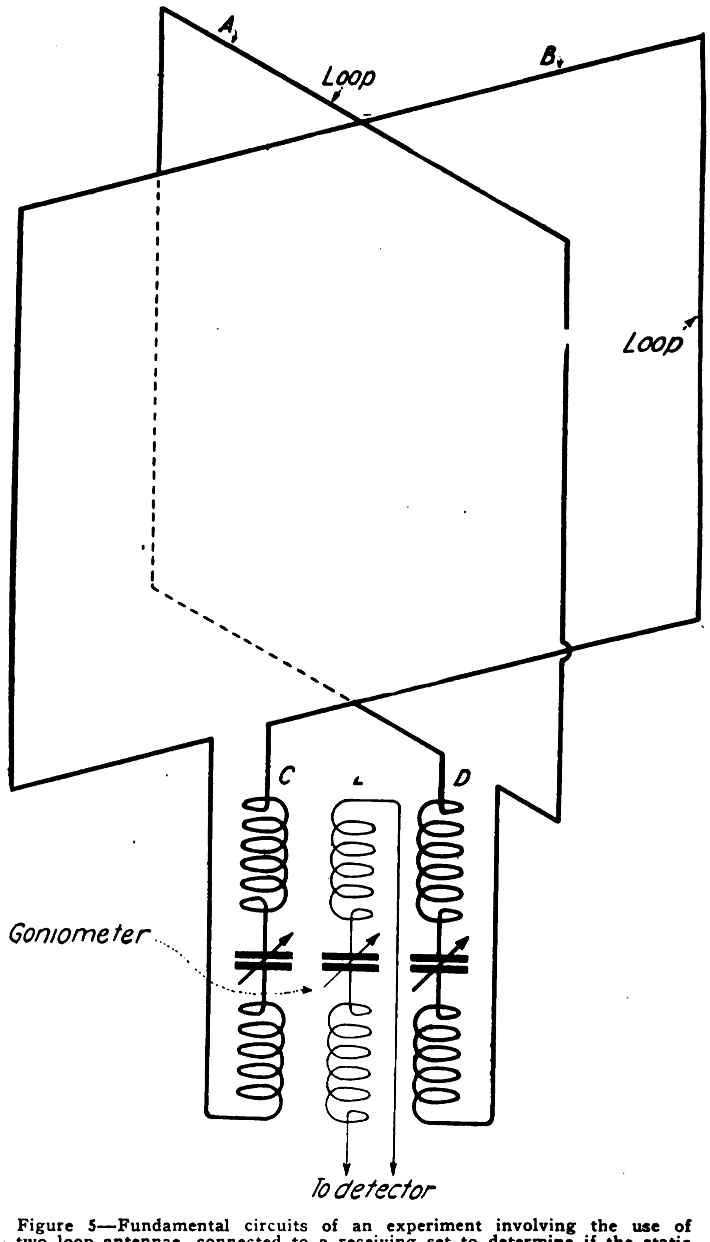


Figure 5—Fundamental circuits of an experiment involving the use of two loop antennae, connected to a receiving set to determine if the static currents could be balanced out while the signaling currents were retained. The test proved fruitless and served to indicate that the electromagnetic waves responsible for static currents are heterogeneously polarized; that is, the axes of the oscillators producing them assume all possible angles in space and the highly damped waves resulting therefrom are propagated perpendicularly to the earth's surface

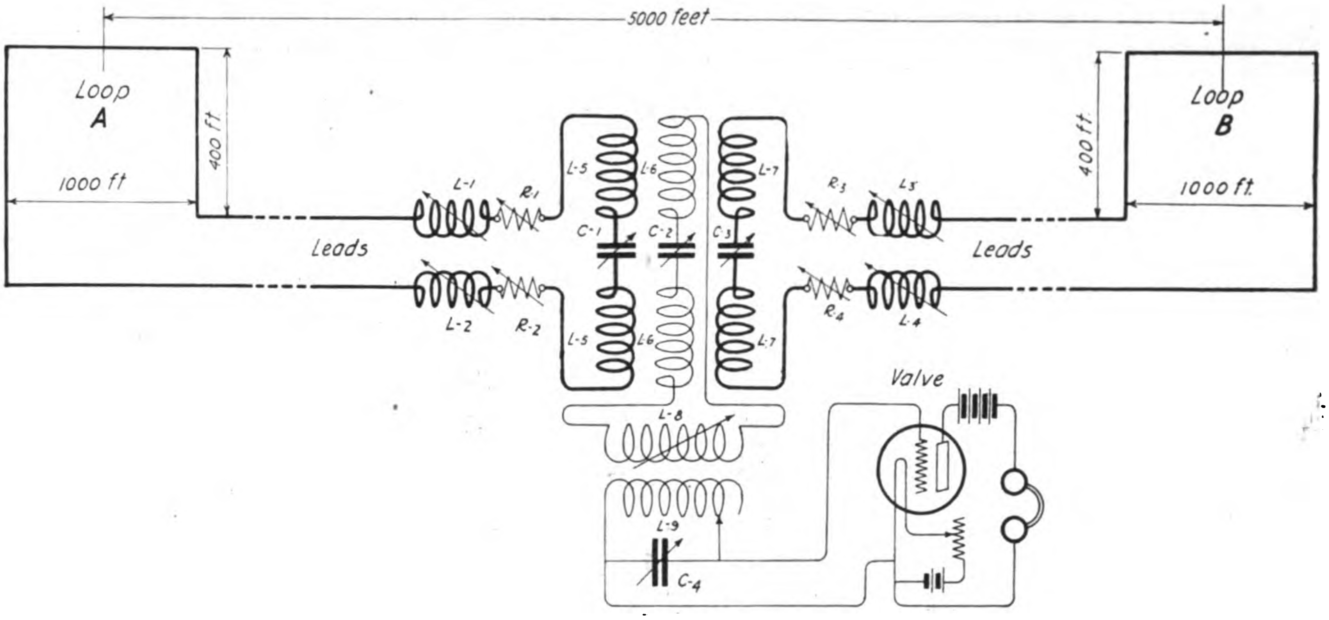


Figure 6—An early form of Weagant's system for eliminating static interference showing two single turn loop antennae spaced 5,000 feet apart. Each loop was 1,000 feet long at the base and 400 feet high. The leads from each loop were connected to the primary coils, L-5 and L-7, of the radio goniometer which were coupled to the secondary coil L-6. By rotating L-6, a position was found where the static currents neutralized and the signal currents were retained. This apparatus and antennae permitted the reception of signals from stations in Europe under conditions of static interference which with ordinary receiving apparatus and antennae would render reception impossible.

L-5, broken at the center point for connection to the variable condenser C-1. The coil L-7 connected to the loop B is similarly connected. Both L-5 and L-7 are coupled to the secondary coil L-6 which is broken at its center to include the variable condenser C-2.

The arrangement of the three coils at the receiving station was similar to that employed in the Bellini-Tosi goniometer shown in figure 7, wherein the rectangular frames L-5 and L-7 are stationary and the rotating frame L-6 is mounted on a vertical axis so that it can be rotated within the resulting magnetic field.

It may be well to describe here the preliminary procedure of adjustment: The coil L-6 is first placed in inductive relation with L-5 of loop A and the incoming signal tuned to maximum intensity. Next, coil L-6 is placed in inductive relation with L-7 of loop B, which circuit is also tuned to maximum signal intensity. Both loops are then connected in and coupled to the coil L-6 which is turned on its axis to receive the maximum induction from both L-5 and L-7. The two primary coils produce a resultant magnetic field which acts upon the rotating coil somewhat after the principle of the radio goniometer.

How the Static Eliminator Works

An explanatory diagram of the system of figure 6 appears in figure 8. Here the two closed circuit loops of figure 6 shown as A′ and B′ are coupled to a common secondary coil L-3 of the receiving apparatus which is installed in a station placed between the loops. The vertically propagated static waves are indicated by the *downward arrows* above the loops and the advancing signal waves which, in this diagram, are assumed to pass from left to right, are represented by the arrows A, A, A, A.

If static waves are propagated vertically, it is clear that they act upon loops A′ and B′ simultaneously and consequently electro-motive forces of equal intensity are generated in both loops and the static currents resulting therefrom flow in the same direction in each loop, as indicated by the single pointed arrows. For purposes of illustration, we have assumed that the static currents flow clockwise in the two loops as shown in the diagram. The current in loop A′ flows downward through the coil L-1 and that in loop B′ upward, through the coil L-2. The two currents will therefore neutralize and consequently none of the static current will flow in the coil L-3.

It now remains to be seen how a useful part of the energy of the signal wave is retained. From figure 8 it is evident that the signal wave acts upon the loop A′ before arriving at the loop B′; and we may assume, for the purposes of illustration, that the arrows A represent the progressive movement of the advancing wave. As the wave motion progresses and the positive half acts upon the loop B′, the negative half of the wave is acting upon loop A′. We will assume that, at a particular moment, its polarity is such that in loop A′ the static current and the signal current pass in the same direction through the coil L-1. The signal and static currents must therefore flow in opposite directions in the loop B′; and inasmuch as coils L-1 and L-2 are coupled to L-3 in such a way that the static currents oppose and neutralize, the signal

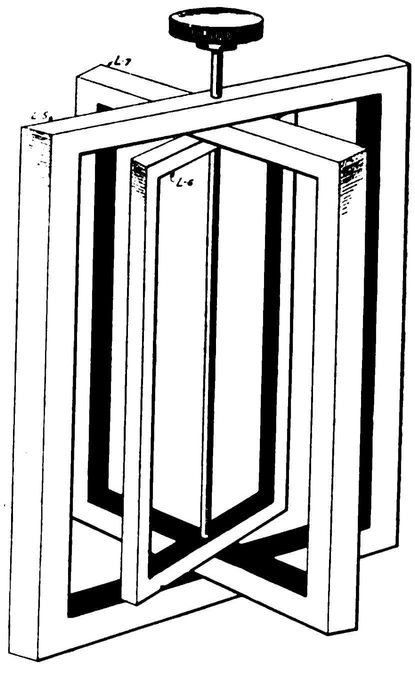


Figure 7—Fundamental construction of the radio goniometer used in the Weagant receiving system. Coils L-5 and L-7 are mounted at a right angle and the coil L-6 may be rotated in the resultant magnetic field

currents must build up in phase and accordingly affect the oscillation detector connected to the terminals of the coil L-3. The principle, of course, holds good when the tive spacing of the two loops in respect to the wave length being received.

The magnitude of the E.M.F.'s generated by the signal

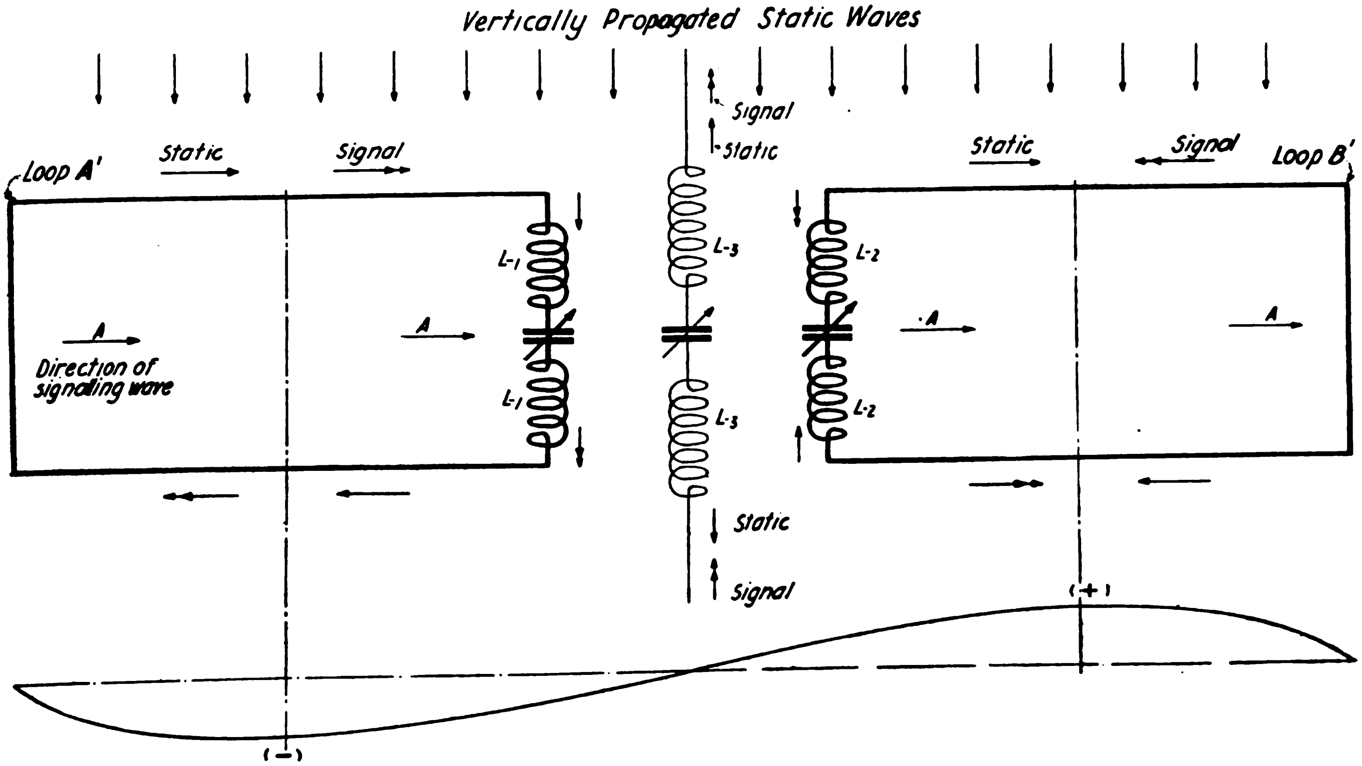


Figure 8—Explanatory diagram of the Weagant static eliminator. Loop A' is connected to the primary coil L-1 of the goniometer; loop B', to the second primary coil L-2. Both primaries act upon coil L-3 which rotates in the resultant magnetic field. The vertically propagated static waves act upon both loops simultaneously and the resulting static currents, as shown by the single pointed arrows flow in the same direction in both loops. The static currents flowing in the coils L-1 and L-2 may be made to act oppositely on the coil L-3 and therefore neutralize. On the other hand, the positive half of the signaling wave is assumed to act upon loop B' and the negative half on loop A'. In loop A', the signal current and the static current flow in the same direction, but in loop B' they flow in opposite directions

Since coil L-3 is coupled to L-2 and L-1 in such a way that static currents neutralize it follows that the signal currents must combine. If the two antennae are spaced one-half wave length from center to center, the E.M.F.'s generated in the coil L-3 by the signal currents, will be in phase and the resultant will be the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length then the E.M.F.'s will be 90 degrees apart and the resultant E.M.F. will be 1.4 times that of the individual E.M.F.'s; that is, they combine in quadrature. It is not essential that the effective spacing of the loops be one-half wave length; for one antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. It is evident that the Weagant system can be used in connection with any type of oscillation detector so far devised, and that the operation of the system as a whole is based on a fundamental principle never before utilized in radio communication

negative half of the signal wave acts upon B', and the positive half on A'.

The foregoing may be stated in another way by saying that the static waves arrive at the two aerials at the same time, while the signals arrive at the two aerials at different times. Therefore the static currents in the two loops at any instant are in phase and the signal currents are out of phase by an amount depending upon the effec- waves will always give a resultant depending upon the effective separation of the loops; that is, the distance from center to center of the loops. If this separation is one-half wave length, the E.M.F.'s generated in the coil L-3 by the signal currents from loops A' and B' will be in phase and the resultant is therefore equal to the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length, then the E.M.F.'s acting on the coil L-3 will be 90 degrees apart and the

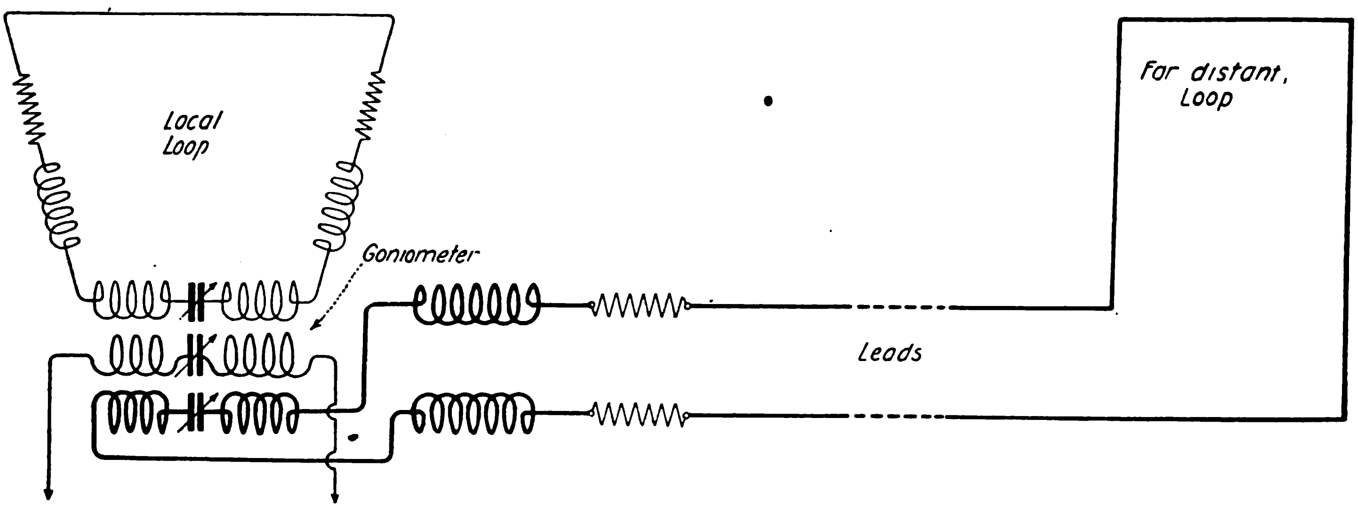


Figure 9—Circuits used in one of the early experiments conducted by Weagant wherein a small closed circuit loop was balanced against a far distant loop. This experiment at first gave a better static balance with a loss of signals and helped uncover the fact that the long low leads extending from the distant loop to the receiving station acted as an antenna, picking up both static and signals which under some circumstances were found to flow in opposite directions. This circuit was abandoned in favor of that shown in figure 6

resultant would be equal to 1.4 times that of the individual E.M.F.'s; that is, they combine in quadrature.

It is clear that the most effective separation for maximum signals is one-half wave length, and, therefore, from any particular wave length, the effective spacing of the loops should be selected to meet the above mentioned conditions. This, however, is not strictly essential in practice. One antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. This, therefore, is not an objection to the commercial application of this discovery.

Now, if the theory advanced by Mr. Weagant concerning the vertical propagation of static waves were not correct, the results described could not be secured; for, if the apparatus in the receiving station was adjusted so that the signal currents combined vectorially and in accordance with the effective aerial separation, then the static currents would combine similarly, and therefore, the entire system would show the same signal to static ratio as a single loop. Since the experiments proved that the static currents do not combine but are annulled, while the signal is retained, the theory of vertical propagation of static waves is well sustained. However, as Mr. Weagant remarked, if this theory is not correct, it is at least certain that the static waves operate on a sufficient area of both loops, simultaneously, to produce the desired balance described.

In accordance with the principle of the invention, the two loops should preferably be symmetrical in every respect. Controlling appliances permitting proper adjustments to be obtained are shown in figure 6. They consist of the loading inductances, condensers and variable resistances therein indicated.

Some practical results obtained with the system portrayed in figure 6 were reported as follows: Signals were received at Belmar, N. J., from Nauen, Germany, 6,000 and 12,000 meters; Clifton, Ireland, 5,600 meters; Carnarvon, Wales, 14,000 meters; Elivese, Germany, 9,600 meters; and Glace Bay, Nova Scotia, 7,600 meters.

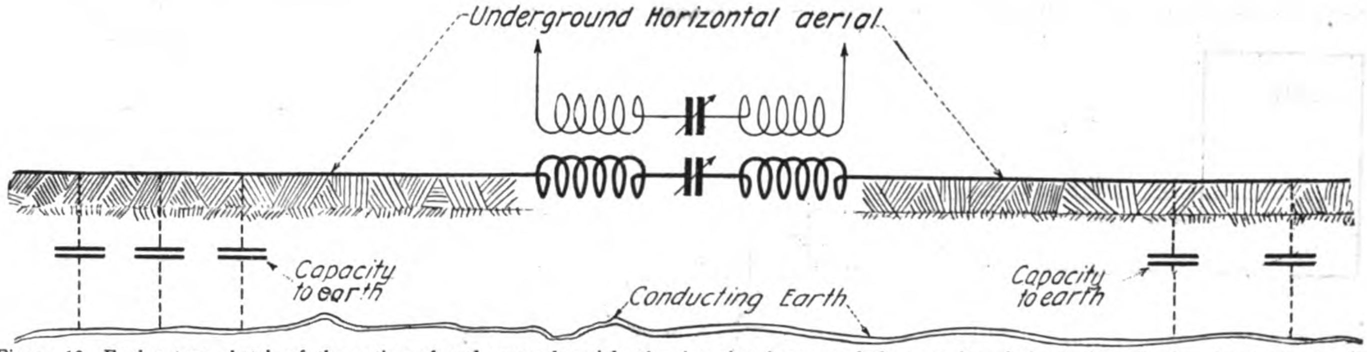


Figure 10—Explanatory sketch of the action of underground aerials showing that because of the capacity of the horizontal wires in respect to the earth, these antennae act as the closed circuit loops of the Weagant system

Mr. Weagant observed that whenever the circuits were so adusted that static disturbances were cancelled or reduced to a minimum, the signals received on the two loops combined, as might be expected from the spacing between them and the wave length of the incoming signal.

It is evident that the spacing between the loops in the diagram of figure 6 is slightly over one-quarter wave length for the wave of 6,000 meters used by Nauen, Germany, during some of the tests. In the case of the 6,000 meter wave, the resultant signal was approximately 40% greater than that due to either aerial alone, while in the case of Carnarvon, at 14,200 meters, the spacing was equal to only 1/9 of the wave length and the resultant signal was materially less than that due to either loop, which was to be expected. The system shown in figure 6 permitted reception from Nauen, Germany, throughout the months of July and August and during the worst static periods of the day. Grinders, of such intensity as to render the signals unintelligible by ordinary receiving apparatus and antennae, were eliminated to such a degree that continuous reception from foreign stations was possible. Other observations, through continued use of the circuits of figure 6, established the fact that the heavier the static disturbances were, the more perfect was the balance that could be secured; with a consequent greater improvement in static reduction to signal ratio. This, as students of wireless telegraphy will agree, is a very desirable characteristic.

A very interesting but erstwhile elusive phenomenon met with in the system of figure 6, was the fact that the long low horizontal leads picked up static and signals as well as the far distant loops, and until this feature was thoroughly worked out, the results obtained seemed to indicate that the farther apart the loops, the less perfectly

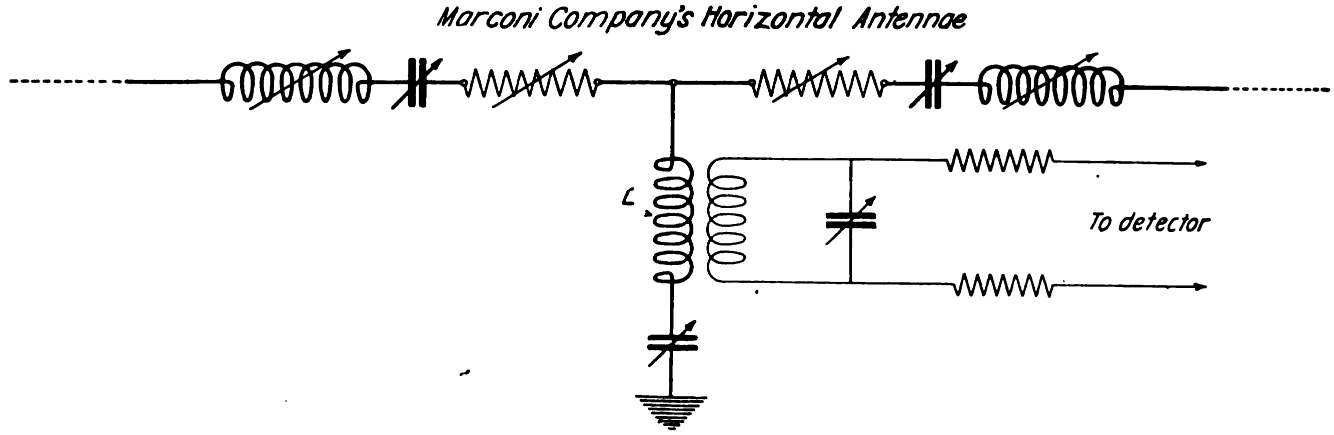


Figure 11—An early experiment conducted by Weagant in which two horizontal aerials were coupled to a detector circuit through a tuning transformer to determine if a reduction of static interference was possible. This and the circuits in figures 12, 13, 14 and 15 following, were found to give an appreciable reduction in static, but not of sufficient magnitude to permit continuous long distance wireless reception

could the static currents be balanced, and also, the converse.

One experiment, seemingly supporting this erroneous belief, made use of a far distant loop, connected to the

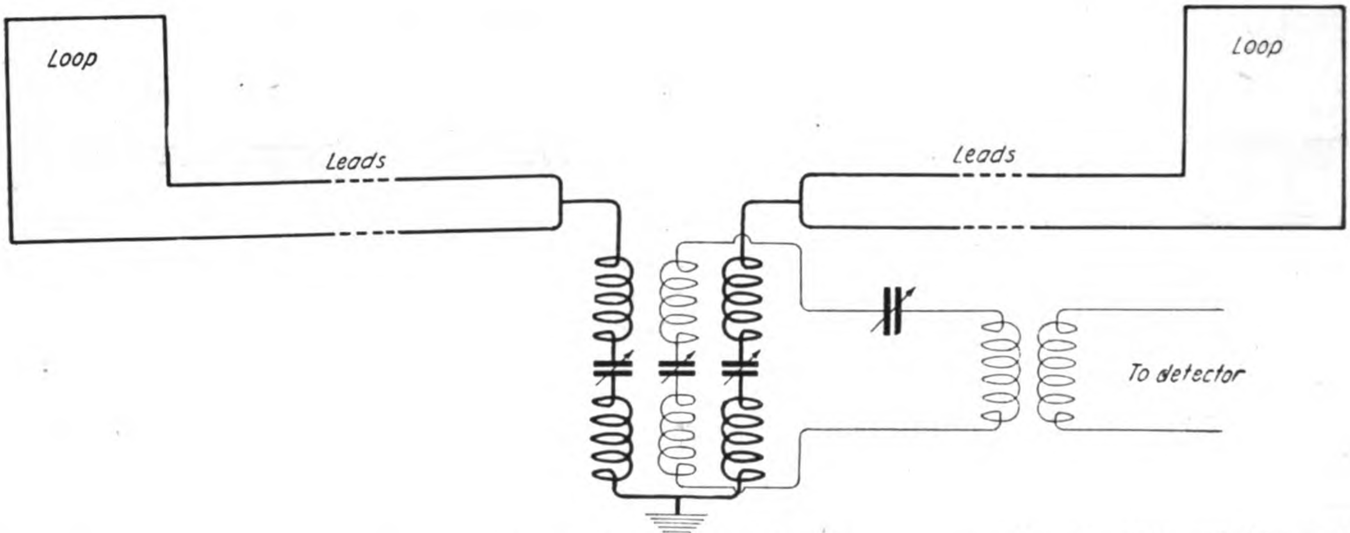


Figure 12—One of Weagant's early experiments in which the leads of two closed circuit loops were connected together, both aerials being coupled to a common detector circuit

receiving apparatus through long low horizontal leads, and another loop with short leads erected at the receiving station, as in figure 9. This arrangement was found for the time being to give somewhat better results than that in figure 6, and the improvement was found to result from the more perfect balance thus secured, in spite of the loss of signal.

However, as mentioned above, it was discovered later that the horizontal leads of the two loops as in figure 6, picked up some of the static and signal energy and, as a result, the static currents in a set of leads and in the loop tended to flow in the same or opposite direction. Adjustments that were made in the circuit shown in figure 6, to balance out static currents in the loop, before this fact was recognized, caused the static currents in the leads under some circumstances to add; but the simple expedient of placing reversing switches in the circuits solved the problem.

The results thereafter obtained with the Weagant system were found to be better with the use of greater rather than less effective separation, by an amount proportional to the separation.

It was observed that, in all arrangements employing two closed circuit loops connected to a central receiving station by long horizontal leads, local tuning of each loop was necessary. This was not a very convenient procedure with aerials 3 miles apart, for it became necessary to station an operator at each loop and to inform him, by telephone, what adjustments were to be made.

Underground and Surface-Ground Horizontal Aerials

The low horizontal aerial for radio reception was first used by Marconi. An antenna of the same type employed by Weagant in the spring of 1914, at New Orleans, gave a distinctly better signal to static ratio, than the large earthed aerial. Later comparisons with a loop aerial showed the two to be substantially identical in that respect.

One important deduction resulting from these tests was the fact that the long horizontal aerials laid under ground, on the surface of the ground, or suspended above the ground, may act as a loop aerial. Because of the capacity to earth (as shown diagrammatically in figure 10) a return path for the currents exists between the ends, which effectively completes the circuit.

It has been noted particularly that, as the distance between the ground and the horizontal aerial is increased, its action becomes more nearly that of an ordinary antenna; and that, because it is then not in the most effective position relative to the incoming signal to collect the maximum of energy, the signals are less in strength than would be secured with less spacing.

Quoting Mr. Weagant:

"The usually accepted explanation of the working of the horizontal aerial is that the wave front of the signal wave is tilted forward and that consequently there is a component of electric force in the direction of its length. It is to be noted, however, that under some circumstances such an aerial may be acting equally well as a loop. An aerial of this type is shown, in figure 10, lying on the

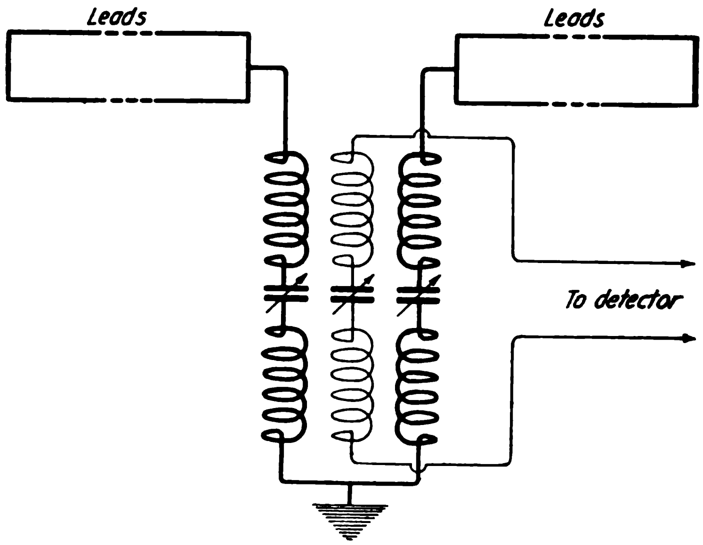


Figure 13—Circuits of an experiment wherein the leads of the Weagant loop antennae were employed as low horizontal aerials, both being coupled to a common detector circuit through a goniometer

surface of the ground and it is evident that by virtue of its capacity to the true conducting earth, a return path between its ends exists and, therefore, it is a form of loop; which method of consideration will account for many of the observed facts, such as its directivity, in a satisfactory way. It will also account for one observed fact which the usual methods of explanation do not account for, namely, that when an aerial of this type is laid on the ground, or buried underneath it, its effectiveness as an aerial does not increase indefinitely with length, but rapidly reaches an optimum value dependent on the circumstances obtaining. This can readily be accounted for under the present hypothesis by the fact that as the length increases its capacity to earth increases and at some point becomes sufficient to close the loop.

"As this capacity increases, however, the currents originating in this increased length have various paths in which to flow, one of which includes the receiving apparatus but others are through the capacity to earth between the conductor and the receiving apparatus, and the larger this gets the greater is the proportion of the currents originating in the ends of this aerial, which are diverted and do not flow through the receiving apparatus. This method of considering such an aerial is further supported by the fact that the greater the capacity per unit of length which exists between the conductor and the true underlying earth, the shorter is the maximum length which can be used to advantage. This capacity is a maximum, of course, when the aerial is actually buried in the ground or under water, becoming less when the wire is run on the surface of the earth and still less when the wire is suspended at some height above the earth, tests having shown that wires suspended some 10 feet above ground can be used up to some six miles in length, the signal increasing with length; that a length about one-half of this is effective when the wire is laid on the ground and of approximately 2,500 feet when the wire is placed under brackish water.

"I have also found that as the distance of such an aerial above ground is increased, its action becomes more nearly that of an ordinary antenna, and that therefore on account of its position relative to the incoming signal, it becomes less effective in collecting this signal energy."

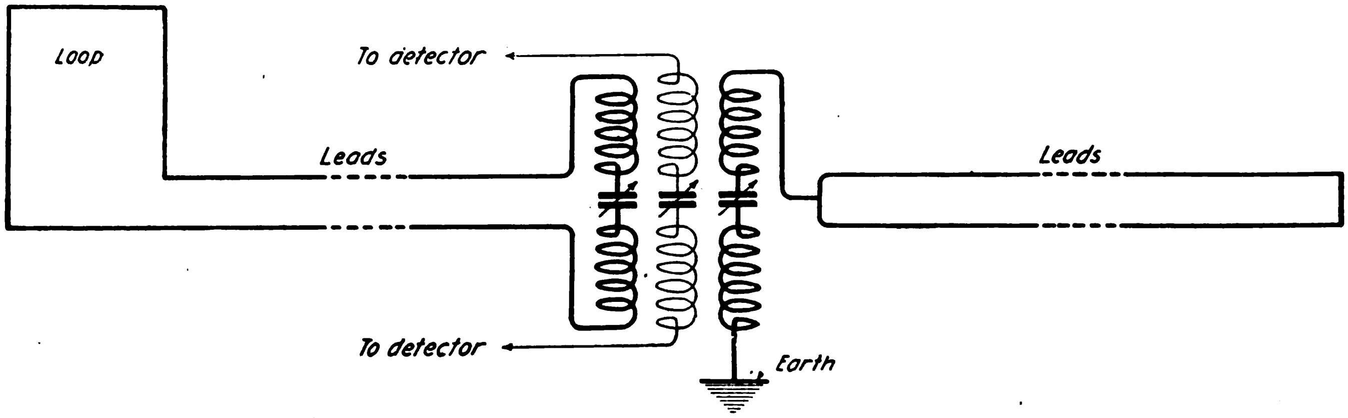


Figure 14—The circuits of an experiment wherein the horizontal leads of one loop were balanced against a second loop used in the regular way but not connected to earth

At an early date, at the Marconi station at Belmar, N. J., additional experiments were made by Weagant with the antenna shown in figure 11 and other combinations. It will be noted that the arrangement shown in figure 11 consists of two Marconi aerials of which the ratio of the length to the height is unusually large. It follows that the aerial which is pointed in a direction away from the transmitting station is a much better receiver of the signal energy than the aerial which runs in a direction toward the transmitting station. Both aerials, however, pick up the same amount of static. The two aerials, therefore, may have a very marked difference in their signal to static ratio, and this effect will add to the effect resulting from their phase separation when this separation is small. At times, this constitutes a factor in the results obtained. While figures 11 and 12 show direct coupling at the coil L, any of the well known methods such as electrostatic, inductive or resistance couplings may be employed.

Mr. Weagant finds that this principle operates in all of the arrangements shown in figures 12, 13, 14 and 15. Figure 12 shows the connections used in an experiment in which the loop leads were connected together and each loop converted into an ordinary aerial tuned to earth. In figure 13, the leads were disconnected from the loops and their ends joined, thus making them horizontal aerials tuned to earth. In figure 14, one loop is used in the normal way and balanced against leads of the other loop tuned to earth. In figure 15, one loop is connected in its normal way while the other one is arranged as an earthed aerial. In all methods where an aerial tuned to earth is employed, it was found that the counterpoise aerials gave the best all-around results, although fair results were obtained with all the foregoing arrangements.

In addition to the foregoing connections, other variations in the circuits were also tried.

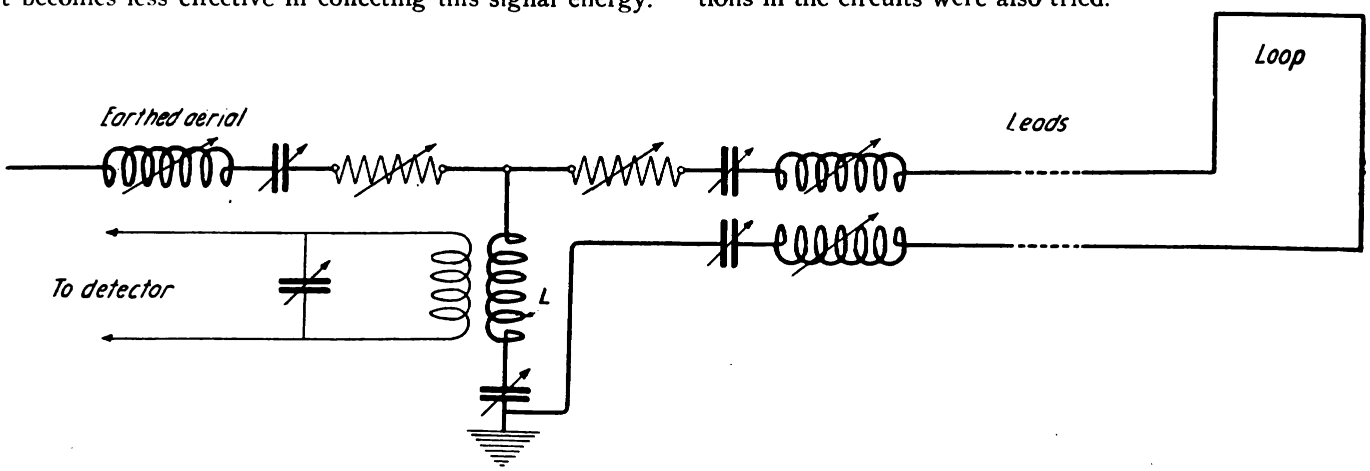


Figure 15—The circuits of an experiment wherein one of the loops in Weagant's system was connected in the regular way and balanced against an aerial tuned to earth

Elimination of Interference by the Weagant System

A discovery of vital importance in connection with the looped antenna of the Weagant system was the fact that it constitutes, as a whole, a uni-directional receiving antenna; that is, signals arriving from one end of the loop can be tuned in, while an interfering signal from the opposite end can, by proper phase adjustments, be tuned out.

When the looped antenna system is adjusted to annul static of the "grinders" type, the system has a reception curve of the form shown in figure 16; its equation, is, $v = V \text{ cosine}^2$, while that of the single loop is the cosine curve. The directional effect in this case is materially greater than with the single loop.

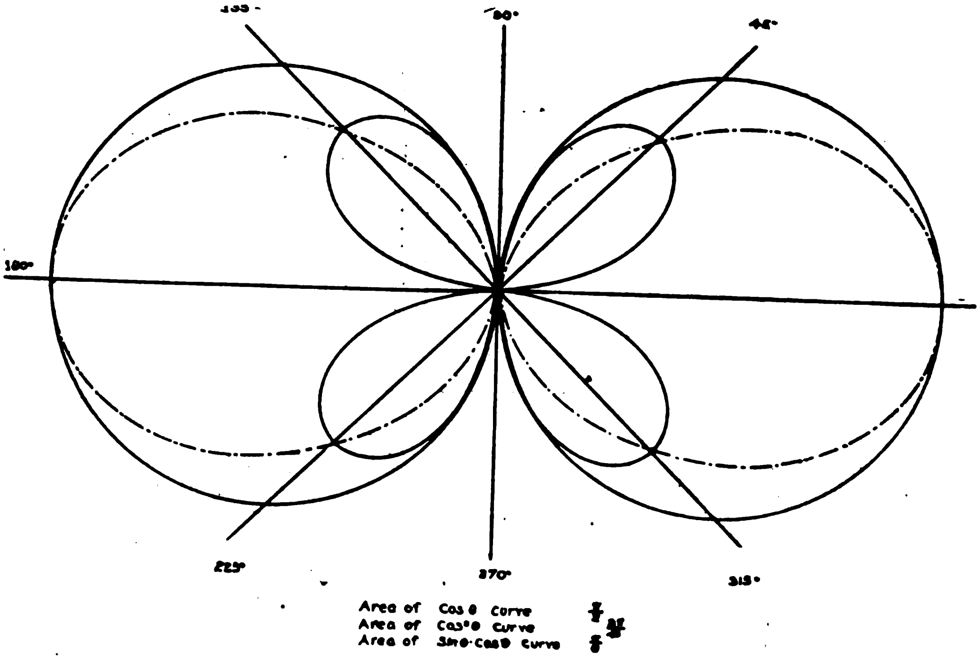


Figure 16—Reception curve of the Weagant system utilizing two-loop antennae

By shifting the phases of the currents in the loop antennae, the reception curve becomes that of figure 17. Between $\theta = 0$ and $\theta = \Pi$, the curve is a cosine² curve while between the angles $\theta = \Pi$ and $\theta = 2\Pi$ the curve is a sine-cosine curve, when the loops are ¼ wave length apart. This curve indicates maximum reception in one direction and zero reception in the opposite direction, with a considerable reduction of signals in the third and fourth quadrants. The line of zero reception can be swung at will through the third and fourth quadrants by alteration of the phases of the currents in the two loops, so that interference from any station arriving in either quadrant can be annulled, while reception is maintained from signals arriving in the first and second quadrants.

Mr. Weagant pointed out that advantage can be taken of this property to eliminate static interference if the static waves happen to come from a direction other than that from which the signal arrives. This is of considerable help when a thunderstorm is gathering in the vicinity of the station. Although the most effective spacing of the loop to obtain this uni-directional characteristic is one-quarter length, a general order of the result is obtainable with any spacing between the loops. The process of adjustment for obtaining one-way reception is quoted from Mr. Weagant's paper as follows:

"Suppose that the two loops of the system are one-quarter wave length apart and that the desired signal arrives from right to left; then the currents in the left-hand loop are 90 degrees behind those of the right-hand loop, if the circuits are accurately tuned, and they will add in quadrature. Next, suppose a signal arrives from left to right; then the currents due to this signal in the left-hand loop are 90 degrees ahead of those in the right-hand loop and therefore also combine in quadrature. Then currents due to both signals exist in the common receiving circuit.

"Suppose now, the phases of all currents in the left-hand loop are shifted forward 90 degrees; then the currents due to the desired signal in this loop are shifted around until they are in phase with those from the right-hand loop, while the phase of the currents due to the interfering signal in this loop, and which were previously 90 degrees ahead of those due to the right-hand loop, are now 180 degrees ahead of those in the right-hand loop, so that they oppose and neutralize. Because of the unusual characteristics of the aerial used, this shift in phase is readily accomplished by a small adjustment of the condenser in the loop circuit. If the interfering signal is not in line the right amount of phase shifting can be made to take care of it, and this general order of result is obtainable to some extent with any spacing between the loops, although one-quarter wave length is best. The reception of Carnarvon's signal, 14,200 meters, through

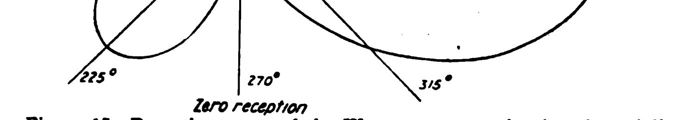


Figure 17—Reception curve of the Weagant system showing the uni-directional characteristic which may be obtained by proper adjustment of the phases of the currents in one loop. Maximum reception is obtained in directions extending through part of the first and second quadrants and minimum reception in the third and fourth quadrants. The line of zero reception may be swung through the third and fourth quadrants at will, by proper phase shifting

the powerful interference of the 200 kw. Alexanderson alternator at New Brunswick, only 25 miles away, working at 13,600 meters, has been an everyday performance of the system, while at the same time preserving a good static balance. All forms of the arrangement described have capabilities of reception through interference, these capabilities varying with the type of aerial employed, the loop aerials and the horizontal aerials giving similar curves."

(To be continued)

My Experiences in the War

Second Instalment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured in the Attempt to Stop the Hun Invasion

By Captain Gordon Adams
South Lancashire Regiment

(*Continued from the February Issue*)

IN addition to wireless telegraphy, the experimental flight dealt with photography, signaling, bomb sights and instruments. Besides wireless as a means of communicating with the ground other methods of signaling were experimented with. The earliest and simplest method of communicating was by means of dropping written messages in weighted bags. Fairly successful results were obtained with a powerful searchlight fitted in front of the nacelle of a "pusher" type machine. Transmitting messages in Morse by means of releasing from a box large and small amounts of soot or color to represent dashes and dots, did not prove a success.

In addition to my other work I was given the job of producing an equation for determining the trajectory of an aerial bomb; if one takes into account the varying resistance of the air due to its change in density at different altitudes, and the effect produced by the state of the barometer, the resultant final equation becomes very complex. Numerical values of coefficients of resistance depending on the shape of the bomb had to be obtained experimentally by dropping a selection of bombs from captive balloons and timing their descent to the ground. This part of the work I did not care much for as I know of no more unpleasant sensation than that which is experienced in a captive spherical balloon on a gusty day.

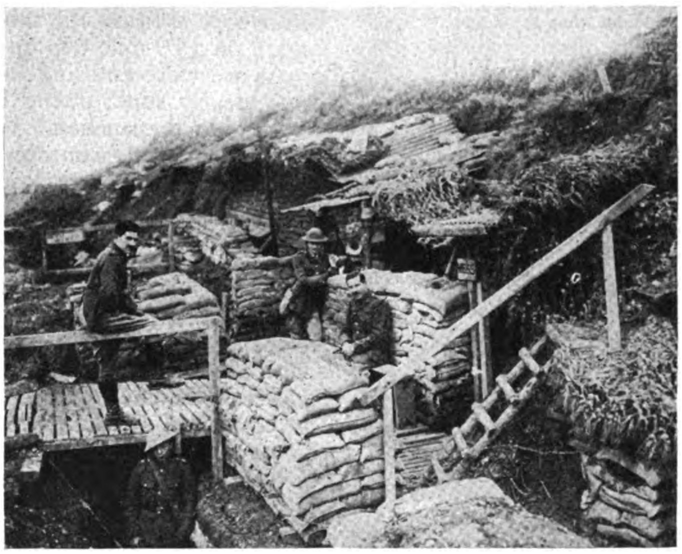


Photo: Press Ill. Svce.

This skilfully engineered dug-out and the almost luxurious mess hall for officers forms a marked contrast to the early days of the war which Captain Adams describes, when he lived in a shallow field trench and was without food for 48 hours

In conjunction with my work on bomb trajectories, I designed a bomb sight which, in addition to its ordinary functions, made allowance for the drift of the machine caused by side winds. Many details have since been greatly improved in bombing range finders, and for that reason a description of my early sight might be of interest. The backsight and foresight were carried on a brass rod about a foot long. The rear end of this rod was attached to another rod mounted horizontally between to fixed uprights, with the rod left free to revolve about its longitudinal axis. The foresight end of the sight rod was attached by a sliding device to a bar which stretched transversely across a ring which was free to turn inside an outer ring. These two rings with the transverse bar could be moved fore and aft on slides, varying with them the foresight.

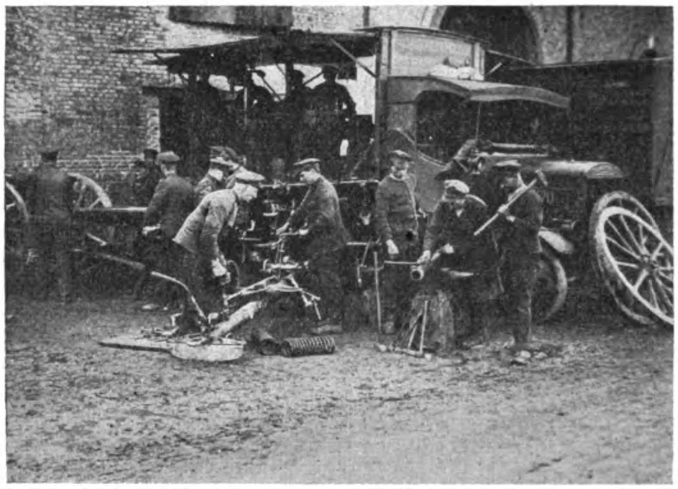
The method of setting the sight was as follows: First, ignoring the wind, the transverse bar was placed in a fore and aft position and the foresight brought to its centre, by means of the sliding attachment. Then the whole system of rings, transverse bar and foresight were moved forward on the slides according to a scale graduated for different heights. The foresight was then moved along the transverse bar to allow for the strength of the wind, and finally the transverse bar and inner ring were rotated inside the outer ring to allow for the direction of the wind.

The wind scale was constructed on the principle of the slide rule, the two factors being time of fall of the bomb and strength of the wind.

While at Farnborough, I acquired the greatest admiration for the test pilots of the Royal Aircraft Factory, whose job it was to test any new and untried type of machine. As aviation then was in its infancy and a great deal about stability had yet to be discovered, their work was attended by the greatest risks. One of these pilots—a close personal friend of mine appeared to have nerves of steel. I have known him to crash and completely pulverize a machine, and then, when he had scarcely cleared out from under the wreckage, to take up another machine straight away, without even waiting to smoke a cigarette. His method was effective, but a trifle rough. I recall that on one occasion when flying at Farnborough his engine gave out and he was just unable to reach the aerodrome; in fact, in his glide he hit the top of a tree in the grounds of a neighboring convent. I am told that the language to which he gave tongue very nearly resulted in the departure of the Sisters of the convent to a part of the country far removed from flying grounds. Leaving aside the potential value of so ready a vocabulary, I am sure that this pilot would have done great things in the war had he not had the misfortune to be taken prisoner in the very early days.

It has often struck me as remarkable how in some cases the most trivial mishap will end fatally for the pilot, while in other cases the most fearsome looking crash will result in nothing more serious than a few bruises. I saw, in the spring of 1914, a collision between two machines at a height of about 1,000 feet, resulting in both machines nose diving straight to the earth. Although the pilot of one machine was killed the aviator in the other was not even temporarily knocked out; in fact when I got to the spot I found him walking about. The subject of accidents brings to mind a somewhat extraordinary coincidence.

On July 20, 1913—I was then at the Central Flying School taking the military aviation course—a discussion of flying accidents came up during the course of a conversation which I was holding with my most intimate friend in the R. F. C. He remarked to me, I recall distinctly, that he wondered if he and I would both be alive



British Official Photo

Mobile workshops followed the British army into the field at an early date, enabling repairs and re-assembling of all equipment to be done without loss of valuable time

in a year's time. On July 20, 1914—a year, to the day—he was killed in a Henri Farman biplane at Gosport.

About two months before the declaration of war the entire military wing of the R. F. C. concentrated on Salisbury Plain. The wing then consisted of 9 airplane squadrons, either complete or in the process of formation, the officer personnel being about 120. It seems to me to be one of the greatest achievements of the war, that from this nucleus was created a flying service numbering its officers and airplanes by tens of thousands.

The work of the R. A. F., as the air service was known when the R. N. A. S. and R. F. C. amalgamated, is even more remarkable when one realizes the meager supply of equipment available at the start and the total lack of any experience with the airplane as an implement of war.

It is interesting to note that at the commencement of hostilities "stunting," particularly "looping," was a court martial offence. Furthermore, in August, 1914, nothing had been done in the way of aerial gunnery. A month before the war I returned to my regiment and tried to change over to the Naval Wing of the R. F. C., which at that time was in the process of being very considerably enlarged. I hoped in that way I should see more of aviation as a whole and have a wider scope. However, I was doomed to disappointment, just as I had got everything practically fixed up. The war broke suddenly and in answer to telegrams which I hurriedly sent to London I was told that for the present all officers would have to remain where they were.

Accordingly I sailed for France with my regiment on August 13, 1914.

* * *

Before proceeding with the narrative which begins with our departure for France, it would be well to give a brief outline of the composition and organization of the British Army at the outbreak of the war. Each infantry regiment consisted of a depot, 2 regular Battalions, 1 or 2 Special Reserve Battalions, and 2 to 4 Territorial Battalions. Of the two Regular Battalions one was always stationed at home and the other abroad, generally in India. The work of the Special Reserve was to supply reinforcements, while the primary duty of the Territorials was home defence. The Depot unit collected recruits and put them through their initial training. When they finished their training, they were sent to the home battalion and generally remained in that unit for another two years. At the end of that time they were drafted to India, where they saw several years service, finally returning home to go into the Reserve or to complete their service with the home battalion.

With the declaration of war the reserves were called up in sufficient numbers to complete the establishment of the home battalions. It was these home battalions which constituted the British Expeditionary Force. When mobilized for war these men had generally averaged about 7 years service with the colors. The officer personnel was brought up to establishment by officers drawn from the Special Reserve. The British Expeditionary Force consisted of 6 infantry divisions and 1 cavalry division. Artillery, Engineers, and other special auxiliary troops were included in the Infantry Division. This was the force of trained fighters which William Hohenzollern was pleased to term the "contemptible little British Army."

The B. E. F. immediately started mobilization on the declaration of war on August 4, 1914; nine days later we embarked at Southampton. At that time I was senior subaltern of my battalion. The secrecy with which we left England has since struck everyone as very marvelous. I believe I am right in saying that the only person who witnessed our departure was a diminutive boy scout who had brought a message to the quay for the colonel. Daybreak on the morning of August 14 saw us anchored off Havre waiting for the tide. At noon we started off again on a 70 mile trip up the Seine.

As we were entering the mouth of the river we were very nearly sunk, owing to one of the men accidentally letting go the anchor. We pulled up with a jerk and were very nearly run down by another and much larger transport which was immediately in our wake. The whole way up the Seine we were greeted by crowds of cheering Frenchman, and finally, about 7 in the evening, we disembarked at Rouen and went into camp about 3 miles outside the town. The second morning following, at 6 a. m., we left Rouen by a train which took us to a place called Aymeries. I was fortunate in being billetted with the right half battalion, for we put up in a very nice old-fashioned farm house, the owner of which provided a most excellent dinner; many toasts were proposed and some stirring speeches made. It was a night to live in memory.

Early the next morning we marched to a small village

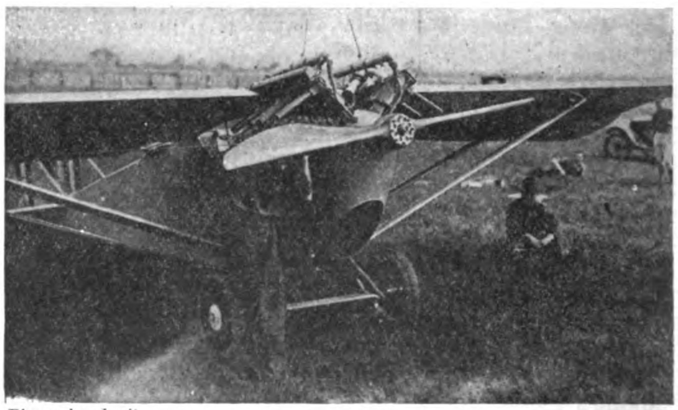
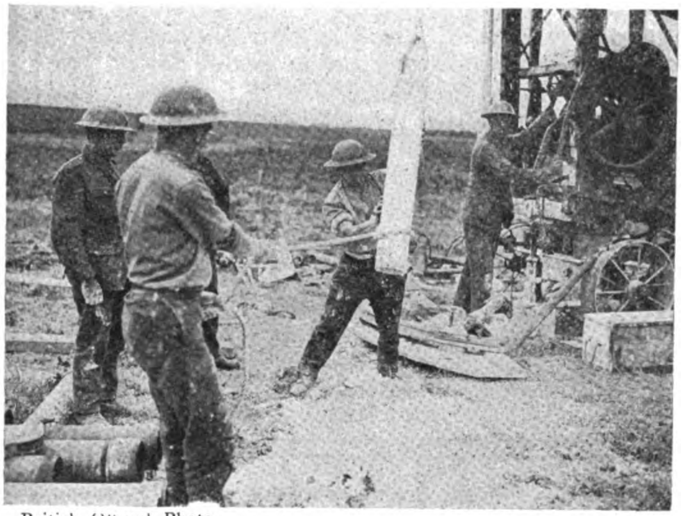


Photo by Int'l

This Loening monoplane, equipped with a 300 horsepower Hispano-Suiza motor, made a speed of 145 miles per hour recently and attained a height of 25,000 feet in 43 minutes. Its monoplane predecessors described in this article had no elements of safety and very uncertain control

called Marbaix. Here I recall seeing a veteran of the Franco-Prussian war of 1870 who had had the whole of his nose, eyes and forehead blown away, but appeared to be perfectly fit and happy. He wore a French Legion of Honor. My billet at Marbaix was comfortable but I could have wished for something better in the way of atmosphere. The building was a cheese factory.

We stayed in Marbaix until the 20th, while the rest of the troops came up. The weather was glorious and I was quite beginning to enjoy war. With the arrival of our remaining units we marched on to a large town called Avesnes where we were given a tremendous reception. The mayor met the General at the outskirts of the city, and drank champagne with him at the head of the column. As we continued our march through the town the ladies showered tens of thousands of flowers upon us. It was vastly amusing to see elderly and very dignified officers riding along profusely bedecked with floral tribute that clung to all parts of their anatomy, including neck and ears. The night was spent at St. Hilaire and the march continued at 4, the next morning. That day we covered a very long distance over French cobbled roads and in stifling heat, and arrived in the evening at a town called Feignies. Another long march the next day landed us at Frameries. It was here that we first heard the enemy's fire and saw a few German prisoners being brought in, captured by our cavalry screen.



British Official Photo

From the day of the outbreak of hostilities the water supply was always a problem. The illustration shows a detail from Britain's "contemptible little army" drilling a well

That night I spent guarding divisional headquarters.

Early the next morning we again marched off—this time, only a few miles—to be rebilletted in a village called Ciphy, a short distance from Frameries. No sooner had we allotted the men to their billets, however, than the order came to "fall in." Rumor had it that we were going to dig some trenches in the neighborhood. But on marching over the crest of a small hill we found ourselves about 2 miles from Mons and virtually in the midst of a battle. We hastily deployed and as rapidly as possible dug some small, field trenches.

About 4 o'clock the enemy started shelling our position, and kept the fire up until nightfall. Our own guns were barking a reply to the enemy's fire from our immediate rear. During the evening I remember sharing my last tin of bully beef with a brother officer. It was the last food I had for 48 hours.

When darkness fell the surrounding country presented a most lurid picture. Every building of any size at all was in flames. Immediately in front of us was a burning church, but all the fire and smoke seemed to be confined to the interior of the building, the only thing that showed that it was on fire was the fact that the spire was glitteringly white hot. I slept something less than an hour and a half during the night.

An hour before dawn, the order was passed down the line in a whisper to stand to. Everything was deathly still. Gradually, the faintest glimmer of dawn appeared, and I could dimly discern about 400 yards to our front a line of ghostlike figures moving about. I whispered to my men to fix their sights at 400 yards. It got lighter. The figures appeared to have approached a bit nearer. Still I held my fire and readjusted the men's sights. Nearer and nearer they seemed to come; the suppressed excitement was intense. Then came the moment when I thought the time ripe to open fire. Peering through the half-light, objects somehow seemed suddenly to take more definite form. My row of supposed Germans was a row of tall thistles waving about in the wind!

With sunrise, the enemy resumed his shelling, and about 9 o'clock an infantry mass attack was launched against us. Numerically, the German strength was six men to our one. I made a hasty estimate of the situation. Our position was roughly as follows: A and B companies were on the right, C and D companies on the left, but pushed forward about 100 yards to the crest of a small rise in the ground. My company was B.

Companies C and D took the brunt of the attack when it came, swiftly and viciously. They put up a very gallant resistance but were driven out of their positions with the bayonet. Through this success, the Germans were now occupying the positions of C and D companies, only 100 yards from companies A and B. Company A was ordered to retire after the remnants of C and D had got back, and my company was left to hold the Germans until the first company had completed its retirement.

When it came my company's turn to retire we had nobody to support us with a covering fire. In order to get back to the rest of the battalion we had to traverse some 600 yards of absolutely open country, flat as a billiard table and in full view of the enemy. It was an uncomfortable prospect, but in covering that ground I received one of the greatest surprises of my life. We had heard much about the efficiency of the German war machine, and we naturally expected that they would be able to shoot with tolerable accuracy. Yet during the whole of that 600 yards retirement the enemy were shooting at us with rifles and scores of machine guns, but their shooting was so execrable that out of a target consisting of 240 men they only succeeded in hitting four!

As we fell back it was plainly evident that it was quite hopeless to entertain any idea of defeating the Hun outright, owing to his overwhelming majority in numbers; our instructions were to continue retiring, holding on to successive positions until the last moment and contesting every inch of the German advance. Thus we were to gain time for reinforcements to arrive. We took up position after position. Halte, Blaigemes, Beaudignes and other villages were successfully evacuated. All this time the weather was intensely hot and we had no food and practically no sleep. During 112 hours I had 6 hours sleep.

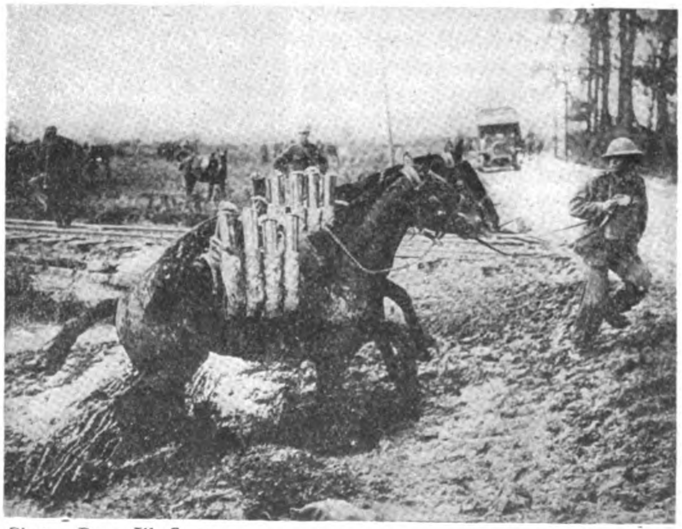
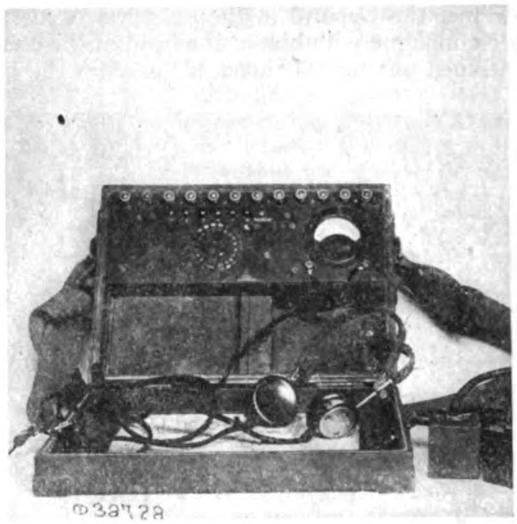


Photo: Press Ill. Svce.

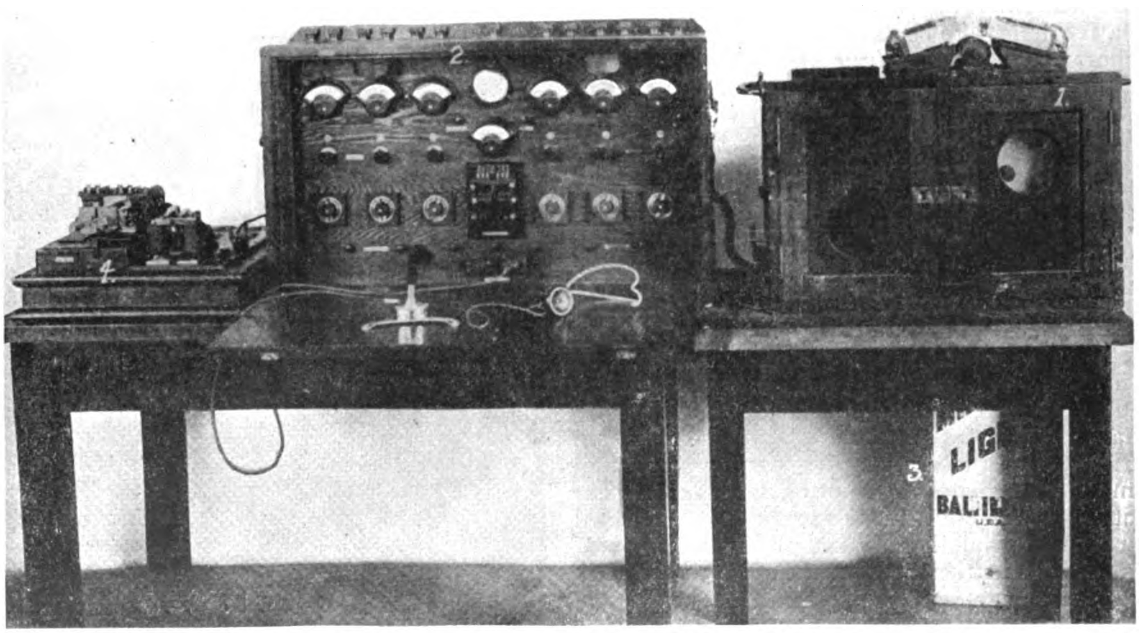
Falling back before the first onslaught of the Germans, as described by the author, was a process made increasingly difficult by the sticky, clinging mud which impeded progress everywhere

(Continued on page 26)

To the right: A signal Corps official photograph of the light microphone set used in trench eavesdropping operations which have been so widely discussed by home-coming soldiers. The apparatus can be used for either local underground or surface listening and the observer may be placed any desired distance from the point of detection



To the left: A photograph taken in St. Laurent, France, on August 20th last, showing members of the 102nd Field Signal Bn. (formerly the 1st Bn. of the New York National Guard), laying wires from General O'Ryan's dugout. This huge dugout was divided into two rooms, one for General O'Ryan and staff of the 27th Division, and the other for telegraph tables and telephone switchboards. The structure, the entrance to which has a camouflage screen, was built by the 102nd Engineers, formerly the 22nd Regt., N. G. N. Y., commanded by Brigadier General Cornelius Vanderbilt, one of America's most noted millionaires



A complete view of the American sound ranging set used for locating enemy obscured guns and batteries; it was by means of this apparatus that one of the big Hun guns which was shelling Paris was located

Photos by Signal Corps, U. S. A.

Wireless Communication with the Far East*

By W. A. Winterbottom

Traffic Manager, Marconi Wireless Telegraph Co., of America

FEW subjects today are of greater interest or importance to the American business man than improved and largely increased facilities for international communication. Without the opportunity for cheap and rapid communication between nations, commercial and social progress is seriously retarded, if not made impossible.

The Far East has long been in close telegraphic touch with Great Britain, and the channels of communication today between continental Europe and the Far East are far more numerous than those we possess. Less than twenty years ago our telegrams for the Far East were sent across the Atlantic to Great Britain, and thence forwarded either across northern Russia or through the Mediterranean on the way to Japan and China. The rate per word was very high indeed, much as $3.00 per word from New York City to Japan. Japan at that time could hardly have been further from the United States.

Then the Commercial Cable Company, with farsighted vision, laid a cable from San Francisco to the Far East, connecting up the Pacific Islands on the way. Our Far Eastern commerce at that time was quite small; it required considerable courage and faith in the future to literally sink from ten to fifteen million dollars in the Pacific Ocean.

The Pacific Cable brought the Far East much nearer to us than ever before; for in the telegraph fraternity, countries are near or distant according to the number of transmission points intervening.

Prior to the advent of the Pacific Cable at least twenty transmissions were necessary to send a message from New York through Europe to the Far East, which did not help to make cipher messages more readable.

The Pacific Cable reduced the number of transmissions to three or four. If we could still further reduce these retransmissions, to that degree would we bring the United States and the Far East closer together.

This problem has at last been solved by wireless telegraphy, and direct and instantaneous reliable communication by radio is now possible between the Far East and the United States. It is only a few months ago that one of Japan's leading statesmen, familiar with the progress of long distance wireless communication, stated in a public address "The Pacific Ocean, which has so long widely separated our two countries, is now no broader than a river." Japan could hardly be nearer.

The fascinating story of long distance commercial wireless has unfortunately been interrupted by the great war. The military and naval authorities have taken over temporarily all wireless services for uses much more important than the requirements of commerce. The United States Navy has found the high power stations of the Marconi Company extremely valuable for European communications and a few weeks ago submitted a bill to Congress providing for the permanent ownership of all wireless stations in this country. To have so monopolized high power radio communication would, I feel sure, have been a serious loss to the commercial world, but I am glad to say that the Congressional Committee unanimously voted against the Government ownership plan.

When peace is officially consummated and we are permitted to operate our stations commercially, a low priced, rapid and reliable means of communication will be available for use to Great Britain and the Continent, Scandinavia and Russia, the Far East and Australia, and a little later Argentina, Brazil and other South American countries, Mexico and the West Indies. It is a large program, but the greater part of it is already completed.

The first, and perhaps most interesting, long distance commercial wireless service was inaugurated in 1912—only seven years ago—between Great Britain and Nova Scotia. It is a little out of date now in its equipment, but it continues to render a satisfactory service between Great Britain and Canada, and at the present time some of our American newspapers are receiving considerable quantities of European news over this route in competition with the cable services.

Other and much larger wireless stations erected by the Marconi Company are located in New Jersey, Massachusetts, California and Hawaii. Another powerful station is now under construction just outside Buenos Aires.

The New Jersey stations will communicate directly with Great Britain and the Continent. The Massachusetts stations will communicate directly with Norway for messages to and from that country, Sweden, Denmark and Russia. The complementary stations in Europe are completed, and are only awaiting the proclamation of peace to change from their military character to that for which they were primarily designed.

The stations in California have already rendered excellent service to Hawaii and the Far East, and will do so again as soon as they are released to us.

Our Navy Department has been making very extensive use of the Marconi high power stations for communications with Europe, working at all times directly with stations in England, France and Italy.

In view of the fact that some people today doubt the reliability of radio communication as compared with submarine cable communication, it is interesting to quote the words of Commander S. C. Hooper—head of technical bureau of the United States Naval Radio Service—who recently testified before the Congressional Committee just referred to. Speaking of the Marconi high power stations and the service they have rendered the country during the past eighteen months, he said: "They are the stations which will compete with the cables for the handling of messages overseas, and I am not making any new prophesy when I state that the competition will be keen. Since the war has been on we have established reliable communication across the ocean and we never miss a message from the other side."

You will recall that the cable service to which the Commander compared the radio service, is over fifty years old in development and experience, while we are only seven. Further evidence of the position now occupied by wireless is the recent order of Mr. Burleson directing that all Government messages for Europe, except those for some special reason routed via cable, should be forwarded by wireless. Since important and confidential Government communications may now be handled by wireless, we may rest assured that a new era of communication is at hand, the possibilities of which we can only conjecture.

And now to mention the service to the Far East.

In 1914 the Marconi Company completed high power stations near San Francisco and Honolulu to compete with

*An address delivered before the Japan Society in New York.

the single Pacific cable, and offered its new service to the public. From the beginning, it was extremely popular with the Hawaiian business men, for they now had competition, and competition in oversea telegraph service is a fine thing. It usually results in cheaper rates, a more expeditious service, and greater satisfaction to the public. For almost fifteen years the citizens of Hawaii were required to pay for every word sent to San Francisco—it mattered not whether it was plain language or code, important or otherwise—at the rate of 35 cents per word. This rate was never changed, and the number of telegraphic communications between Hawaii and the mainland, and vice versa, was very small indeed. The Marconi service opened at 25 cents per word, a reduction of 10 cents per word, and further, introduced the popular night and week-end letters to the Hawaiians at a rate of approximately 8 cents per word.

Reflect for a moment. Rates reduced from 35 cents to 25 cents and 8 cents per word. No wonder the Marconi Company has so many friends and supporters in Hawaii, that small but important mid-Pacific outpost whose Chamber of Commerce sent a representative to Washington to raise its official voice in vigorous protest at the proposal for Government ownership of all wireless services. The business men of Hawaii have had a practical demonstration of the reliability and rapidity of commercial wireless, and are urging its early resumption by the Marconi Company.

Suffice to say, that within two months the submarine cable tariff which had stood so long was lowered to the level of the new wireless tariff, and it is generally acknowledged that within two or three years thereafter the number of telegraphic communiations to and from Hawaii was increased fourfold.

The trans-Pacific wireless service was not planned to stop at Hawaii. The Far East, and even Australia, was our goal. Our Hawaiian station had been built (at a cost of approximately $2,000,000) in two distinct sections, one to work to California, the other to work with Japan, both sections to work simultaneously. But the war again interfered. The Japanese station built at the same time was taken over by its Navy Department (for Japan too was at war) and it was not until 1916 that the station was released to commercial operation nine hours per day. Nine hours per day is not a very satisfactory way of conducting a telegraph service, but it was the best we could get until peace came, when we could expect the full use of the station.

In 1916, therefore, I went to Hawaii to supervise the inauguration of the first wireless service conducted between the United States and Japan. The usual messages of felicitation were exchanged between President Wilson and the Emperor of Japan, Ambassadors and other notables, and then we settled down to commercial business.

The cable rate from San Francisco to Japan, which had prevailed for years, was $1.21 per word, with no deferred or other cheaper service. The Marconi service opened at 80 cents per word for urgent communications, or a reduction of 41 cents per word, and also offered for the first time a non-urgent service at 40 cents per word, a reduction of 81 cents per word.

The service immediately became so popular and satisfactory that some means had to be adopted to curtail the volume of business offered for transmission, as it must not be forgotten that we were restricted to 9 hours per day and that was divided into three periods. It was therefore decided to confine the service to the city of San Francisco, which is perhaps our second largest center of Far Eastern trade.

Although it was expected to utilize the Hawaiian station as a necessary relay point for Japanese messages, it was soon discovered that practically all messages transmitted from the Japanese station were received with equal facility in California, and it was only occasionally that the assistance of the intermediate station in Hawaii was required. Further recent improvements in the radio art have assured the regularity of this direct Japan-United States wireless service.

I might add that, while I was in San Francisco, several of the large Japanese steamship companies and export houses expressed their amazement at the high grade service we rendered. The accuracy of the service, due to the elimination of relay stations, was most gratifying and the economy was of course fully appreciated. The service continued to increase in efficiency and volume of traffic until April 7, 1917—the great day in our history on which war was declared upon Germany—when the Navy Department commandeered our stations and has not yet permitted us to resume commercial operations. I understand that since the armistice the Navy Department has been offering a limited public wireless service from San Francisco.

And so science has at last brought the United States and Japan very close indeed, and with the advent of freer and cheaper communication, we may confidently look forward to a constructive age of peace, goodwill and a better understanding between the once widely separated peoples of the world.

My Experiences in the War

(*Continued from page* 23)

Among the troops falling back before the German onslaught was a celebrated British cavalry regiment, of which an amusing incident is told. On one occasion, thinking that they were at last free from the enemy for a few moments, they repaired to a neighboring stream and proceeded to bathe. While engaged in this refreshing recreation the alarm was sounded. A regiment of German Uhlans was approaching. Not waiting to dress, our men seized their sabres, mounted their horses and charged—clad simply but tastefully in their birthday suitings. The Germans stopped, amazed, and then beat it for all they were worth. The redoubtable Uhlans were not sufficiently brave to try conclusions with this absolutely unknown and unheard of type of soldier.

The war always held its humorous moments; but these were rare; in the main it was ever a grim business. At about 4 o'clock on August 25th, just as we were approaching the town of Solesmes, the enemy opened heavy shell fire on us from our right flank. The men were in the last stages of exhaustion, but at the sound of fire they immediately seemed to become revitalized. We rapidly took up a position on the top of a hill immediately north of the town. As soon as we were in position there came a temporary lull in the enemy's fire; but only for a few minutes. The Hun guns very shortly reopened with a veritable tornado of shells. For about 3 hours we were subjected to this hail of high explosives. Our reply was a crashing heavy rifle fire on his gun position, and we kept it up until nightfall. When we had expended all our ammunition our instructions were to hold the position at all costs until dark, in order to give the forces behind us time to consolidate their position at Le Cateau, about 6 miles in our rear.

At 8.30 the Colonel gave orders to retire. I had covered about 100 yards and was just congratulating myself in still being alive, when a shell exploded about a yard away and blew my thigh bone to pieces. I went down like a shot rabbit; and where I fell, there I stayed.

(*To be continued*)

EXPERIMENTERS' WORLD

Experimenters are urged to submit manuscripts covering the design and construction of all types of wireless apparatus for amateur use. Such articles will receive immediate consideration and those published will be paid for at regular space rates. The scope of this department is constantly enlarging

Amateur Transmitting Panel

Improving the Efficiency of a Wireless Station

By A. R. Zahorsky, New York

IT behooves every amateur to prepare for the time when the Government will give out the order to go ahead. The design of the transmitter should be given careful consideration, for whether one is able to transmit signals 1,000 miles, or only 100 miles, with a one kilowatt set, will depend upon the mounting of the component parts, as well as upon the electrical characteristics of the apparatus. The objects of this article are: To set forth methods of eliminating certain factors which tend to reduce the efficiency of a wireless station, and to show drawings of a transmitting set which will help to illustrate the fundamental points of this discussion.

Ground Connection

The ground connection is a vital part of a wireless station. If it is poor, the effectiveness of the system is greatly diminished. The most efficient "ground" to be obtained by the amateur is a connection to the city water mains. The water pipes should not be used if the earth wire measured from the instruments to the water pipe exceeds 30 feet in a horizontal direction. In case it exceeds this length, it is advisable to construct a separate earth plate. The following table gives the resistance of different types of earth connections. The amateur should choose the best suited to his purpose, remembering that grounds of lowest resistance have the highest efficiency.

Resistance of Different Types of Grounds

(1) 10 lb. scrap copper set 6′—0″ deep surrounded with 10 lb. coke ......14.2 ohms
(2) Copper plate 5′ x 3½′ set 4′ deep surrounded with 2′—0″ crushed coke.... 5.6 ohms
(3) 9′ length 1¼″ black iron pipe driven 6 ft. into solid earth .... 25.1 ohms
(4) 12′ length black iron ditto........... 14.8 ohms
(5) Two 9′ lengths ¾″ pipe set 6′ deep in coke. 15.2 ohms
(6) Perforated metal cone 18″ long filled with charcoal buried 6 ft. in 2 ft. of coke. 14.4 ohms
(7) Connection to city water main........ 0.44 ohms
(8) 1″ pipe in deposit of ashes 1 ft. deep.... 26. ohms
(9) 1″ pipe driven in 5′—0″, surrounded with 16 lb. salt mixed with earth, water poured around ....20. ohms
(10) 1″ pipe 5′—0″ long buried 12″ horizontally salted and watered after 4 days ....15. ohms

The resistances given are for rich black soil.

The wire leading from the instrument panel to the ground connection should be short and run as nearly vertical as possible. A No. 4 B & S stranded, rubber covered wire serves the purpose.

Operating Panel

The operating panel, shown in the accompanying figures 1, 2, 3 and 4, may be made of transite asbestos wood, from ½ inch to ¾ inch thick. This is the best kind of material to use, because it is cheaper than slate or marble, more easily worked and is fireproof. However, a panel of neat appearance may be built of 1 inch oak or pine boards and given two coats of floor varnish. The panel is mounted by means of wood screws on two 2″ x 2″ wooden uprights or on iron brackets and braced at a point 15 inches from the wall.

For switching from a transmitting to a receiving position, two single pole double throw high tension knife switches are employed. The blades as shown in the side elevations, figures 2 and 3, are interlocked by means of bell-cranks and levers, and are operated by a lever approximately 2′—7″ from the floor. This places it in a convenient position for a man sitting in a chair.

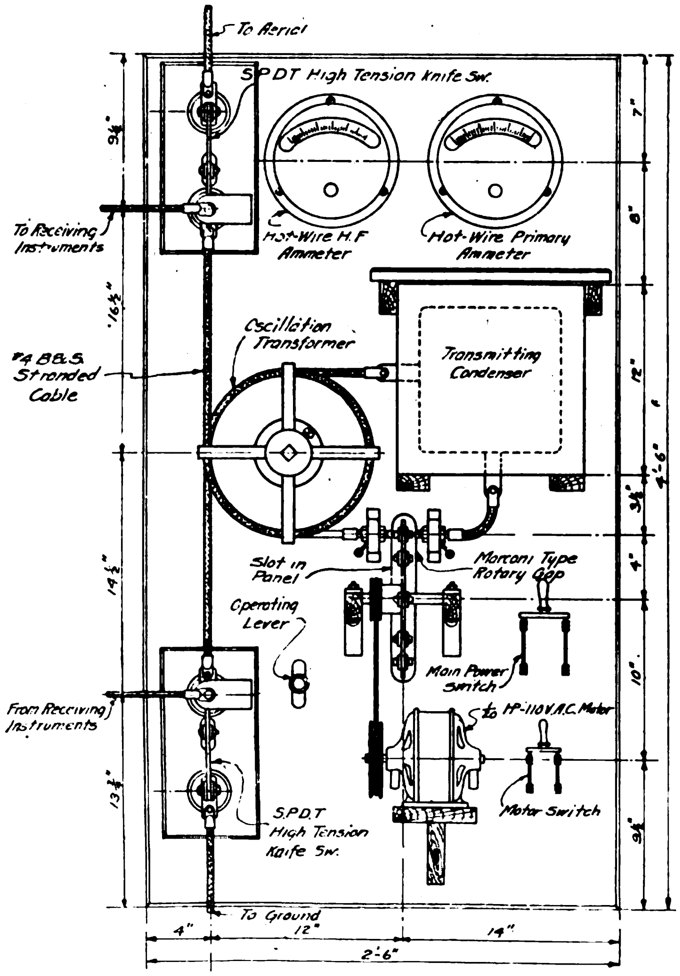


Figure 1—Front view of transmitting panel for an amateur radio station

The wire used for the oscillation transformer shown in figure 3 should be in size no less than No. 4 B & S stranded bare or insulated cable. If none is available, the amateur may build up an equivalent cable by twisting together 27 No. 18 B & S bare wires, or 40 No. 20 B & S wires. The smaller the wires the better will be the conductivity for high frequency currents. The conductor for both primary and secondary of the oscillation transformer are wound on crosses made of pine boards impregnated with paraffine. Both coils are supported so that they may slide back and forth on a square brass rod set into the front of the panel. The coils are 10 inches in diameter.

The condenser in the primary circuit is built up of ¼ inch glass plates 12 inches square. Half the plates are coated with extra heavy tin foil 9 inches square, applied to both sides. Terminal lags are placed on the case, one on the lower edge, the other on the side. They are preferably made of thin sheet copper. In assembling the condenser a plain glass plate is placed between two coated plates to vary the capacity. This method avoids taking taps from the helix, as is usually done and is simpler.

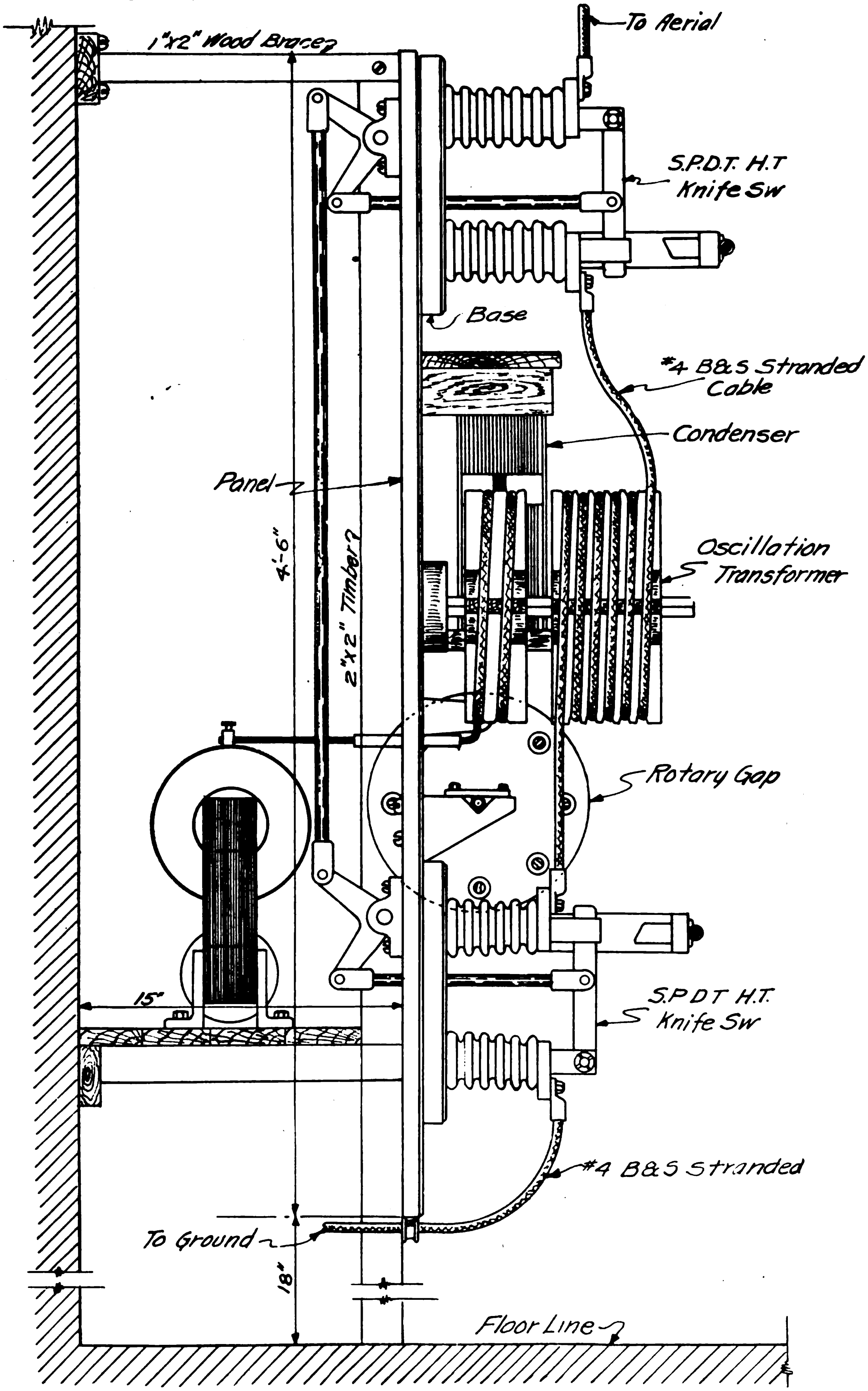


Figure 2—Left end view of transmitting panel showing single pole double throw high tension switches interlocked by means of bell-cranks and levers

The rotary gap is one of the Marconi type of dischargers. The disc is made from a piece of red fibre ¼ inch thick, 10 inches in diameter, impregnated with paraffine.

It has eight 3/8 inch brass studs spaced equally around the circumference and fastened by means of a nut on each side. The nuts are thin, being made by cutting in two with a hack saw a 3/8 inch brass nut. The pulley

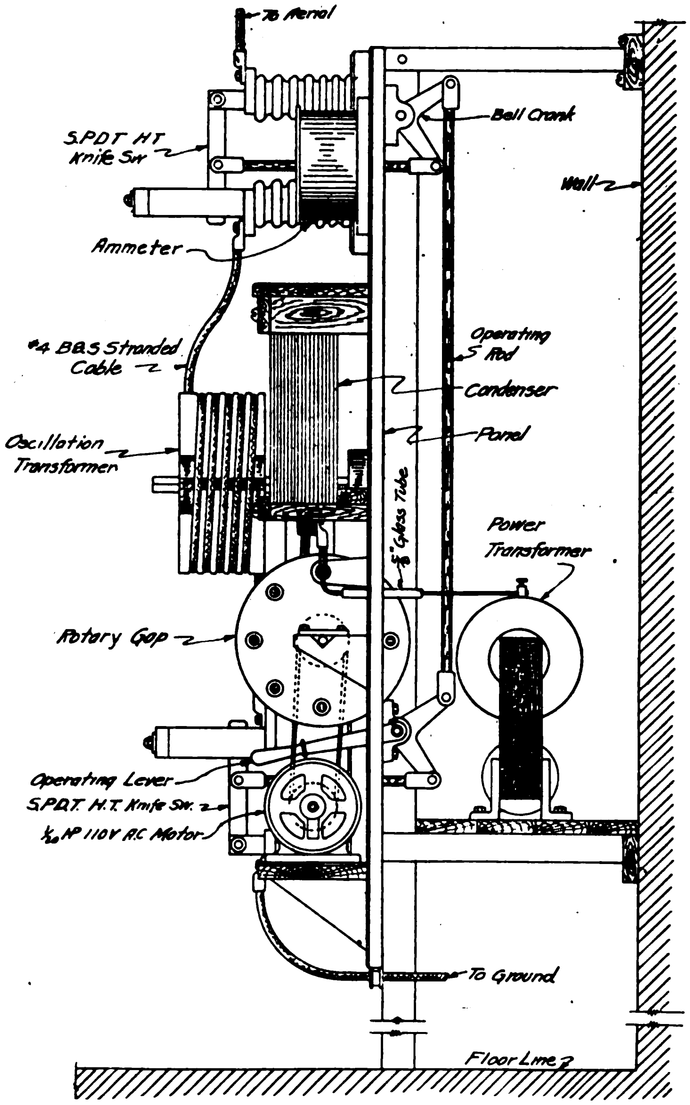


Figure 3—Right end view showing instruments and facilities for their operation

should be about 3 inches in diameter. The disc and pulley are mounted on a piece of 3/8 inch drill-rod 6 inches long, which serves as a shaft. The rotary gap should be driven by a small induction motor and run about 1,800 R. P. M., giving 240 discharges per second. The size of the pulley on the motor depends on the motor speed. A leather belt serves as a driving medium.

The hot-wire ammeter on the left hand side of the panel should have flexible leads with spring clips so that it may be inserted in the aerial circuit when required. The other ammeter is placed permanently in the 110-volt supply line as shown in the wiring diagram, figure 4.

The special features of this transmitter are the short leads in the oscillating circuits and the lack of sharp bends or kinks which would cause leakage at high voltages. All sharp corners on both conductor and insulators should be rounded off with a file. The insulators shown on the high tension knife switches may be porcelain or electrose, or hard wood baked dry and then boiled in paraffine. High voltage insulation is necessary.

It will be noted that there are 5 turns on the secondary of the oscillation transformer. This may have to be modified for aerials of different heights and lengths. The inductance of such a coil is given by Nagaoka's formula:

$$L = \frac{4\pi^2 a^2 n^2}{b} \times K, \text{ cms.}$$

where a = mean radius of coil = 5" = 12.7 cm.
b = overall length of coil = 3.5" = 7.89 cm.
n = number of turns = 5
K = a constant depending on the ratio of 2a/b
Obtained from tables by Nagaoka which may be found in Bureau of Standards bulletin No. 74 or bulletin No. 169.

For 2a/b = 3.22, K = .412.

Substituting these values in the preceding formula we obtain, L = 8325 cms.

If we insert this inductance in a "T" aerial 120 feet long and 60 feet in height we obtain a wave length of $\lambda = 203$ meters.

The inductance of the primary coil may be obtained in a similar manner making corrections for the leads from the condenser. If the coil is built to dimensions given in the illustrations, its inductance will be 2084 cms.

The capacity of a condenser used in conjunction with primary inductance L = 2084 cms. is given by,

$$C(\text{mfd}) = \frac{\lambda^2 \text{ (meters)}}{3550 \text{ L (cm)}}$$

If $\lambda = 200$ meters
C = .0054 mfd.

The capacity of a glass plate condenser is given by,

$$C = \frac{n K A}{4 \pi d} \times 1/9 \times 10^{-5} \text{ mfds.}$$

where n = number of plates required,
K = a constant which for plate glass may be taken as approximately 6.

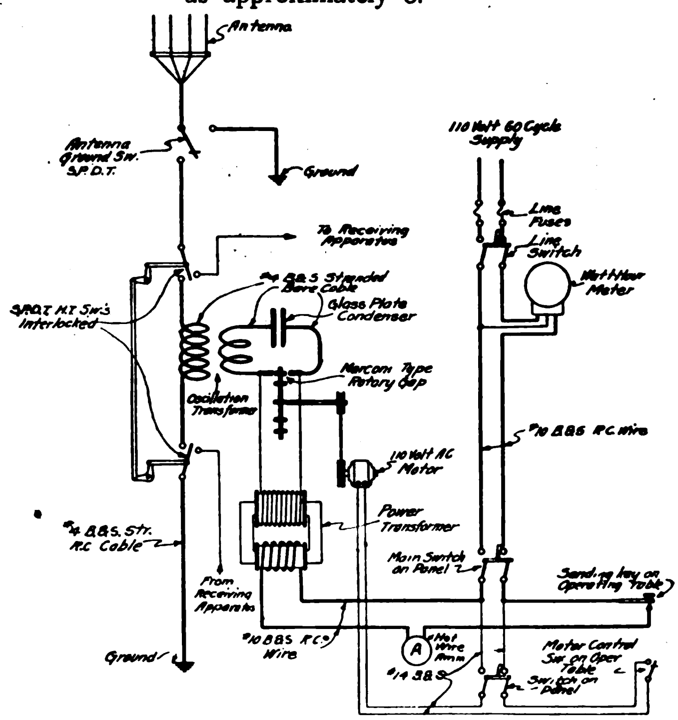


Figure 4—Diagram of connections for the panel set

A = area of the metal foil = 81 sq. in. = 523 sq. cm.
d = thickness of the glass = .25" = .635 cm.

The number of plates required then is,

$$n = \frac{4\pi \text{ d C}}{\text{K A}} = 12.35.$$

We shall therefore use 13 plates and adjust the capacity by varying the distance between the plates. For the wave length of 250 meters, it will be necessary to use 20 plates.

The diagram, figure 4, does not show protective condensers. A protective unit consists of two 2 microfarad condensers connected in series. The central wire is connected to earth and the two outside wires across the power line close to the meter. A protective spark gap might also be connected across the secondary of the high voltage transformer.

The Up-to-Date Amateur Radio Station

A Station Designed to Permit Reception from all Transmitting Stations Irrespective of Type or Wave Length

By Fearing Pratt, Massachusetts

THE ideal amateur station should be designed to permit reception from all stations, irrespective of the type of transmitter or the wave length employed. The apparatus should be installed to permit the conduct of experiments to determine the best method of connection for a particular set of conditions. Such a station has many possibilities, but it may prove too expensive for some experimenters.

In order that it will not be necessary to duplicate certain parts of the apparatus which are essential to all circuits, the instruments should be assembled so that the connections are easily accessible. The principal receiving set should not, however, suffer any loss of efficiency by complicated connections and combinations of switching devices.

The station I have in mind is composed of three receiving sets with one or more transmitters. Any one of these sets may be installed without interfering with the operation of the others. An amateur is likely to be fully satisfied with his first set, but he will later install additional apparatus from time to time which gives the station the appearance of an experimental laboratory. The main set described in this article has a receiving range of 450-3,000 meters, mounted in a cabinet which is always ready for use. Two additional sets are provided to take care of the upper and lower ranges of wave lengths.

The Aerials

Two aerials are to be used, one for transmitting and the other for receiving. The transmitting aerial should be 60 to 75 feet long and 40 to 60 feet high, with a natural wave length of about 160 meters. A pole erected on the roof directly above the transmitting set permits a short lead-in. Six wires, two feet apart, will give the necessary capacity. This aerial is to be used in receiving stations from 150 to 500 meters and a special transfer switch should therefore be provided.

A larger aerial, running at a right angle to the transmitting aerial, is employed for receiving wave lengths above 400 meters. It should be from 300 to 500 feet long and 50 to 100 feet high, consisting of two wires. The natural wave length should be near to 800 meters. With this aerial it is possible to receive wave lengths down to, say, 450 meters with a series condenser. By appropriate loading inductances, waves up to 12,000 meters may be received.

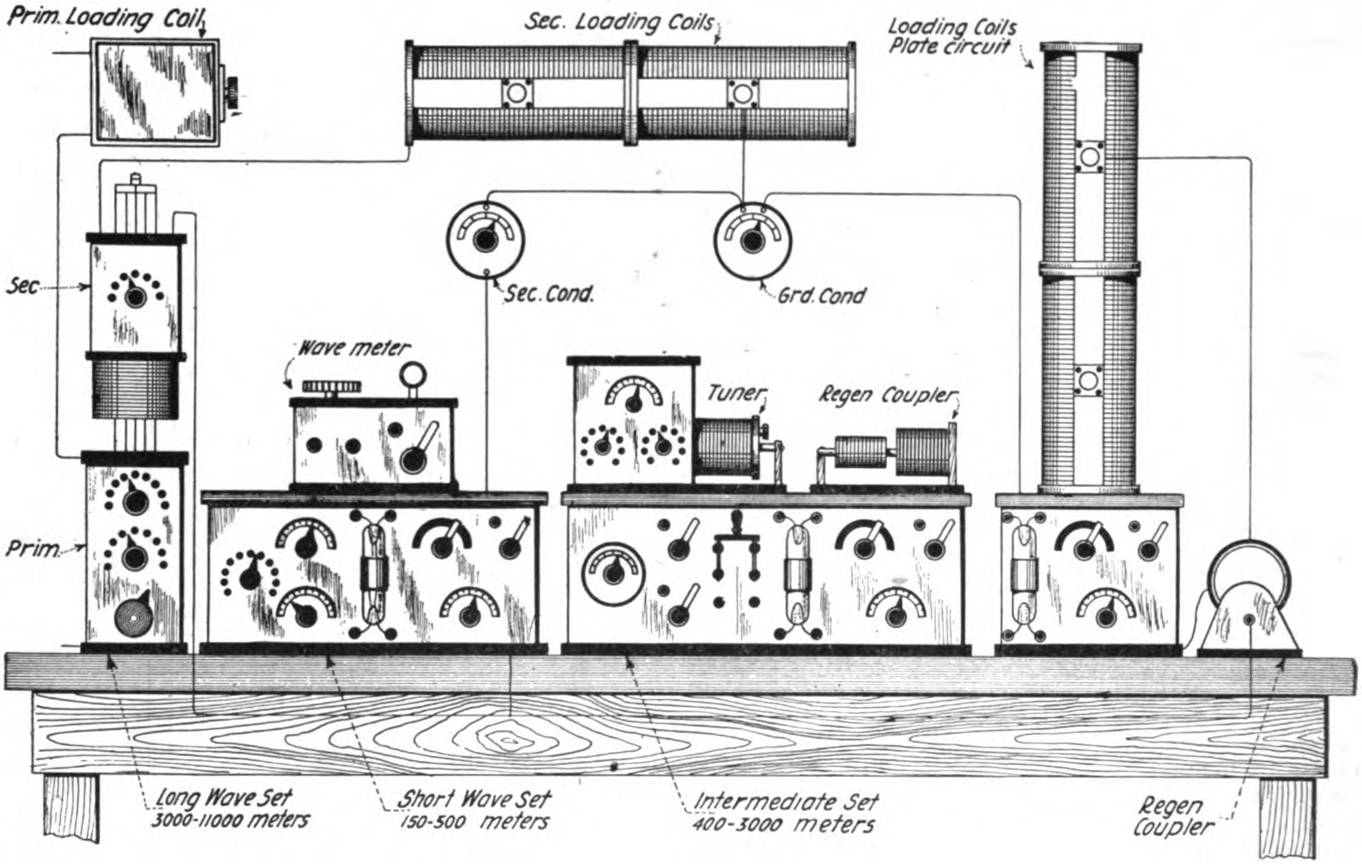


Figure 1—Front view of cabinet with the secondary tuning condenser, vacuum tube controls and the necessary switches mounted in place

The Transmitter

The transmitter consists of a 1 kw. transformer having a secondary voltage of 15,000 volts, connected to a 110 volt, 60 cycle, alternating current circuit. An impedance coil is necessary to regulate the current in the primary circuit. A hot wire ammeter in the primary circuit permits an approximate indication of the power consumed, since the power factor is fairly high and the line voltage remains practically constant. A good key and kick-back preventer are necessary, of course.

A rotary spark gap having studs protruding from the circumference, the studs and outer rim forming one casting, is the most suitable gap for operation with 60 cycle current. This type of rotary gap has two distinct advantages over that type in which the studs are perpendicular to the face of the disc. First, slight variations of the disc due to warping have no effect on the spark length. (The writer has not yet found any material that will not warp slightly in time.) Second, if the fixed electrodes are brought into contact with the rotating studs while in motion, no damage will be done to the disc. The motor on which the gap is mounted, must have generous bearings. It is much better to use a motor that is a little larger than necessary so that silent operation will be obtained.

A molded high voltage condenser is the best type for amateur use. It will withstand high voltage and have long life. An oscillation transformer of the pancake type is very satisfactory. If the secondary is provided with a rotating contact to permit tuning with the key closed, considerable advantage is gained.

A hot-wire ammeter is accurate enough to measure the antenna current. A thermo couple type of meter may be a little better, but its greater cost may make it prohibitive.

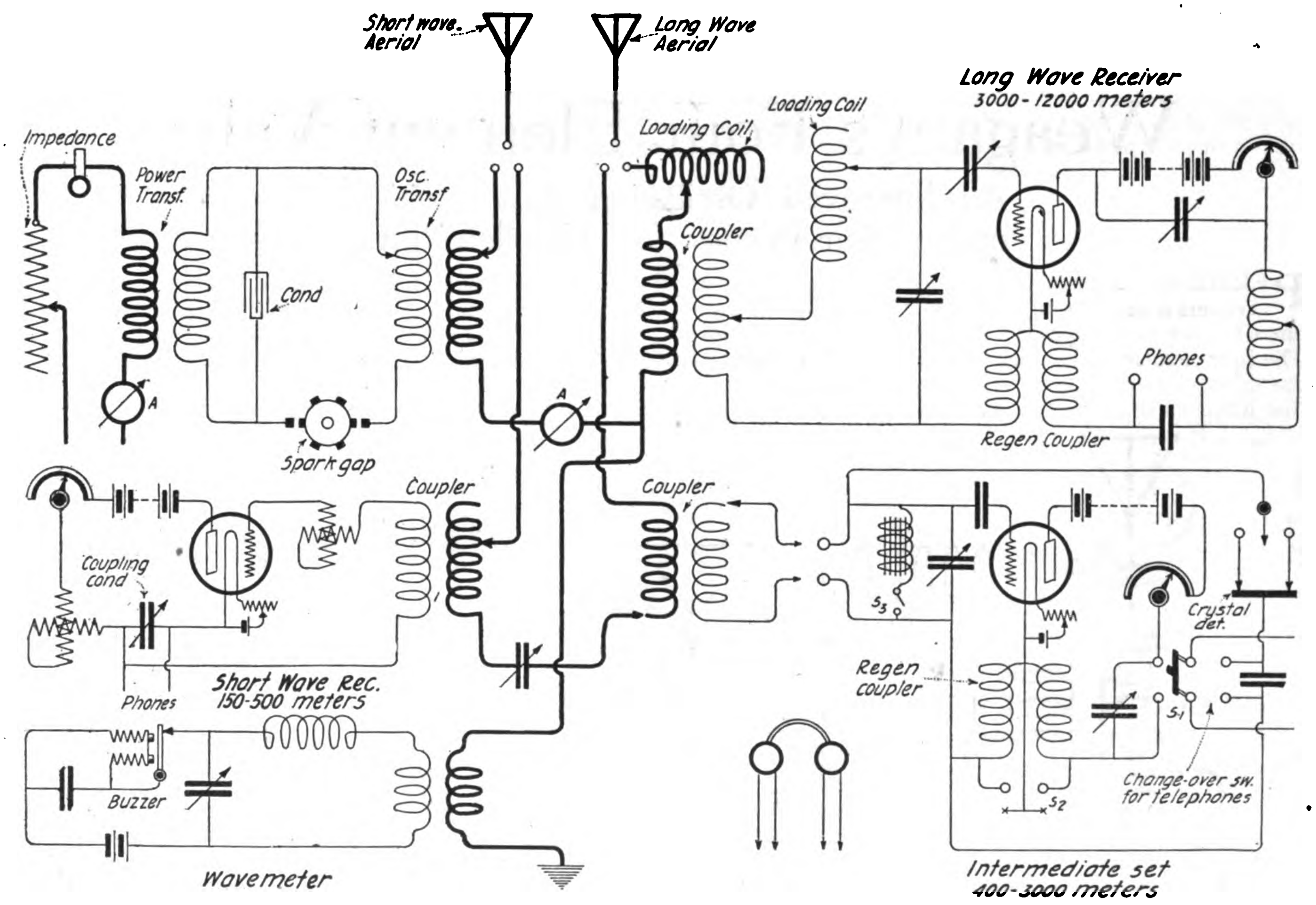


Figure 2—Diagram of connections for the receiving apparatus of an up- to-date amateur radio station

RECEIVING SETS

The receiving apparatus shown in figures 1 and 2 consists of three complete sets, each being provided with a vacuum tube connected in a regenerative circuit. One set is used for reception from amateur stations and has a range from 150 to 500 meters. It is connected to the transmitting aerial. The second set is the main stand-by set and has a range from 450 to 3,000 meters. The third set is used for receiving from high power stations and has a range from 3,000 to 11,000 meters, or greater.

The first set consists of a small loose coupler with a multiple point switch to vary the antenna inductance. The secondary has but one tap. A variometer is employed as a secondary loading coil; all tuning in the secondary circuit is effected with this instrument. It has been found that a secondary condenser, even if set at zero value, has too great a capacity for short wave lengths. A variometer is also used to tune the plate circuit. A plug is provided for inserting a pair of telephones or coupling the output circuit to the input circuit of another vacuum tube for amplification.

The second, or intermediate wave length set, consists of a series antenna condenser, a coupler, and a secondary circuit with a regenerative coupling. Condensers are used in the secondary and grid circuits. A double throw double pole, and a single throw double pole switch are provided. The first switch marked S-1 shifts the connections from the vacuum tube detector to crystal detectors; the second switch, marked S-2, shifts from a regenerative connection to a simple vacuum tube detector connection. Another single throw single pole switch, marked S-3, connects in an auto transformer so that the tube may be used as an amplifier for either of the other sets. The secondary circuit coils are placed in a cabinet on top of which is mounted the tuning coupler, the regenerative coupler and a series condenser. Most any loose coupler of the proper range will prove satisfactory if the inductance is changed by a multiple point switch. The regenerative control switch is located on the back of the regenerative coupler. On the front of the cabinet are mounted the secondary tuning condenser, vacuum tube controls and the necessary switches.

The third set consists of a 3,000 to 7,500 meter coupler, a regenerative transformer with a vacuum tube and loading coils of sufficient inductance to raise the wave length to 12,000 meters. The coupler is of the multiple point type, with a secondary which moves in a vertical plane. This design is economical in space and, as shown in figure 1, it is desirable that all the nearby inductances shall be perpendicular to each other. Each loading coil is built in two sections, which makes it possible to remove unused units from the circuit.

The primary loading coil is mounted on the wall to the left. The secondary loading coils are shown mounted on the wall over the main set with the secondary and grid condensers below. The tuning switches on the coupler and the secondary tuning condenser must have long handles for operation.

On the right are shown the plate circuit inductances. vacuum tube, and regenerative coupler. The output of this detector circuit may be coupled to the input of the vacuum tube of the principal set, as in the case of the short wave set. Audio frequency amplification is employed. Radio frequency amplifying circuits may be a trifle more sensitive but the slight advantage gained is lost in the complex operations that a radio frequency amplifier introduce. Copper tubing or flexible wire may be used to connect the apparatus as shown in figure 1. The apparatus in the writer's opinion, is arranged for convenience and for maximum efficiency.

A telephone headset of 1,500 ohms each is used for recording the signals. If the experimenter will run a pair of separate cords to each receiver and attach plugs at the ends he can connect one receiver to one of any two sets. This makes it possible to hold communication with another station and at the same time stand-by for a high power station. Both receivers may be plugged in on the same set if desired. Auto transformers may be installed in the long wave and short wave sets so that a detector and two-step amplifier may be added to the circuit.

A wave meter (shown above the short wave tuner) is a very convenient accessory. A small wave meter inductance may be used for tuning the transmitting set and a large inductance for tuning the long wave receiving set. Long distance stations usually have a fixed schedule and fixed wave lengths. This makes it possible to pre-adjust the receiver to the required wave length by the wave meter.

Weagant's Four Element Valve

An Improved Oscillation Valve with Increased Sensitiveness for Detection Purposes

PERMISSION has been granted to present to our readers a description of an improved oscillation valve, one of a series of types developed by Roy A. Weagant. The four element valve illustrated in figure 1, differs from the three element tube described in last month's issue in that it has an unconnected grid element G placed between the filament F and the plate P. The sensitiveness of the tube for detection purposes is thus considerably improved. External to the glass container and parallel with the internal electron stream is the electrostatic control element K, which is generally connected to the high potential terminal of the secondary of the receiving transformer. The immediate effect of inserting the element G is to give the tube a more favorable characteristic for the detection of radio frequency currents by the head telephone.

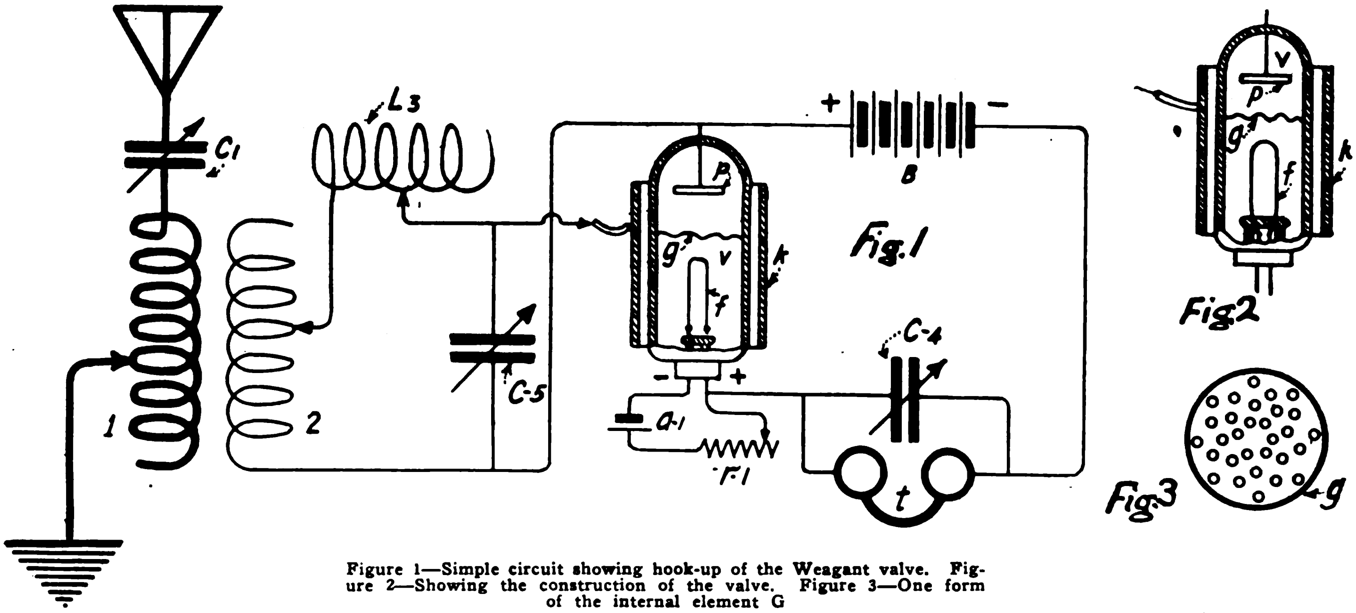


Figure 1—Simple circuit showing hook-up of the Weagant valve. Figure 2—Showing the construction of the valve. Figure 3—One form of the internal element G

According to the inventor, a tube without the element G behaves as follows: If the cathode F and the anode P are spaced far apart, the valve is very sensitive; but because this spacing requires a low potential in the anode circuit, there is a distinct upper limit of signal amplification. On the other hand, if the spacing of the cathode and anode be increased, the plate voltage may be increased with marked amplifications for strong incoming signals. Its sensitiveness to weak signals is, however, reduced. The four element tube combines the desirable characteristics of the two opposing conditions; that is, short spacing may be employed and high voltages applied to the plate circuit with consequent amplification of all signals from the weakest to the strongest. It appears, therefore, that the external element K is the essential element for impressing the received oscillations upon the electron stream, whereas element G permits operation on a favorable point of the characteristic curve.

Any of the well-known circuits for cascade audio or radio frequency amplification, or regenerative amplification, may be employed. An illustrative and simple circuit is shown in figure 2. One terminal of the secondary circuit of the receiving transformer is connected to the external sheath K and the other to the anode or plate P. Figure 3 shows one form of construction for the internal element G.

In the interests of historical accuracy, it may be mentioned that the U. S. Patent specification for this invention was filed April 5th, 1915, and granted January 7th, 1919.

A Four-Valve Cascade Amplifier for Radio Reception

EDITOR'S NOTE—Cascade amplifiers with inductive couplings and resonant circuits between tubes introduce complications which require the attention of an engineer. Because of the simplicity of the four-valve amplifier herewith described, it is especially recommended to the progressive radio experimenter. This is the forerunner of a variety of special circuits and designs that we will present to amateur enthusiasts, from time to time.—Technical Editor.

THE following is a description of a four-valve high-frequency amplifier utilizing one of a series of arrangements described by J. Scott-Taggart in one of his latest articles on valve circuits. It is a complete wireless receiving circuit and possesses the peculiarity and great advantage to amateurs and experimenters of having no inter-valve or step-up transformers. Another advantage is that all the valves, except the first, detect, rectify and amplify incoming oscillations. The first valve is only for amplification purposes. The accompanying diagram, figure 1, shows the complete circuits.

The open or aerial circuit, which has a variable condenser C-1 in series with the aerial, is coupled to the grid oscillatory circuit of the first valve. Another variable condenser C-2 is placed in parallel with the secondary inductance, and although this condenser is for tuning purposes, the inductance should be used as much as possible, and the capacity reserved for fine tuning.

By means of the potentiometer P the grid potential of the first valve is adjusted to a point where best amplification of the oscillations in this circuit is obtained. The separate filament rheostat R-1 also assists in the selection of a suitable adjustment for better amplification.

A small condenser C-3 (about .004 mfd.) placed across the potentiometer allows high-frequency oscillations to pass freely. In the plate circuit is a resistance R-2 of 80,000 ohms. There are similar resistances in the plate circuit of the third and fourth valve.

The high-frequency oscillations which are reproduced in the plate circuit of the first valve are communicated to the grid of the second valve, as the plate circuit resistance R-2 offers too much resistance to the flow of such high-frequency currents. In each grid circuit except the first is a leak R-3 connected between grid and filament. The resistance of the leak is 4 megohms.

As the functions of the third and fourth valves are similar to the second, the filament current should be the same. A rheostat R-4 of 5 ohms, connected as shown, will give a uniform current to these three valves.

The high resistance R-2 can be easily made by scratching grooves, about 1 to 3 inches long, with a sharp instrument on a piece of ebonite and filling them with graphite by simply rubbing a pencil along them. Terminals should be fitted to the ends in such a way as to ensure good contact.

The telephones T, if connected directly in the plate circuit of the last valve, must be of high resistance; but if a step-down telephone transformer is used low resistance telephones will give better results. The latter arrangement is preferable.

The battery which supplies the potential to the plates should be of about 80 to 100 volts, while a 4 volt accumulator is usually best for the filament.

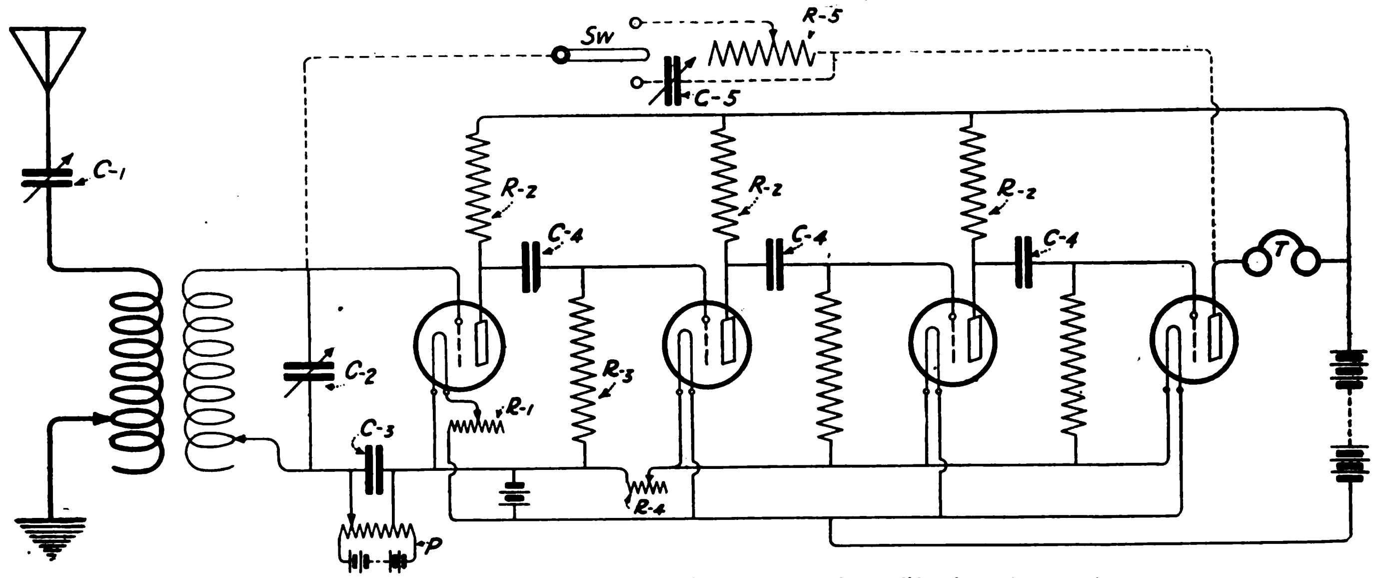


Figure 1—Diagram showing circuits of the four-valve cascade amplifier for radio reception

If the plate of the last valve is connected through a small variable condenser C-5, or a very high resistance R-5, to the grid of the first valve, a further increase in the strength of the signals is noted. By suitably adjusting the resistance or condenser, the circuit can generally be made to oscillate and continuous wave signals may then be received. The resistance and condenser together with a switch S and connections are shown on the diagram by dotted lines.

The results obtained with such an amplifier are very satisfactory. The adjustments are simple, when compared to the circuits employing inter-valve transformers. With transformers the rectification of signals is chiefly left to the first valve which often has to deal with very weak signals and therefore small variations of grid potentials. In this circuit the incoming signals are first amplified.

So simple and economical an amplifier should appeal to amateurs. Its sensitiveness and peculiarity of amplifying weak signals to a far greater extent than strong ones, should be of great assistance to those who wish to receive from stations which hitherto have been unreadable owing to the great distances being spanned or because of using too small an aerial.

A High Frequency Generator for Code Practice

THIS instrument, as constructed by the writer, was made entirely from old apparatus found around the workshop. The generator will furnish enough power to operate from one to six or even more telephones over a line from room to room in the same building. It furnishes an ideal source of high frequency oscillations for fast sending. This is due to the fact that there are no vibrating parts to be stopped and started between each character, as is the case when a buzzer is used. The writer does not claim to be the originator of the principle involved but only of the details of application.

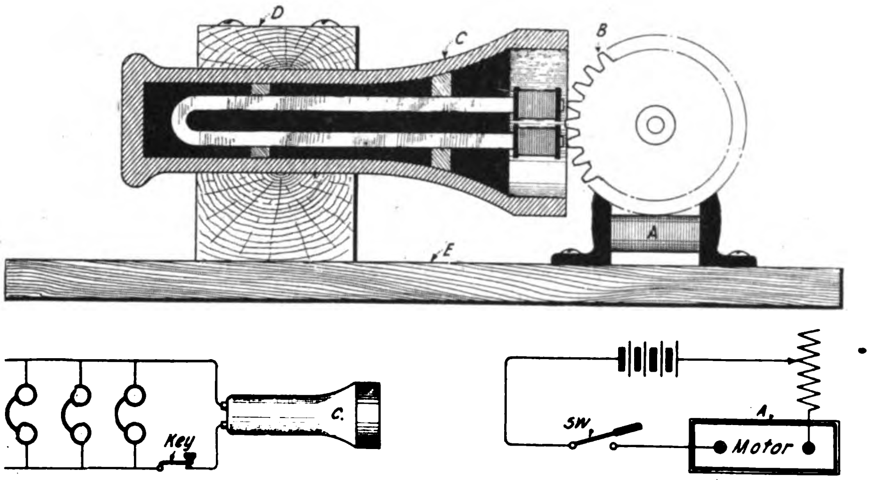


Figure 1—Showing construction and connections of the high frequency generator

There are three fundamental parts to the generator. "A" is a small Ajax motor which had been rewound with small wire (size about No. 24) to reduce its current consumption. When running it takes from three-quarters to one ampere depending on the speed. "B" is an iron gear two inches in diameter by one-quarter inch thick with twenty-five teeth. The gear used by the writer was taken from an old lathe. It was put on an arbor and turned down to the right thickness and then fastened on the motor shaft by a brass bushing, which was made long enough to allow a set screw to be inserted. "C" is an old pear shaped telephone receiver with the cap and diaphragm removed.

The motor is screwed to one end of base "E" and the telephone receiver is supported by a split block "D." The top of this block is clamped to the lower part by two screws, one in each side of the telephone receiver. A small rheostat may be mounted on the base for regulating the motor speed.

Any type of small motor may be used and a watch case telephone receiver will work as well as the pear shaped one if properly mounted. It is necessary, however, that the line through the center of the telephone receiver be at the same height as the center of the motor shaft. While twenty-five teeth gives the best results with the Ajax motor it is not necessary that the iron gear have exactly this number but it is absolutely essential that it be mounted true on the motor shaft if a clear note is to be obtained.

The diagram figure 1 shows the proper connections. It should be noted that there is no direct electrical connection between the motor and the pear shaped telephone receiver. The power developed by this instrument varies inversely as the distance of the telephone magnets from the iron gear.

E. S. PALMER—*Rhode Island.*

Suggestion for Prize Contest, May Issue Wireless Age.

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

Which of the two following types of wireless transmitters do you consider to be the most practical for amateur use, namely: the panel type or the isolated instrument type?

Improved Cell Design for High Voltage Battery

ONE of the primary requisites of a modern radio receiving set, is the vacuum valve detector. Of the two sources of direct current necessary to operate this instrument, the high voltage battery gives the most trouble. Flash-light batteries are expensive and short-lived compared to the amount of current used. For those who are content to have test-tubes or other containers arranged in racks, filled with acid, the high voltage storage battery solves the problem, provided they have a convenient source of charging current. From my point of view, I believe that dry cells of a special design, easily constructed by the amateur and small enough to be contained in the receiving cabinet, solve the problem for portable as well as stationary sets.

I think the best shape for the cell, is that of a disc. The best method I have found for making the cells, is to use fibre of cardboard rings to separate the metal electrodes. The outside dimensions are about 1¾ by ⅜ inches. The fibre or cardboard ring has the same outside diameter as the finished cell and the cross section should be about ¼ by ¼ inches square. The rings are soaked in melted rubber compound, such as used to seal storage batteries, and then hung on a rod or nails so they may be removed easily when cold. The negative electrode is a zinc disc the size

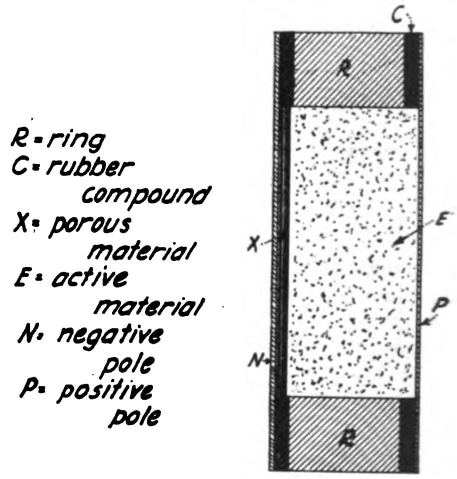


Figure 1—Detailed construction of cell for high voltage battery

of the cell and the positive electrode may be copper or other metal depending on the active material in the cell. Carbon cannot be used in this type of cell to advantage.

The method of assembling is to place a zinc disc on one of the rings and then press it down with a hot flatiron until the rubber compound is melted. Then a cold one is put on with pressure until the compound is cold. A tight fitting disc of blotting paper is placed next to the zinc on the inside and the electrolyte, in the form of a paste, is next applied. A layer of some depolarizing agent such as black oxide of manganese should complete the filling. Then the other electrode should be sealed in position as the first.

In presenting this suggestion to your readers, I hope some of them will be interested enough to start where I am obliged to leave off, i. e., the finding of the best material for the positive electrode and the electrolyte for the highest efficiency. These cells would have many advantages such as, their cheapness, their small size and ease of construction. Thick metal discs should be placed at each end and a little pressure maintained at their centers by set screws. These act also as binding posts.

LEO. M. LAFAVE—*New York.*

First Aid to the Amateur

BY E. T. JONES

A DETECTOR STAND.

THE detector in figure 1 was constructed mostly of parts of a telegraph sounder and a telegraph key. The support U for the swinging arm A which also carries the contact point originally was the support of a telegraph sounder which held the lever. The crystal holder H is made of a U shaped piece of brass and an 8/32 screw is passed through it at the top to clasp the mineral in its ends. The adjusting knob K is an 8/32 screw with a key knob for its handle. A small piece of tapped hard rubber somewhat similar to the handle of the switch handle on the key gives it a finished appearance.

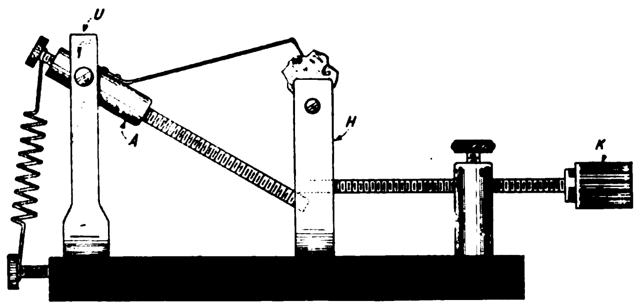
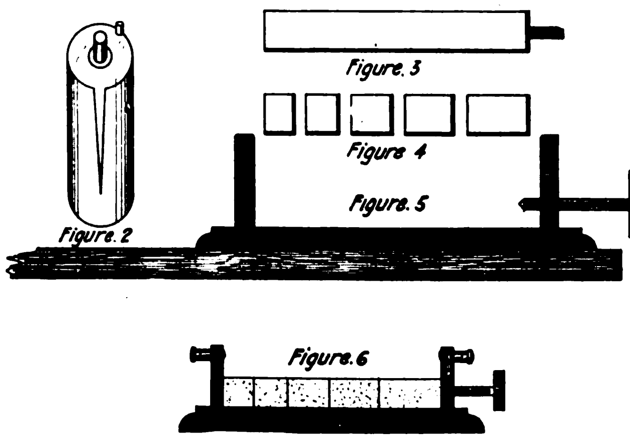


Figure 1—View showing the construction of the detector stand

The main advantages of this detector are that immediately a good adjustment is secured the point can be raised while sending and returned to the exact spot for receiving merely by turning the handle and lowering it to its original position. This is a feature that cannot be obtained from any other form of detector holder. It is optional what kind of mineral is used as the adapter is made to hold any of the well known types. I find this to be one of the best detectors I have had the pleasure to work with owing to the fact that whenever one desires to send he merely has to take the point off the mineral and when finished lower it gradually until the point comes in contact with the exact spot used before.

A COMPRESSED CARBON RHEOSTAT

The variable resistance element of this rheostat is the carbon electrode of an ordinary Columbia No. 6 dry cell. As shown in diagram figure 2, this may be removed by simply splitting the zinc down the edge with the sharp edge of a hatchet. Figure 3 shows the carbon when removed, and figure 4 shows the same carbon with the binding post removed and cut into small blocks of different lengths. Figure 5 shows a suitable stand for the blocks which permits a variable pressure, thereby raising and lowering the resistance at will. Figure 6 shows the completed apparatus.



Figures 2, 3, 4, 5—Detailed construction of the compressed carbon rheostat. Figure 6—The complete device

The blocks can be cut into very thin strips, that is, about 3/8" or 1/2" thick thereby increasing the resistance. This is a very good instrument for the laboratory and one which is easily constructed and operated.

A CAT WHISKER DETECTOR.

Figure 7 shows the drawings of a novel type of cat whisker detector. The mineral (galena or cerusite) is clamped in the stationary wood support (3) and held by clamp (2). The points as mounted on the copper wire (soldered) which in turn is made fast to the 1/4" square brass rod (9). Each point as will be seen from the drawing is made longer than the preceding one, or they can all be the same length but each of different gauge spring wire making each a little more "springy" than the preceding one. The sliding arrangement (8-9 and 10) should be constructed to allow the rod to move to and fro easily on the wood support (6). The detector as a whole is very efficient and a point is readily found

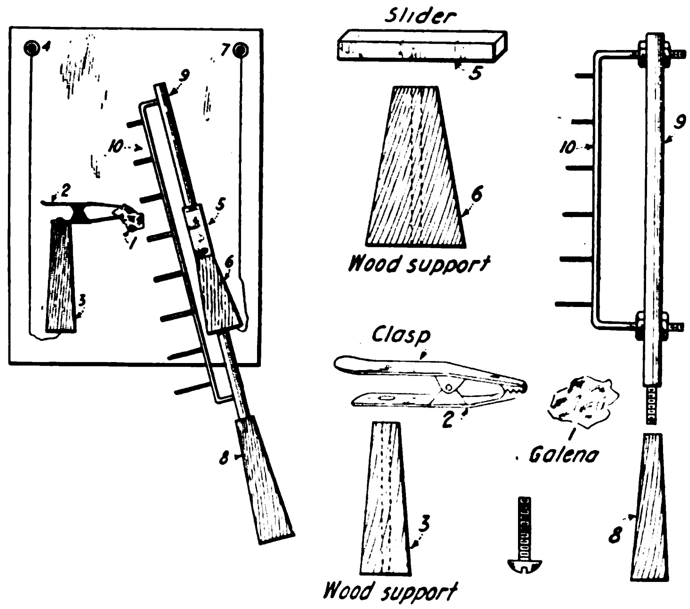


Figure 7—The cat whisker detector illustrated in detail

by sliding the arm (8-9-19) backward and forward—slowly.

A "Quick Throw" Switch.

As shown in figure 8, A and B are knife blade contacts for connection

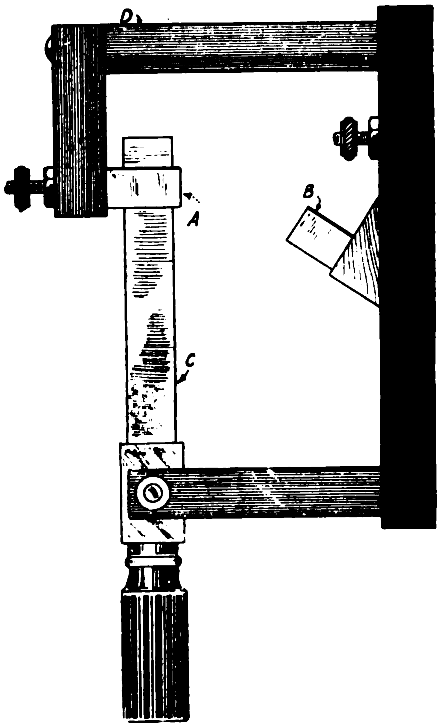


Figure 8—"Quick throw" switch

with the switch arm C. H is preferably a hard rubber or hard wood handle. A is supported by an overhanging arm D which is of hard rubber. This ought to make a good antenna change-over switch or a lightning switch. It may be used for many purposes around the amateur station.

Donle's Electron Valve for Wireless Reception

COMING on the heels of a multiplicity of patents covering the design and use of vacuum valves for wireless transmission and reception,

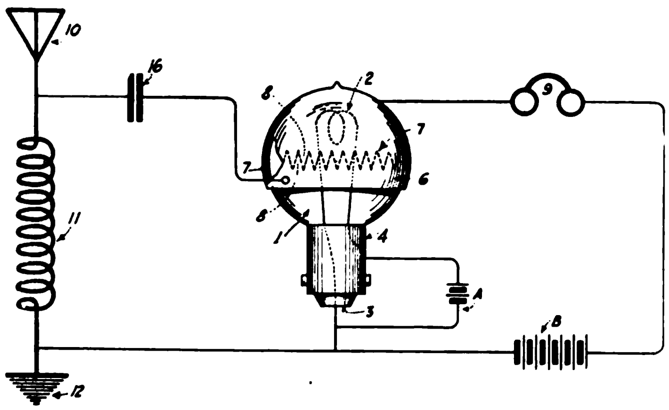


Figure 1—Donle's vacuum tube connected for radio reception

we have a newcomer for which some startling performances are claimed. Those who have been accustomed to conceive of the electron as moving with great freedom in a vacuum are now called upon to believe that the electron stream actually may pass through glass under certain conditions of temperature. H. P. Donle of Connecticut, is credited with the discovery.

In one type of his valve shown in figure 1 the elements corresponding to the grid and plate of the usual tube are placed on the outside of the glass container. The external metallic covering 6 called the "deflector" is insulated from another metallic covering 5 called the "target." These elements are in jagged conformation which the inventor remarks to be essential to successful operation. The target and the deflector may be of silver or copper.

In his own language: "The two external conducting elements are shown as having their adjoining edges relatively closely approached but as having a clear insulating space 7 therebetween. The adjoining edges of the two elements furthermore, are indi-

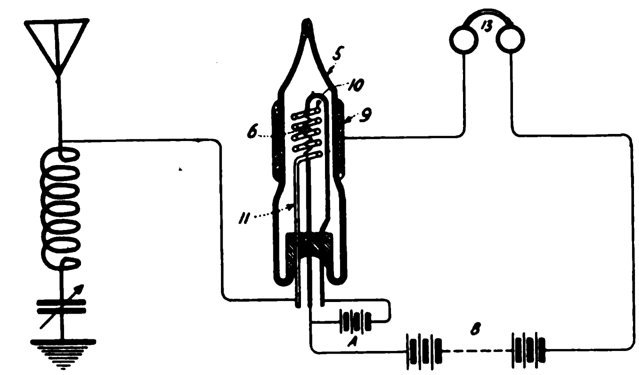


Figure 2—Modified form of tube in a modified circuit

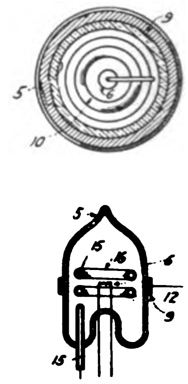


Fig. 3 (top)—Cross section
Fig. 4 (bottom)—Vertical section

cated at 8 as of serrated or jagged outline, thus providing a zigzag intervening space between the two members. This in effect increases the areas of the two elements which are opposed to each other.

"It is desirable that as many as possible of the electrons which control flow from the filament to the target shall be influenced by the deflector. In order that the deflector influence these electrons, its electrical field should be as close as possible to the target. The portion of the target not affected by the electrical field from the deflector will receive an uninterrupted flow of the electrons from the filament. As an amplifier, the action depends upon the volume of electron control. The deflector should therefore control as great a percentage of the electron flow as possible. This in effect is what is accomplished by the intermeshing or 'overshadowing' of the target by the deflector."

According to the inventor, when the temperature of the glass is raised to 100° C. or more, it becomes conductive to the electron stream and some current flows from the battery B through the glass and across the intervening space between the plate and filament. The circuit may be traced from one terminal of the B battery through the telephone 9 to the target 5. The other terminal of the B battery is connected to one side of the filament. The deflector 6 is connected to a terminal of the secondary circuit through the condenser 16. Direct coupling is shown at 11.

The inventor declares that the electrons flow through the warm glass or other normally non-conducting wall of the globe and not simply through the evacuated space as in tubes heretofore. He states that the efficiency of the tube is not dependent solely upon the maintenance of the vacuum. Furthermore, he believes that the electron discharge at the inside of the bulb may be considered, because of its unilateral conductivity, a polarizing conductor or polarizing medium. The electrode on the outside of the bulb is of a material that does not polarize in contact with the glass and he therefore terms it a nonpolarizing layer or conductor. He believes that the deflector, connected to a source of radio frequency oscillations, varies the electron current in the tube much in the same way as in the ordinary three element tube with all electrodes inside the bulb.

A tube of modified construction and a modified circuit are shown in figures 2, 3 and 4. Figure 2 shows the tube with the filament 6 inside the grid element 10, the container being surrounded by the metallic conductor 9 which forms the anode for the tele-

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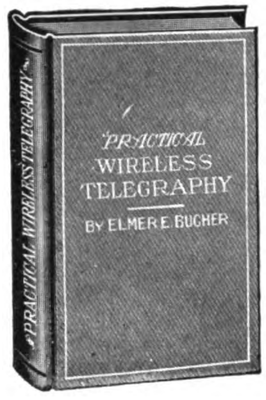

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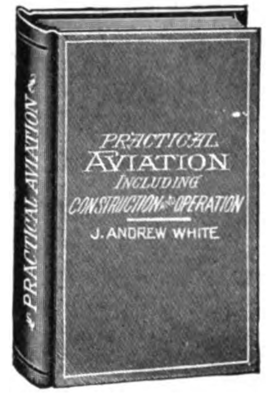

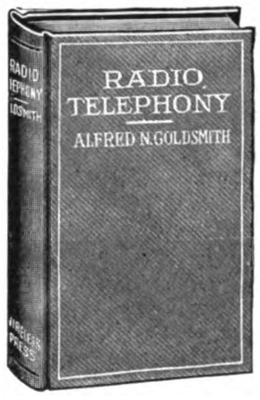

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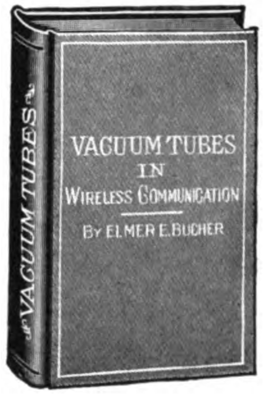

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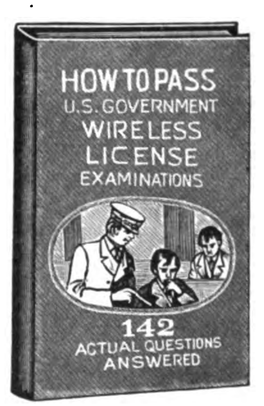

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phone circuit. The grid element 10 is connected to one terminal of the antenna circuit through the wire 14. This constitutes an open oscillation circuit which has been covered by patent specifications of another inventor. Figure 3 is a cross sectional view of the tube on the plane 2-2 in figure 2. Figure 4 is a vertical sectional view of a modified form of construction.

It is to be noted in circuit of figure 2 that the plate current furnished by the B battery is assumed to flow from the external element 9 through the glass container to the filament 6.

The operation of the tubes and the circuits in figures 2, 3 and 4 is described by the inventor as follows: "The filament when energized by the battery A heats up the globe which, as before stated, is usually made of glass or other material normally non-conductive at room temperature but which when heated to a higher temperature of say, 100° C. or over, becomes conductive to a certain degree, whereupon current from battery B passes from the anode through the heated glass to the layer of electrons on the inner wall of the globe, said current being conducted between this wall and the filament by the electron stream. If a charge is now placed upon the controlling member, as by means of radio oscillations, for instance, the flow of current through the glass is decreased by the decreasing in area of the electrons laying upon the inner wall of the globe, the controlling member apparently acting in this case to absorb unto itself a certain number of these electrons."

The operation of the tube in figure 2 is in general similar to that first described, the controlling member being connected to one terminal of the oscillation circuit. Quoting the inventor:

"The polarizing layer of electrons or ions in contact with the inner wall of the globe, it will be seen forms in effect a polarizing conductor which in combination with the non-polarizing conductor in contact with the outer wall of the globe makes of the device a rectifier which may be used as such. The device may also be used as an amplifier in which event the connections will be such that the area of the polarizing conductor will be varied according to the energy to be amplified."

Regarding the special construction in figure 3, the inventor states: "The construction illustrated in figure 3 differs from the first form described, particularly in that both the anode and the controlling member are separated from the filament or electron source by a wall of glass. In this case the anode is located on the outside of the globe 5, as in the first instance but the controlling member is in the form of a metallic coating 15 of silver, or the like, lining the inner wall of a sealed glass tube 16 located within the globe and surrounding the filament."

The Effect of a Shunt Condenser in Tuning the Primary Circuit of a Receiving Set

By Ralph R. Batcher

EDITOR'S NOTE.—A condenser shunted across the primary of a receiving tuner does not always give the desired results. Just what may be expected in practical operation, the author explains by a simple mathematical analysis. Careful study of this article may help the experimenter to understand some of the apparent "freaks" met with in "parallel tuning."—Technical Editor.

THE effect upon the wave length of the antenna circuit when a condenser is placed in series with the localized inductance, is well known. This method is often used to cut down the wave length of the circuit. However, the practice of placing the condenser in parallel with this inductance, does not always lead to the results that were expected.

The circuit shown in figure 1 typifies the shunt connection. If we allow the letter R to stand for the ratio between the wave length resulting from particular adjustments of L_1 and C with respect to fundamental wave lengths of the antenna, i.e.,

(1) $R = \lambda_1 \div \lambda_0$, it will be shown in the latter paragraph of this article that the following relation is obtained:

(2)
$$\frac{C}{C_0} = \frac{R^2 L_0}{L_1} + \frac{R^2}{1 - R^2}$$

It would be advantageous to solve the above equation for R but the solution of a fourth degree equation is in this case more complicated than in the above form. It is also impossible to plot the above equation as it stands owing to the fact that it contains five variables. However, L_0 and C_0 are constants for any one station so that absolute values can be ascribed to them and an illustrative solution worked out by curves.

Suppose that $L_0 = 50{,}000$ c.m. and $C_0 = .00025$ mf. (which are the approximate values of an antenna 60 feet high and 60 feet long). The equation now contains but three variables and can be more readily plotted. Curves showing the value of R with C ranging in value from 0 to .005 mf. for several values of L_1 are plotted in figure 2.

Similar curves may readily be drawn for any antenna if its inductance and capacity are known. In this article the effective values of the inductance and capacity only are used. There has been no attempt to consider the distributed nature of L_0 and C_0, as its introduction would tend to complicate the formula and to obscure the results that were to be disclosed in this article. Other formulæ* have been recently published that can be applied to the distributed values of L_0 and C_0 to obtain their effective values. These latter values should be used in formula 2.

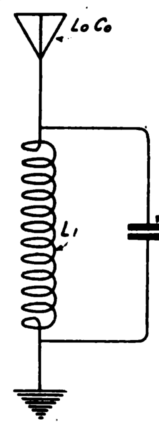

Figure 1

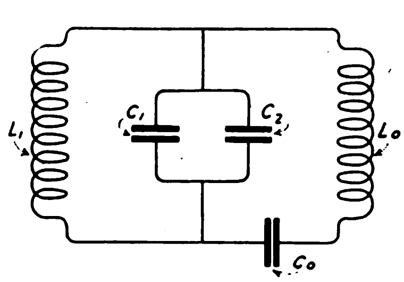

Figure 3

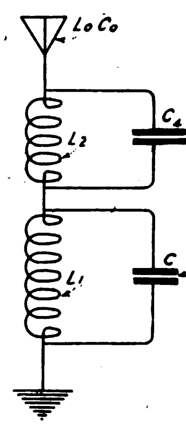

Figure 4

Symbolic diagrams of "parallel tuning"

It will be seen that this circuit can be used for lowering the wave length as well as raising it. This principle has been used for many years by certain commercial companies to lower the wave length of an antenna to a value below the natural wave length, but amateur operators have rarely made use of it knowingly.

In plotting these curves it will be

* See Bureau of Standards Bulletin No. 74, pages 71-86.

found that the computations are simpler if values are assumed for R and for L_0 and the corresponding value of C obtained by substituting these values in the formula.

It will be seen by analyzing the sample curves that there are certain wave lengths, around the fundamental wave length of the antenna that cannot be received with this circuit, except with very small values of L_1 and C.

The derivation of the formula is as follows:

The equivalent circuit corresponding to figure 1 is shown in figure 3.

$$\text{Let } \lambda_0 = 59.6 \sqrt{L_0C_0}$$
$$\text{and } \lambda_1 = 59.6 \sqrt{L_1C_1} \qquad [2]$$

An emf. of frequency n will effectively "split up" the condenser C into two capacities C_1 and C_2 so that both cir-

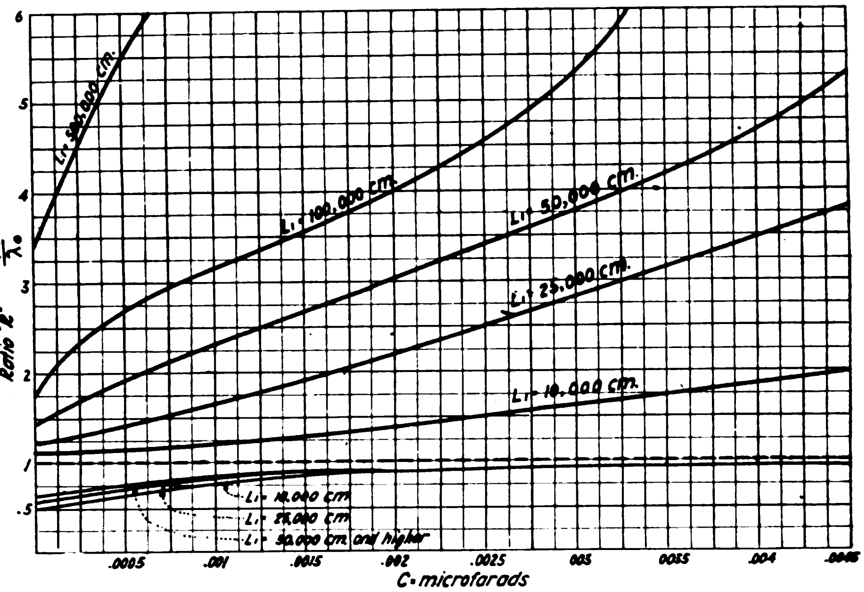

Figure 2—Graphic curves showing ratio values in shunt condenser connection

In other words the circuit L_1C acts as a high impedance for these wave lengths. It will also be noticed that there are certain combinations of L_1 and C, that make the circuit responsive to slight changes of capacity, and that at other places a large variation of the condenser C is needed to produce a given change of wave length. Doubtless every amateur has noticed this condition in practice but was unable to account for it. The circuit will always respond to two wave lengths, one above the other below the fundamental wave length of the antenna.

Applying this method to a transmitting circuit to enable the operator to use a rather large antenna for 200 meter waves, it will be seen that some sort of a filter circuit must be added in series with antenna, to shut out the unwanted frequency. This additional circuit added to the antenna circuit would probably decrease the efficiency of the apparatus, but it remains to be tried out in practice to determine whether it is better than a plain series condenser to accomplish the same result. Figure 4 shows the apparatus needed to cut the natural wave length down in this manner. L_2 and C_4 must be of such a value that they correspond to the undesired wave length produced by the condenser C.

cuits L_1C_1 and $L_0C_0C_2$ will if possible be in resonance with the frequency n. Then

$$L_1C_1 = \frac{L_0C_0C_2}{C_0 + C_2} \qquad [3]$$

squaring eq [2]

$$\lambda^2_1 = \frac{L_0C_0C_2(K)}{C_0 + C_2} \qquad [4]$$

$$\text{and } \lambda^2_0 = L_0C_0(K)$$

solving [4] for $C_2 \div C_0$

$$\frac{C_2}{C_0} = \frac{\lambda^2_1}{\lambda^2_0 - \lambda^2_1}, \qquad [5]$$

from eq. [2] and [3]

$$\frac{C_1}{C_0} = \frac{\lambda^2_1 \times L_0}{\lambda^2_0 \times L_1}, \qquad [6]$$

adding [5] and [6]

Let $C = C_2 + C_1$, then

$$\frac{C}{C_0} = \frac{\lambda^2_1 L_0}{\lambda^2_0 L_1} + \frac{\lambda^2_1}{\lambda^2_0 - \lambda^2_1},$$

substituting $\lambda_1 = R\lambda_0$,

$$\frac{C}{C_0} = \frac{R^2L_0}{L_1} + \frac{R^2}{1 - R^2}$$

This last formula is the one given at the first of the article.

Contest Winners for the April Issue

In response to the call in the February issue for manuscripts concerning the ideal amateur set, prizes have been awarded to the writers of the following articles. The subject upon which the contest was based was: What, in your opinion, is the most efficient receiving set for amateur wave lengths, and what should be the dimensions of the antenna and the tuning coils for best results?

First Prize—A Short-Wave Regenerative Receiver

THE receiving tuner herein described is designed for use on an average amateur aerial having a natural wave length of about 175 meters. An inverted L type aerial, 80 feet long and 60 feet high, answers these requirements, although the length and height may be varied to fit the location. A natural period greater than 175 meters is not recommended if the station is to operate on 200 meters, as an aerial of such dimensions will not permit sufficient inductance in the primary of the receiving tuner, nor in the secondary of the transmitting oscillation transformer, for efficient transformation.

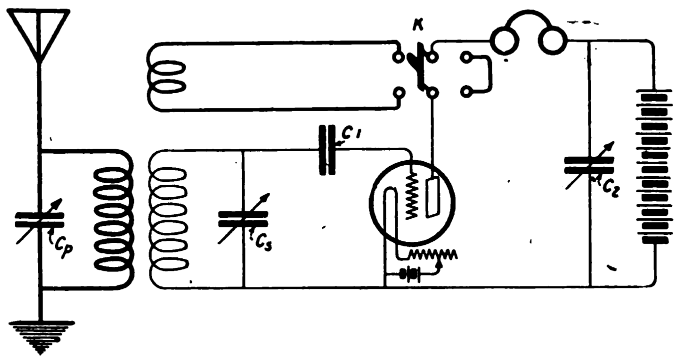

Figure 1—First prize article

In choosing a type of receiver for amateur purposes, and for construction by amateurs, three fundamental points should be considered: 1st, efficiency; 2nd, simplicity of construction; and, 3rd, ease of operation. That these points have been carefully kept in mind in the tuner described, the following will bear out.

With respect to efficiency, it should be noted that this type of circuit has been adopted by the Navy Department, the U. S. Signal Corps, and by many foreign governments. The size of wire for the coils herein specified will give maximum conductance, which IS IMPORTANT, contrary to the popular belief that, because the vacuum tube is a potentially-operated device, its efficiency is not lowered by using fine wire. The absence of variometers eliminates another source of energy loss, and the tuning of the secondary by a condenser instead of taps, makes a further improvement.

The simplicity of construction will be apparent after noting the details given. There is an efficient circuit employing variometers, but the construction of a variometer is much more difficult than the simple coils required in this tuner.

This receiver consists of three coils, a primary, a secondary, and a tickler coil. The primary and secondary are each shunted by a variable condenser of 0.0005 mfd. capacity, and a variable condenser of 0.001 mfd. capacity is shunted across the high potential battery.

The primary coil is a tube three inches in diameter, wound for a distance of one inch with 30 turns of No. 22 D.S.C. magnet wire, and tapped to two 5-point switches for single turn variation. This coil has a total inductance of 0.1 millihenries, and if used on the aerial described above, with the shunt condenser, will respond to wave lengths ranging from 200 to 600 meters.

The secondary coil is a tube 2½ inches in diameter, wound with 50 turns of No. 24 D.S.C. magnet wire. No taps are taken from the secondary, the variation of wave length being obtained by the variable condenser. The secondary has an inductance of 0.14 millihenries, and will respond to the same range of wave lengths as the primary. A maximum separation of 6 inches between the primary and secondary coils should be provided, but the constructional details can be varied as individual requirements may dictate.

The tickler coil is wound on a wooden ring, the center of which is turned out large enough to permit sliding the ring over the secondary. A groove is cut out on the edge of this ring, the inside diameter of which is 3 inches, the width ⅜ inch. In this groove are wound 12 turns of No. 18 annunciator wire, in 3 layers of 4 turns each. A D.P.D.T. switch is provided for throwing the tickler coil out of circuit when a plain valve connection is desired, and the coil is so designed that its insertion will not detune the secondary circuit.

When operating this receiver, the desired signal is tuned in with the switch K to the right. When this is accomplished, the tickler coil is thrown into the circuit and moved over the secondary until regeneration occurs. Condenser C2 is then adjusted, and the coupling gradually loosened, so that freedom from interference will be obtained. It is possible to receive strong signals with a very loose coupling, as the amplification obtained (3 to 6 times) will compensate for the loss of energy resulting therefrom.

By the use of suitable loading coils in the primary and secondary circuits, this tuner will respond to waves as long as 2,000 meters, but it is advisable to remove these coils completely from the circuits when short waves are being received.

In conclusion, I would say, the construction of this tuner will prove a revelation to many amateurs who have been content with the simple vacuum tube connections heretofore employed, and will certainly repay anyone for the time and materials expended.

Arno A. Kluge—*California.*

Second Prize—A Receiving Set for Amateur Wave Lengths

THE amateur is, of course, primarily concerned with the reception of signals from amateur transmitting sets which usually operate at the wave length of 200 meters. To do this most efficiently he ought to design a set especially for short waves. Such a set was constructed by the writer in the Physics Department of the State College for Teachers at Albany, N. Y. and exceptional results were obtained with it. Amateur stations in Ohio, New Jersey and even Nebraska were heard far above readable loudness. The wiring diagram appears in figure 1.

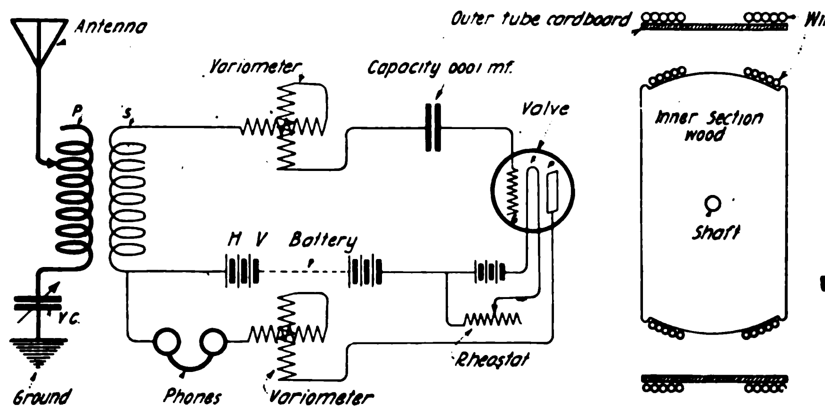

Figure 1—Second prize article

A regenerative vacuum tube receiver is used. With such a set it is advisable to use small capacities and provide a means for carefully regulating the inductance continuously from a minimum to a maximum. Such variation may be effected by placing two coils, having equivalent values of inductance, concentrically with provision for rotating the inner one to vary their self-inductance.

The mutual induction between two wires varies inversely as the distance between them. It is, therefore, well to construct the inner coil of the variometer so that its winding will be as close as possible to that of the outer coil. In order to do this the inner coil is wound on part of a spherical surface, that is, a section of a ball, made of wood. This section is 3 inches in diameter and 1½ inches wide. It is made to rotate by means of a brass shaft, within a carboard tube 1½ inches wide of the correct diameter to allow clearance. The tube and the inner core are both wound nearly full with equal quantities of No. 28 copper wire in one layer. The coils are then arranged in boxes and provided with a handle carrying a pointer which travels over a scale of 180 degrees.

Two of these variometers are connected in the circuit of a specially constructed coupler. The primary of the coupler contains some 20 turns of No. 28 wire on a cardboard tube about 6 inches in diameter. The secondary coil has 15 turns of wire on a tube 5½ inches in diameter. Provision is made to allow very loose coupling between the primary and secondary. A complete circuit diagram is shown in figure 1.

It would be of further advantage to wind the outer coil on a curved surface to bring the two windings in close proximity. This, however, is difficult without proper tools. The side drawing of figure 1 gives the constructional details of the variometer.

The antenna should be as high as possible. A two wire aerial 150 to 200 feet in length with the wires spaced 4 to 6 feet will do. The variable condenser in series with the primary circuit gives very close tuning and is essential for very short waves. An additional variometer might be connected in the antenna circuit.

Although amplifiers are in use at the college laboratory, the records mentioned above were made without an amplifying device of any sort.

E. L. LONG—*New York.*

Third Prize — Amateur Radio Receiving Station

THE set I am about to describe is very efficient for wave lengths between 200 and 3,000 meters. It is easily constructed, low in cost and employs but one vacuum tube. I use two couplers and two aerials. One aerial and tuner are built specifically for 200 meters, and the second combination for wave lengths up to 3,000 meters.

The large coupler may be any good make of transformer the operator has on hand, but I recommend that the 200 meter be specially constructed. By

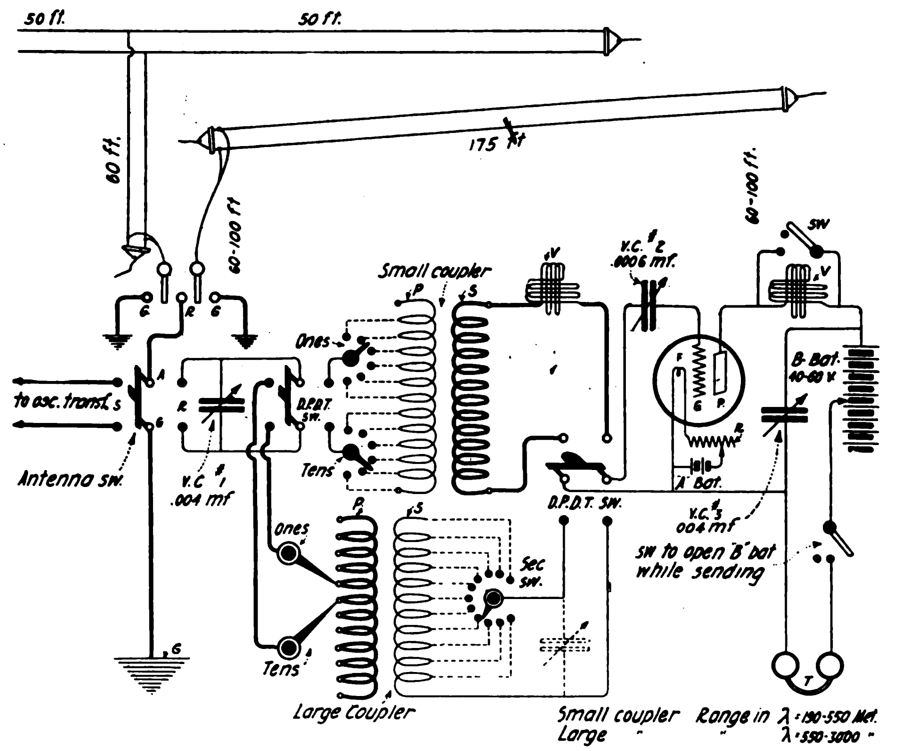

Figure 1—Third prize article

means of a change-over switch either coupler and aerial may be employed as desired. I consider the "T" type antenna to be the most efficient for short wave work, but for longer wave lengths I would advise a separate antenna of the "L" type about 175 feet long and as high as possible above the earth. The higher it can be elevated the longer the range. The "T" type should be 100 feet long and 60 feet high of 2 wires of stranded phosphor bronze spaced about 8 feet apart, the vertical section being separated about 15 feet above the earth by an 8 foot spreader. For the "L" type only one wire is necessary, 175 feet long and 60 to 100 feet high.

The primary coil for the short wave coupled in figures 1 and 2 should be 3 inches long, 3 inches in diameter, wound with No. 24 S.S.C. wire tapped so as to allow a variation of one turn at a time. The secondary should be 2½ inches long and 2½ inches in diameter wound for 1¾ inches with No. 28 S.S.C. wire. It is not necessary to take any taps off of the secondary. A small variometer is used in the secondary circuit to allow very fine tuning.

A full description of a variometer which is very efficient for this purpose may be found in the book "How to Conduct a Radio Club."

A small variometer of a simple design may be constructed that will answer this purpose very well. The outer coil should be 3½ inches in diameter, 1½ inches wide, wound with 25 turns of No. 28 S.S.C. wire. The inner coil should be 3 inches in diameter wound with No. 28 S.S.C. wire. Care should be taken that the inner coil has the same amount of wire as the outer coil. Cardboard tubes may be used and the wire should be well shellaced. It may be mounted on a base and placed on the operating table, or if so desired it can be mounted on the back of the panel board, with the rod that is used for rotating the inner coil extending through the panel. With the pointer and scale on the front of the panel, it presents a very neat appearance.

The large coupler has a primary 5 inches in diameter and 6 inches long wound with No. 24 S.S.C. wire tapped so as to allow a variation by one turn at a time. The secondary should be 4 inches in diameter, 5 inches long wound with No. 28 S.S.C. wire, tapped every ⅜ of an inch.

Variable condenser No. 1 should have a capacity of about .004 mfd. Variable condenser No. 2 has about .0006 mfd. capacity. The variable condenser shunted across the telephones has a capacity of .004 mfd. It can be replaced by a fixed condenser of similar capacity but it reduces the efficiency especially in the short wave set. Variable condenser No. 3 can also be replaced by a small fixed condenser made of a piece of mica 2 x 4 inches covered on each side with tin foil; but for the best results I believe a small variable should be used.

The variometer in the plate circuit should be the same in design and size as the one described above, and if properly constructed will give considerable increase in signals on the low waves. It should be shunted by a small switch so that it may be cut out when using the larger transformer.

By means of the two double pole double throw switches shown in the diagram, either of the couplers may be connected to the valve detector. This does away with the dead end effects that are particularly noticeable on the two hundred meter wave lengths. This set may not look so well as the cabinet type of short wave regenerative receivers on the market for amateur use, but if properly constructed it will give equal results. The appearance of this set can be increased considerably by mounting it on a panel except the tuning couplers which should be mounted on the operating table. The telephones can be any standard make such as the Brandes or Murdock 2,000 ohm type which I find to give equal if not better results than the telephones ordinarily employed. A fundamental wiring diagram appears in figure 1 and the assembled apparatus with all connections in figure 2.

W. S. Taylor—*New York*.

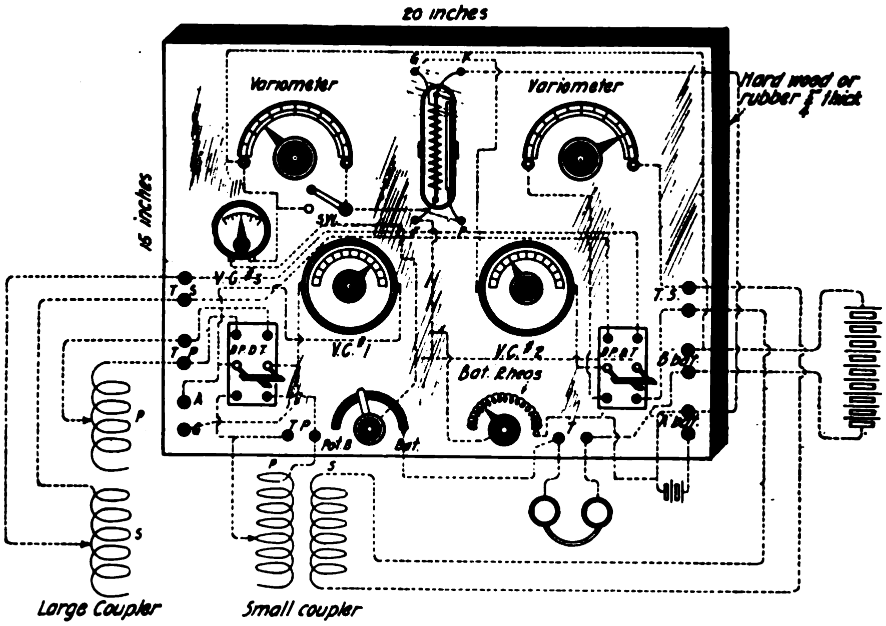

Figure 2—Third prize article

A Method for Reviving an Audion "B" Battery

I THOUGHT perhaps it might be of interest to amateurs to know how to revive their old "B" batteries used with three element vacuum tubes and save money. I carefully stripped the old cells of their zincs, leaving the wax on top of each carbon and scraped the decomposed zinc from the bag around the carbon. I made new zinc cups, lined them with paper and soaked them in a solution of zinc chloride and saturated ammonium chloride. I also soaked the carbon sacks in the same solution. The proportion of the two chemicals is not very important, one part ZN CL to two or three NH_4CL being used. The cells worked over in that way gave 1.4 volts. The zincs were formed around a cylinder of the right diameter and soldered. It is a rather big job, but if ten-cent flashlight batteries are not to be had it saves money.

Jacob Jordan—*Indiana*.

The Monthly Service Bulletin of the

NATIONAL WIRELESS ASSOCIATION

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

Guglielmo Marconi, *President* — J. Andrew White, *Acting President* — Alonzo Fogal, Jr., *Secretary*

Pre-War Amateur Radio Work

MANY of the radio amateurs throughout the United States will be interested in the pre-war distance records made by Station 6EA, at Los Angeles, California, some of which have never been published.

Radio amateurs on the Pacific Coast have done some very excellent long distance work both in regard to transmission and reception. Our amateur radio station, for one, obtained good results, especially between the hours of ten-thirty at night, and two and after, in the morning. Using a homemade regenerative receiver, the writer picked up 9ZN of Chicago, (1730 miles) on a wave of 425 meters, calling 9ZF of Denver. This occurred during March, 1917, on a clear evening after midnight. In February, 1917, we heard 7ZC of Lewiston, Montana, (1,005 miles), also on a 425 meter wave. He was working with 7ZN at Vancouver, Washington. Another night in February we picked up two stations on 425 meters. One was 9XN at Grand Forks, North Dakota, who was calling 9XV, 5BV and 8YI, between the hours of ten and midnight. The other one was 5ZC at Dallas, Texas, who was heard working with 5ED after midnight. These distances are, respectively, 1,445 and 1,240 miles. The above mentioned distances are the maximum we have been able to cover.

We have had excellent results in transmitting over long distances. Our transmitter is entirely homemade and of half-kilowatt capacity. The aerial is of the inverted "L" type, fifty feet high and forty-five feet long, giving a wave length of about 195 meters.

We received a letter from the operator at the Marconi station KDU, at Juneau, Alaska, stating he had heard our signals quite distinctly while we were working with 7ZN, on March 1, 1917, at eleven-fifty p. m., Sitka time (12.50 A. M. Pacific Coast time). The distance to Juneau, Alaska, from Los Angeles as computed by spherical trigonometry, is 1,840 miles, which is our record transmission. The operator at KDU was using the Marconi type 101 tuner, crystal detector, and Baldwin Mica diaphragm receivers.

The steamer D. G. Scofield (WRD) heard our station 1,289 miles west of San Francisco, which is approximately 1,500 miles from Los Angeles. This same ship picked up our station when 20 miles north of Seattle. Station 9ADL of Milwaukee, Wisconsin, heard our signals, the distance being 1,730 miles.

The above is a fair illustration of the possibilities in amateur long distance communication previous to the war. By utilizing some of the discoveries made during the war, these records will undoubtedly be excelled.

HOWARD C. SEEFRED—*California.*

Undamped Stuff

I tired of interference, so I though it would be fine
To buy a tube and build myself a feed-back heterodyne,
To hear the latest line of dope, swift-wing'd by night and day,
From Eiffel Tower or Babylon, Iceland and far Cathay.

(*That was the prolog*)

I scraped up microfarads, enough to choke a horse;
A flock of milihenries too, to balance up, of course;
Then I beat 'em all together till the racket made me deaf,
And multiplied each screw and bolt by L C 2 Pi F,
I made a characteristic curve, I liked the way it bent,
I smeared the proper volts and juice upon the filament,
And hooked up just enough dry cells for pressure on the plate.
Nothing went amiss, I thought—but it wouldn't oscillate!
I tied a new condenser with a leak up to the grid;
Then I jerked it out again; but no matter what I did,
My efforts were in vain; I tried most everything
But no canary bird inside woke up to start to sing.

Avaunt, O, feed-back heterodyne! and straightway let's prepare
Another way to hear the lay of sigs in ether'd air.
From dark to dawn, to list, adorn'd, in chaste and simple nighties,
While the stuff comes in on bent hairpin and good ol' iron-pyrites.

The Vacuum Tube Transmitter for the Amateur

AMONG the manuscripts published in the January issue of The Wireless Age on interference, the one by A. J. Holborn is of real value. The vacuum tube transmitting set is practical. It is easy to operate when the proper tubes can be had. Of course, any undamped wave sender is more efficient than spark sets.

Any oscillating audion set such as used for receiving from arc senders may be used for transmitting. I wonder how many amateurs ever stopped to think that their heterodyne receiving sets are sending out feeble undamped waves.

I have repeatedly used an ordinary receiving set of the above type to transmit over a distance of almost one-half mile. The source of energy was the small B battery in the plate circuit. With a standard set using 50 watts I have carried on excellent communication over a distance of 18 miles. I give these examples to show that my "dope" is not theoretical but is based upon actual experiments.

Among other tests, three sets of equal power were operated at equal distance from a receiving station at only 10 meters difference in wave length. The receiving operator was able to read any of the three at will without undue interference from the others.

By using the hook-up formerly employed in the receiving set and substituting a larger tube and a higher plate voltage, considerable power may be radiated. In case one tube is not sufficient, they may be operated in parallel.

Two pieces of apparatus called for which may be difficult to obtain are a proper tube and a source of high voltage for the plate circuit. It is customary to use a motor generator set to change any convenient source of current such as 110 volts AC into about 300 to 500 volts DC. A high voltage battery of reasonable cost may be on the market at a later date.

Geo. E. Baker—*Texas.*

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.

H. P. M., Royse City, Texas:

The crystaloi detector will not respond to undamped oscillations, therefore your first query does not require further comment.

In reply to query No. 2, the dimensions of an aerial for receiving foreign stations abroad are immaterial, provided you possess sensitive receiving apparatus. A cascade radio frequency amplifier will permit reception of signals over enormous distances with small antennae.

* * *

A. N. W., Bolivar, N. Y.:

Ques. (1)—I have a telephone generator giving about 115 volts and 2 to 3 amperes. When run at 2,000 R.P.M., it should give over 300 watts, 60 cycle A. C. Barring difficulties, such as heating, could this generator be used to excite a ¼ kw. closed core transformer for wireless transmission or experiment?

Ans. (1)—If the output of this generator is as you state, and it does not overheat on full load, we see no reason why it could not be employed in the manner you state.

Ques. (2)—I have an 8 volt, 10 ampere dynamo which I desire to employ to charge a storage battery to be placed 800 or 900 feet from the source. What size wire would you suggest as being desirable to carry the necessary charging current with a minimum of line loss?

Ans. (2)—A No. 6 or No. 8 wire would have sufficient current carrying capacity to meet this requirement.

* * *

W. P. B., Freedom Station, Ohio:

In reply to your first query, we are unable to give you data regarding an earth transmitting system, because you have not stated the type of apparatus you wish to use. If you will go to a local Public Library and obtain a copy of Fahie's "History of Telegraphy," you will find complete descriptions of various types of induction telegraph systems.

In regard to the matter of receiving aerials: the dimensions make little difference if you use a vacuum tube amplifier as a detector. For the reception of amateur wave lengths, the antenna should not be more than 120 feet in length. Two wires will do as well as four wires.

We have no data on the Arlington and Key West press schedules, but we presume that the old schedule will be adhered to in the future.

Replying to your fourth query: The radio stations of the United States employ both damped and undamped wave transmitters. Ships generally use spark transmitters although the larger battleships have installed high power arc transmitters for long distance communication.

The book "How to Conduct a Radio Club," will give you complete dimensions of a receiving tuner suitable for reception of the time signals. The text-book "Practical Wireless Telegraphy" contains a description, with dimensions, of a receiving tuner for wave lengths up to 12,000 meters.

* * *

M. L., Champaign, Ill.:

Your questions regarding a specific type of vacuum tube are too general. In fact the data you have supplied is insufficient to give you definite information regarding the circuit for this particular tube. Various connections are used in vacuum tube transmitters and some of them cannot be published until the signing of the armistice. The text-book "Vacuum Tubes in Wireless Communication" gives numerous diagrams covering the vacuum tube situation in general.

Regarding the 500 watt generator for the vacuum tube: It is suggested that you communicate with the Crocker-Wheeler Co. of New York, for further details.