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June, 1917

THE WIRELESS AGE

HELEN CAMPBELL, THE FIRST WIRELESS OPERATOR ENLISTED BY THE NATIONAL LEAGUE FOR WOMEN'S SERVICE

IN THIS WAR PREPARATION NUMBER:

Signal Officers' Training Course
FIRST ARTICLE BY MAJOR WHITE

Military Wireless Instruction
SECOND INSTALLMENT BY E. E. BUCHER

Vacuum Tubes in Radio Telephony
SIXTH ARTICLE BY PROF. GOLDSMITH

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THE WIRELESS AGE

An Illustrated Monthly Magazine of RADIO COMMUNICATION

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

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CONTENTS

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The Declaration of War

THE radio spark flashing through the ether has long since become recognized an inseparable corollary to all epochal events. That this highest of scientific arts should be the forerunner of a mighty nation going to war in the modern way was, therefore, to be expected, but the incidents of its employment have been found worthy of record for their dramatic elements alone.

It was in the afternoon of April 6th that war was declared. A few minutes after noon of that day the joint resolution of the House and Senate was signed by the Vice-President and but one formality remained to make the United States an ally of the Entente in the world war of democracy against autocracy. The document awaited President Wilson's signature, only two minutes; precisely at 1:13 his pen scratched across the parchment. Instantly, Lieut. Commander Byron McCandless at the window signaled across the street to the Navy Department, and while the ink was still wet on the historic war resolution orders were being flashed by wireless to the ships at sea; at the same moment all the countries of the earth were notified of this government's action.

Thus between ticks of a watch Uncle Sam's widely distributed fighting units were consolidated in purpose and the silent machinery of defense set in motion.

The wartime employment of this humanitarian agency has been many times described in these pages, but never, it seems, with the force that this incident brings home, both in portent of message and the feeling that it is our American voice—yours and mine—that spoke in the ether-waved message.

Making Ready for the Call to the Colors

THE mistaken idea which seems to be held in foreign quarters that America's young manhood will reluctantly respond to the call to the colors is due for an immediate upset. It is a national characteristic to wait for the "something doing" period before stirring to action, but once we know that it is our duty to enlist, the citizen training army will be enrolled almost literally overnight. As a matter of fact, men of military age are not shying at the draft; they merely want some assurance of active service—now that they have it, business careers and education will be instantly interrupted to serve the nation. The response in advance of the draft definitely supports this statement. Communications from readers of this magazine requesting enrollment have been gratifyingly numerous and men with exceptionally valuable qualifications for the navy and the army signal corps have offered their services without restriction, even when they had one or more dependents to consider. The enrollment for the Officers' Reserve Corps camps far exceeded the number to be accommodated.

Much still remains to be accomplished, however. There is a growing conviction that the United States, once embarked on its mission of placing an army in the field, will turn to careful consideration of a permanent policy of adequate defense of the wide territory we occupy. More men will be needed, both for the duration of the war and the permanent reserve. Skilled electrical signalmen will be greatly in demand.

Thousands of articles have been printed on the vulnerability of our coasts to invasion. The average reader knows now that once a European enemy got past the American fleet he could easily land an army anywhere at one of the 116 places along our northeastern coast and establish a base of strategical importance. And this is the fact. To illustrate its feasibility we have only to consider that the British landed 120,000 men on the Gallipoli Peninsula, in spite of the waters being heavily mined and the peninsula surrounded by hostile submarines.

While sensational disclosures of our weakness before an invading force have been liberally sown, little has been said of our plans for defense. Possibly many believe that such plans do not exist. But they do; and they are the result of very careful study by the General Staff over a period of eleven years. A special board has since been constantly engaged in revising from European experience the defensive plans for coast fortifications and directions for the mobile army to prevent an enemy seizing any permanent base on our coast. An outline of the use of the "service of information"—or the army signal corps—is given in the new book "Military Signal Corps Manual," prepared especially for amateur wireless men, and the principles of communication with mobile troops will be given in the Signal Officers' Training Course, which begins in this issue of the magazine.

For the communication service of an army of 2,000,000 men, as now proposed, the signal corps ranks would require every single qualified wireless amateur in the country. This is the time to prepare.

Excellent training courses have been instituted by colleges and universities for the months of May and June. A typical course is that of Columbia University, where through intensive study of field service students may learn the elements of signal corps duties. This course occupies a period of classroom study of seven weeks, the tuition fees being $54 to $60. This is an excellent way to grasp the fundamentals of military service, and it is cordially recommended. For those, however, who cannot overcome the handicap of home location or restricted finances, the same subjects may be mastered by close study of the self-training courses to be published in forthcoming issues of this magazine. Any carefully prepared military course is valuable; the principal thing is to get started **now**, to be prepared for any eventuality.

The Possibility of Utilizing Amateur Stations

IT seems almost incredible that some owners of amateur wireless stations in New York delayed dismantling their sets for several days after the issuance of Secretary Daniel's order. The reason given in eighteen reported cases was that they didn't consider it necessary, as their equipment was not in working order. Of course the so-called reason was not heeded; it should never have been given, in fact, and these dozen and a half addle-pated amateurs may feel that the mere fact of raising the question has put them outside the ranks of the loyal Americans who hastened to comply with the regulation when war was declared. As an indication of the co-operative spirit shown, the Police Commissioner of New York reported that in that city alone 1,010 amateur plants in operation closed down immediately.

It is quite a hardship for amateurs to be silenced, but it must be remembered that the nation is at war and there are many problems for the Navy to solve unhampered. Wireless is but a small part of the work under its supervision and it is quite in order for every citizen to stand by the Government loyally as the military establishment prepares for action. The day is not far distant when the invaluable assistance to be rendered by amateurs will be recognized. But it is not now a propitious moment to direct attention to this defense auxiliary. All amateurs must be patient for months to come; study hard and await the time when, with greater problems out of the way, the Government will seek amateur assistance in accordance with a definite schedule.

Those who thoughtlessly disobey the closing-down edict should be immediately reported by their amateur acquaintances. Amateur experimenting is here to stay, and every serious devotee of the art should feel it a point of honor to see that all observe the order absolutely.

Hostile Communication on Short Wave-Lengths

OF great interest to the public was the recent statement of Lord Northcliffe that censorship, no matter how well planned, is relatively inefficient. "Some time ago," said this famous British journalist, "Marconi told me that he would undertake to erect a wireless plant that would demand some months effort on the part of our Government to locate, and that before it had been located he would be able to erect another at some other place in England."

We in the wireless field know that this is entirely possible; and that it may now be done by enemy agents in this country is not beyond belief. Short distances could be worked—say in communication with submarines off our coast—on wave lengths that are not audible to the Navy stations in commission. No doubt the Government has considered this possibility and in due time will arrange a wireless espionage system, utilizing amateurs. A definite plan for this auxiliary can be made up only by appointment of a representative board, and it is obviously useless to attempt its consideration until more vital naval questions have been disposed of. Individual efforts of amateurs to bring about measures of this kind will end in nothing; the cue is now to await the developments patiently, obey the law rigidly and prepare for eventual service by study of the advances in the art.

Meanwhile, all changes in the laws regulating wireless operation should be resisted. The present statutes have proven their efficiency; nothing can be gained by changes and considerable damage can be done. Amateurs have considerable unoccupied time on their hands now; each worker in the field should make it his duty to write regularly to Congressmen and Senators, stating clearly that the present law should remain as it stands.

The Father of Wireless Speaks

AMBASSADOR PAGE has made public a communication from Mr. Marconi which in its warmth of expression seems a personal message to each individual wireless worker in this country. In his letter Mr. Marconi said:

"The sincere admiration and affection I have always felt for your great nation and the encouragement and hospitality invariably ungrudgingly extended to me by Americans, in carrying out my wireless work, render more intense the satisfaction which I feel, in common with my countrymen, at American participation in the great war, which we are fighting for the freedom of civilization.

"Having had the good fortune to work for years in your country and the opportunity of appreciating your democratic institutions, I rejoice at the knowledge that you now have become our ally, not only because it is the most eloquent confirmation of the justice of our cause and because it affords us most valuable material assistance, but also because it enables Americans and Italians to understand and appreciate each other much better.

"No political antagonism can exist between America and Italy. Both fought for freedom and are now fighting together for a common cause—the liberty of the world."

Real Benefactors and Alleged Inventors

BY contrast the issues of the universe are determined. The noble spirit of the inventor of wireless has been so often disclosed in his words and actions that he has long been recognized the world over as a man of wonderful humanitarian instincts; by the same token, other men who have pursued wireless as an avocation have been disclosed both as charlatans and promoters of sharp business practice. Once in a while these latter come a cropper. The most recent instance of this kind concerns the career of a former amateur who secured considerable newspaper notoriety some five years back as a supposed shining light in amateur work and then threw discredit upon the whole field by being haled into court, shortly after the passing of the Radio Act, for operating a powerful 'phone station without a license. Now it appears that last December, this one-time amateur, Elman B. Myers, while in the employ of the de Forest Company, burglarized the Belmar station. He was indicted for breaking and entering and larceny and placed under arrest on April 25th. "The evident purpose of the burglar in entering the station," says the attorney's statement, "was to steal certain valuable patented articles and records of the Marconi Company and turn them over to the de Forest Company." Myers has been held without bail pending his extradition to the State of New Jersey for trial.

The incident speaks for itself. It is under such moral handicaps that the wireless art has labored since its inception. It is to be hoped that this is the last instance of the kind which will have to be recorded in a field mainly composed of thousands of genuinely earnest and sincere workers.

The Award of the Honor Medal, I. R. E.

AN item of genuine interest which we are able to announce exclusively in these columns, is the first award of the medal of honor of the Institute of Radio Engineers. It is to be presented to Edwin H. Armstrong in recognition of the valuable contribution to the art represented in his work in connection with receiving apparatus. This testimonial to the efficiency of the now familiar Armstrong circuit will be a popular one, and should prove a great incentive to amateur experimenting since Mr. Armstrong's regenerative circuit was evolved in his amateur days.

—THE EDITOR.

Signal Officers' Training Course

A Wartime Instruction Series for Advanced Amateurs Preparing for U. S. Army Service

By MAJOR J. ANDREW WHITE

Chief Signal Officer Junior American Guard

As editor of this magazine and acting president of the National Amateur Wireless Association during Mr. Marconi's absence at the front, I have had for the several years of the war a chance for observation of the American wireless field that has been of incalculable value in estimating our radio needs and resources. It has been my great privilege to sound the first note of preparedness warning in these pages and to observe with increasing gratification the spreading of the get-ready gospel through other technical journals. Fortunately, this preliminary work was thoroughly done; there is no longer any anti-military apathy to overcome and with the draft legislation enacted the business of training an army for service abroad will go through without any serious hitch, and certainly no opposition worthy of consideration.

We now, therefore, face a condition, not a supposition. The time has come for active participation in warfare by the readers of The Wireless Age. Some will be called to the colors at once. Others beyond military age will loyally, and, perhaps, impatiently, await their turn on a second call. And a great many will now begin to prepare themselves for the service for which they will be eligible with a few months added to their ages.

To all genuine Americans whose love for country means desire for service this series is dedicated. Much of the outline instruction embraced in these articles has already been imparted first hand to enrolled members of the Junior American Guard, sponsored by the N. A. W. A. and actively engaged in its work of military instruction for nearly two years. It is gratifying to state that a number of young men who embraced the opportunities of cadet soldiering when it was first offered through this means have now qualified as soldiers in the regular army and the militia. Some saw service on the Mexican border last summer and others have been cordially welcomed into the regular establishment for this war. The response to the appeal has been generous in twenty-one states; it is now hoped that wireless amateurs *in every state —and COUNTY—in the Union* will organize for Signal Corps instruction. In clubs where activities have been checked by silencing of apparatus, most important work may be carried on through military instruction. There may be a war behind this one; perhaps a war of invasion; preparation for maintaining military communication over the enormous territory of the United States cannot be begun too soon. Older men may "do their bit" by supervising the instruction; younger men may prepare for an eventual call to the colors; and it is hoped that those who go now into training may find some principles of value in this series for study in odd hours while in camp.

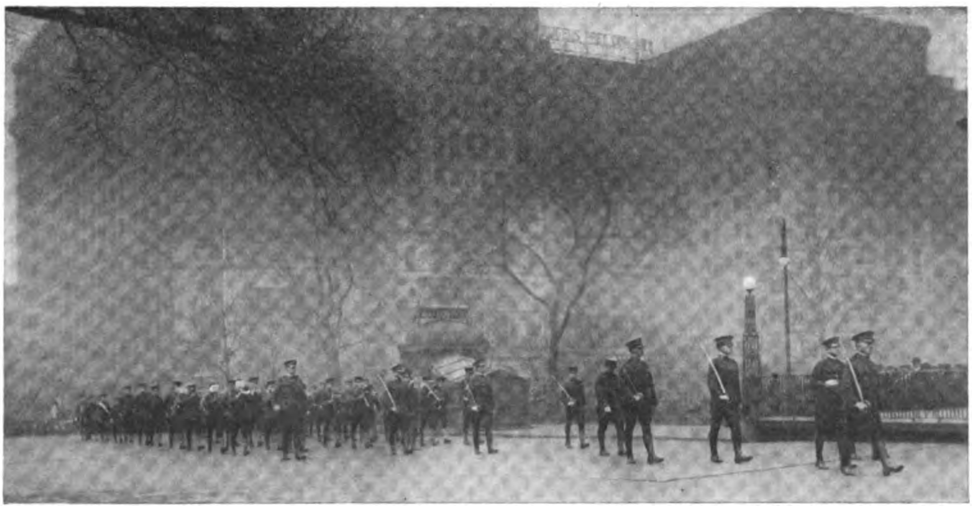
* * * * * *

To properly introduce an instructional series created by a condition, the inspirational factor must be stated. Briefly, it is this: Nearly every young man who has looked to military service—and hundreds have spoken to me personally on this subject—feels he is entitled to go to war as an officer.

It is a natural ambition. But the qualifications for leadership in the signal corps are not solely a superficial knowledge of electric phenomena and ability to inspire respect, as many imagine. Definite military knowledge—and a considerable amount of it—is *absolutely essential* with a signal officer. Most of my well-intentioned friends have believed that this could be acquired in a few weeks or months. They have realized the enormity of their task, however, once they have been given the outline of the soldiering requirements.

This outline is all that I purpose giving in the pages of The Wireless Age. The detailed information has been given in the book "Military Signal Corps Manual," which I have had the honor to compile with the invaluable assistance of Brigadier General George O. Squier, chief Signal officer of the Army, a vice-president of the N. A. W. A. and a soldier-scientist without a peer in the world. This book is now available and will be found particularly valuable to amateurs, I believe, because it has been specifically written for the citizen-soldier.

In considering signal corps units or-



Arrival of staff at City Hall, New York, at the head of a column of 2000 members of the Junior American Guard, reviewed by General Dyer on April 21st ganized in radio clubs, organizers must face a condition to which my attention has been drawn. There is a tendency among members to consider their knowledge of radio complete after attendance at a baker's dozen meetings. In signal corps of any cadet efficiency whatever, this viewpoint is ridiculous. Experience has proven that it requires about three years' instruction to make a non-commissioned signalman and double that time to qualify a soldier for a lieutenancy in signal corps. In consequence, the club that takes up military work seriously has embraced a subject of lasting interest. To promote the interest in instruction requires merely that the leader rule with firm discipline according to regulations, and conduct, in addition to the weekly drill, a school for privates seeking promotion. This latter instruction should be given at least *once a week* and 100 per cent attendance required of those who volunteer for the extra study.

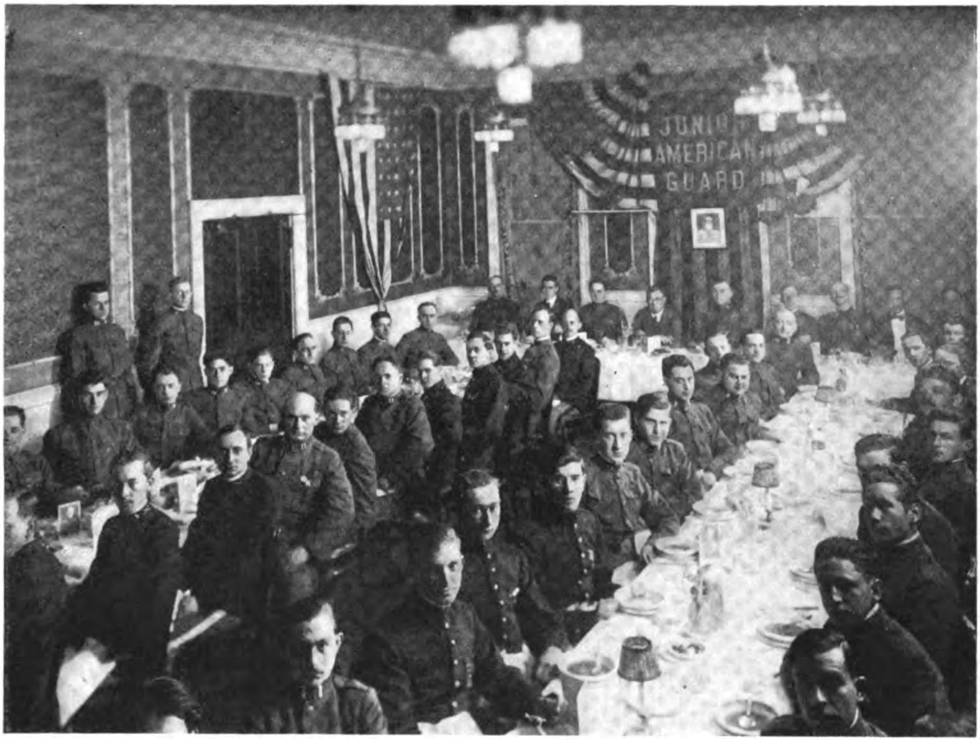
* * * * * *

The U. S. Army requirements for men seeking promotion to the non-commissioned grade of master signal electrician may be used as a basis of estimate for the knowledge required of signalmen. Master signal electricians, it must be understood, are rated below second lieutenants, the M. S. E.'s grade being about equal to a quartermaster sergeant, senior grade. Yet this is the knowledge required, and the method of rating:

	Value (units).
1. **Theoretical electricity and signal equipment**	100
The voltaic cell, Ohm's law, primary and secondary batteries, telegraphy and the induction telegraph set, telephony, the camp telephone and the buzzer, cable and cable systems, aerial line construction, post telephone systems, small-arms target range signaling systems, technical equipment issued by the signal corps and requisitions and general maintenance regulations, tests of submarine cables, etc.	
2. **Drill regulations for field companies**	10
3. **Gasoline engines**	10
4. **Army regulations**	5
Arrests and confinements, commands, honors, courtesies and ceremonies, courts-martial, property accountability and disbursing, transportation, subsistence, etc.	
5. **Algebra, not including quadratics**	10
6. **Regulations for U. S. Military telegraph lines**	5
7. **Army signaling**	5
American Morse code, general service code, visual signaling by flag, torch, hand lantern or searchlight, heliograph, ardois, stationary semaphore, rockets, bombs, small-arms, guns, coston lights, Very pistols, cipher messages and improvised codes, etc.	
8. **Commercial radio regulations.**	10
9. **Radiotelegraphy**	30
Theoretical and practical.	
10. **Telegraphy**	10
11. **Visual signaling**	5
12. **Record and recommendations.**	50
Technical duty performed, etc.	
Total units	250

The foregoing subjects are covered in an examination occupying four days, as follows: First day, forenoon, three hours, electricity; afternoon, three hours, drill regulations and army regulations. Second day, forenoon, three hours, radiotelegraphy; afternoon, three hours, commercial regulations. Third day, forenoon, three hours, theoretical electricity, electrical signal equipment and army signaling; afternoon, three hours, regulations for U. S. military telegraph lines. On the fourth day three hours of the forenoon are devoted to algebra and three hours of the afternoon to gasoline engines.

The examinations are very thorough. For example, electrical knowledge embraces alternating currents; gasoline engine requirements include principles of engine, carbureters, electrical ignition devices, troubles and remedies. In radio a full knowledge of theory and practice is required. In telegraphy, candidates must show ability in transmitting and receiving in both codes, and in visual signaling, ability to transmit and receive ordinary messages at a minimum speed of 15 mixed letters per minute using the 2-foot flag kit. Thus, without further consideration of the exhaustive military knowledge required, it is immediately apparent that every amateur has lots to learn before becoming eligible to even a non-commissioned officer's grade in signal corps.



Officers' dinner of local New York units of the Junior American Guard, at which the first presentations of commissions were made to the sixty successful candidates. At the speaker's table in the background, reading from left to right, are Major Vail, Lieut. Osmur, aide to Maj. Gen. Leonard Wood, Major White, General Dyer, and Majors Elliott, Nicholson, Erbeck, Schmerl and Roy

But it is the most fascinating study imaginable. Once the technical information is carefully packed away in responsive brain cells, the ability to command and the accomplishment of difficult drill evolutions and solution of field service problems in maneuvers presents itself for mastery in striving for the junior commissioned grades such as lieutenant. An amateur's club, fully uniformed and equipped and maintaining discipline according to army regulations is insured a long and successful existence. I know of a number of cadet organizations that have kept together constantly for ten or more years, and these studied only the comparatively uninteresting infantry drill. Among the Junior American Guard units is a cadet corps which was recently mustered in as a body into the national organization; at an official inspection which I made recently this unit presented to a member a *five-year* medal for 100 *per cent duty!* That record is indicative of how citizens are made into officers for wartime enlistment, and it speaks eloquently for the permanency of cadet military activities when properly conducted.

The practicability of this training is

best expressed in the official attitude of the War Department, as disclosed in the following extract from the book "Military Signal Corps Manual":

"The country must be prepared to prevent throughout the vast extent of its seaboard, the seizure and occupation of any one of many important points.

"The communications by which the first line and the reserves will be linked together and to the permanent works should, from the early efforts at concentration, be ample and effective, and so continue, for without them the whole army of the defense will become a mere aggregation of inert units.

"It is hopeless to suppose that the signal corps of the regular establishment can ever supply more than a leaven for the mass of men needed . . . or even that the militia possessing signal troops of approved efficiency can provide more than the framework of the organizations that will be required. The signal troops mobilized for war must be filled in by men drawn direct from civil life."

And again, quoting from the book:

"There are still people of intelligence who in practice think that the transmission of military thought is summed up in the use of notebook, the orderly, and his horse. But these are passing, and the trained soldier and educated volunteer understand the vital importance of time in military operations and the need for the immediate transmission of information. Hence, the necessity for a signal corps or its equivalent; for without its aid modern armies can no more be controlled than can great railway systems; the commander in the field remains blind and deaf to the events occurring around him, incapable of maintaining touch with conditions, and out of reach of his superiors or those under his authority, upon whom he depends for the execution of his plans. The brain lacks the power to control because the nerves are wanting. Time is the main factor in war; to arrive first with the greatest number of men, and with the clearest understanding of the situation, is to succeed. The last, and often the first, of these conditions depends upon the lines of information of the army.

"Half a century ago rapidity of transmission of information in campaigns was in general measured by the speed of the couriers; distant movements were left to take care of themselves or neglected, since, if discovered, they could only be reported after the event; immediate operations were limited; the chessboard was small. Now all this is changed, and if everything concerned in war and with the efficiency of armies should be of the best, certain it is that the nerves extending from the controlling brain to the striking arm—that is, the lines of thought transmission—should be the most perfect, the most rapid, and the most certain that science can give. Only the best should find a place. Air service, the radio, telegraph, telephone, and visual signaling apparatus, all must be supreme of their kind lest a club be placed in the enemy's hands, to our own destruction." This is a truth that every soldier knows in general, but it seems worth while to repeat that if a commander's service of information is better than that of his adversary he possesses wider knowledge and superior control; he selects with certainty his objective and arrives at it first; he perceives weakness before his own is discovered or strength before his weakness is known; he anticipates movements, alters dispositions, executes plans unknown to his enemy; in short, the successful soldier commands the situation by force of superior knowledge.

"It has been said that recent field experiments with troops have conclusively proved that for every specially trained signal corps soldier provided, not only is the field information service many times increased in efficiency, but that at least two men are returned to the firing line who would otherwise be removed therefrom to perform the inefficient and often impossible work of the orderly of the past. Since this messenger service must be provided, either through orderlies or trained signal troops, it is manifest that the provision of a minimum per cent of the total strength for this purpose results in increasing the number of men for the firing line instead of taking from that line.

"The duties of a corps for intelligence communication are not, however, confined to the transmission of information alone, though that is its principal function. For in addition to this service its troops will have plenty of fighting, if not of plain soldiering, to do, not only with the infantry at the outposts and at the outposts and at detached stations, but with the cavalry in reconnaissance work, and with both when serving with contact troops and with patrols. The chief duty of signalmen is, of course, to transmit information collected, but they are by no means to remain blind and deaf to the events taking place around them. They should gather all the information possible and transmit it, through the proper channels, to headquarters, as is the duty of all soldiers. Obviously, while signalmen have unusual opportunities for the collection of information in the enemy's country, they have at hand the means of transmission as well, and thus form one of the strongest corps of observers with an army. Still, it is not to be forgotten that an army has eyes and ears everywhere, and that the duty of obtaining information is imposed upon all. The chance of observation of a sentinel, a report from an outpost, the story of a prisoner or native may have value if sent in time to the proper authority. This is the first duty of the signalmen; but in addition signal troops, and especially the aviators, have become, even more than the cavalry, the eyes and ears of the army.

"The need for training and experience on the part of the officers and men engaged on this service is too obvious to need more than a mere mention and it will be here sufficient to quote, as an indication of expert opinion on this subject, the following remarks of a distinguished French officer:

"'Information service fails especially because the world is ignorant of its principles, processes and modes of action. The transmission of intelligence demands special organs. Most armies give some telegraphic training to non-commissioned officers and troopers; it is lost time. Those partly informed are always incompetent; special-trained men are necessary.'

"This brief statement might be well considered a military axiom to be placed at the head of all treatises and laws affecting the army."

From the foregoing may be determined in a general way the value of a trained amateur when the nation is at war. In the articles of this series to follow, the method of study and the application of military knowledge thus gained will be covered. It is hoped that the readers of this magazine will recognize the importance of co-ordinated effort, that is, the desirability of applying the material in practical operation by the use of club members or other young men of the vicinity, possibly unskilled in a technical sense, but organized into a uniformed military unit. The course of instruction, which will have as its basis the book "Military Signal Corps Manual" can be successfully pursued by home study, of course, but it is obvious that better results can be obtained with a group learning signal duties by actual drill.

In the next issue I shall take up the practical side of organization of citizen-soldier Signal Corps and outline the preliminary technical and military instruction. Meanwhile, all amateurs who feel the deprivation of silenced apparatus and wish to prepare themselves or others for service to the nation at war, can well employ their time in gathering together twenty or more prospective recruits for enrollment, using the material contained in this article as an outline of what the cadet signal corps will attempt to accomplish for members.

Wireless Instruction for Military Preparedness

A Practical Course for Radio Operators

ARTICLE II

By Elmer E. Bucher

Instructing Engineer, Marconi Wireless Telegraph Company of America

EDITOR'S NOTE.—This is the second installment of a condensed course in wireless telegraphy, especially prepared for training young men and women in the technical phases of radio in the shortest possible time. It is written particularly with the view of instructing prospective radio operators whose spirit of patriotism has inspired a desire to join signal branches of the United States reserve forces or the staff of a commercial wireless telegraph company, but who live at points far from wireless telegraph schools. The lessons to be published serially in this magazine are in fact a condensed version of the textbook, "Practical Wireless Telegraphy," and those students who have the opportunity and desire to go more fully into the subject will find the author's textbook a complete exposition of the wireless art in its most up-to-date phases. Where time will permit, its use in conjunction with this course is recommended.

The outstanding feature of the lessons will be the absence of cumbersome detail. Being intended to assist men to qualify for commercial positions in the shortest possible time consistent with a perfect understanding of the duties of operators, the course will contain only the essentials required to obtain a Government commercial first grade license certificate and knowledge of the practical operation of wireless telegraph apparatus.

To aid in an easy grasp of the lessons as they appear, numerous diagrams and drawings will illustrate the text, and, in so far as possible, the material pertaining to a particular diagram or illustration will be placed on the same page.

Because they will only contain the essential instructions for working modern wireless telegraph equipment, the lessons will be presented in such a way that the field telegraphist can use them in action as well as the student at home.

Beginning with the elements of electricity and magnetism, the course will continue through the construction and functioning of dynamos and motors, high voltage transformers into wireless telegraph equipment proper. Complete instruction will be given in the tuning of radio sets, adjustment of transmitting and receiving apparatus and elementary practical measurements.

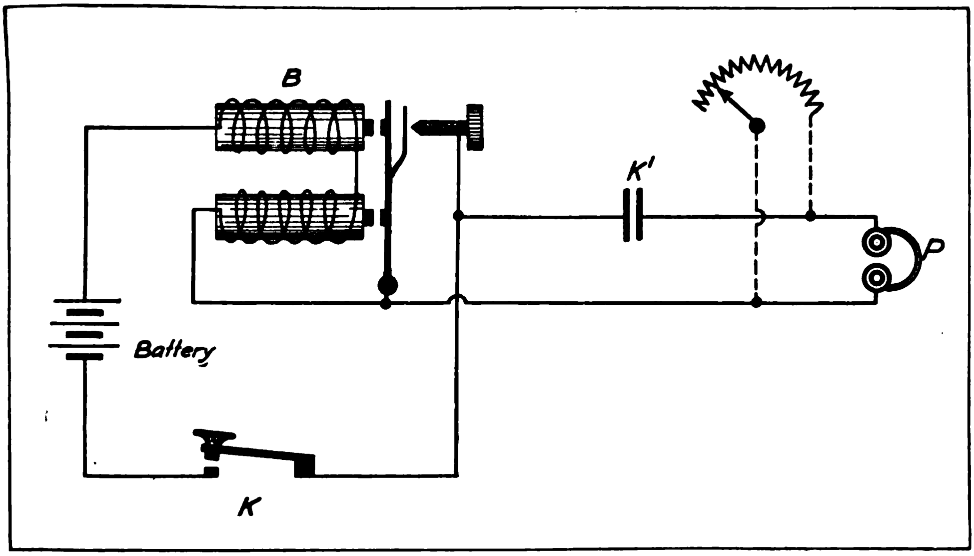


Figure 1

CODE PRACTICE.

OBJECT OF THE DIAGRAM.

To show the apparatus and circuits of a beginner's code practice set, for the production of artificial wireless telegraph signals.

PRINCIPLE.

The counter electromotive force of a vibrating buzzer charges the condenser K^1 in series with which is the head telephone P. A "buzzing note" is produced in the head telephone corresponding to the rate of interruption of the vibrator.

DESCRIPTION OF THE APPARATUS.

B, an ordinary electric buzzer is connected in series with a four-volt battery and a sending or signalling key K. Across the vibrator is shunted the circuit consisting of the one microfarad condenser K^1, the head telephone P and the shunt variable resistance.

OPERATION.

The sending operator (one thoroughly familiar with correct formation of the code characters) presses key K, whereupon the armature of the buzzer (if properly adjusted) is set into vibration.

The counter electromotive force of the buzzer winding in charging the condenser K^1 produces high-pitched buzzing sounds in the receiving telephone.

By regulating the shunt telephone resistance the strength of the sounds can be varied suitable to the ear.

SPECIAL REMARKS.

If the platinum point of the buzzer is attached directly to the soft iron armature (the buzzer spring being removed) a very high-pitched note, somewhat similar to that produced by modern 500 cycle spark wireless telegraph transmitters, will result.

INTERNATIONAL MORSE CODE AND CONVENTIONAL SIGNALS

A	· —
B	— · · ·
C	— · — ·
D	— · ·
E	·
F	· · — ·
G	— — ·
H	· · · ·
I	· ·
J	· — — —
K	— · —
L	· — · ·
M	— —
N	— ·
O	— — —
P	· — — ·
Q	— — · —
R	· — ·
S	· · ·
T	—
U	· · —
V	· · · —
W	· — —
X	— · · —
Y	— · — —
Z	— — · ·
Ä (German)	· — · —
Á or Å (Spanish-Scandinavian)	· — — · —
CH (German-Spanish)	— — — —
É (French)	· · — · ·
Ñ (Spanish)	— — · — —
Ö (German)	— — — ·
Ü (German)	· · — —
1	· — — — —
2	· · — — —
3	· · · — —
4	· · · · —
5	· · · · ·
6	— · · · ·
7	— — · · ·
8	— — — · ·
9	— — — — ·
0	— — — — —

Period	· · · · · ·
Semicolon	— · — · — ·
Comma	· — · — · —
Colon	— — — · · ·
Interrogation	· · — — · ·
Exclamation point	— — · · — —
Apostrophe	· — — — — ·
Hyphen	— · · · · —
Bar indicating fraction	— · · — ·
Parenthesis	— · — — · —
Inverted commas	· — · · — ·
Underline	· · — — · —
Double dash	— · · · —
Distress Call	· · · — — — · · ·
Attention call to precede every transmission	— · — · —
General inquiry call	— · — · — — · —
From (de)	— · · ·
Invitation to transmit (go ahead)	— · —
Warning—high power	— — · · — —
Question (please repeat after ......)—interrupting long messages	· · — — · ·
Wait	· — · · ·
Break (Bk.) (double dash)	— · · · —
Understand	· · · — ·
Error	· · · · · · · ·
Received (O. K.)	· — ·
Position report (to precede all position messages)	— · — ·
End of each message (cross)	· — · — ·
Transmission finished (end of work) (conclusion of correspondence)	· · · — · —

Figure 2

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION

LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

ABBREVIATION.	QUESTION.	ANSWER OR NOTICE.
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is ....
QRB	What is your distance?	My distance is ....
QRC	What is your true bearing?	My true bearing is .... degrees.
QRD	Where are you bound for?	I am bound for ....
QRF	Where are you bound from?	I am bound from ....
QRG	What line do you belong to?	I belong to the .... Line.
QRH	What is your wave length in meters?	My wave length is .... meters.
QRJ	How many words have you to send?	I have .... words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? • • • ▬ • for adjustment?	I am receiving badly. Please send 20. • • • ▬ • for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are the atmospherics strong?	Atmospherics are very strong.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with ......). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No. ....
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad? Is my spark bad?	The tone is bad. The spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is ....
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	....	Transmission will be in series of 5 messages.
QSH	....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for ....?	Collect ....
QSK	Is the last radiogram canceled?	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is .... degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with ....)?	I am in communication with .... (through ....).
QSP	Shall I inform .... that you are calling him?	Inform .... that I am calling him.
QSQ	Is .... calling me?	You are being called by ....
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at ....o'clock)?	Will call when I have finished.
*QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wave length of ...... meters?	Let us change to the wave length of .... meters.
QSZ	....	Send each word twice. I have difficulty in receiving you.
QTA	....	Repeat the last radiogram.

*Public correspondence is any radio work, official or private, handled on commercial wave lengths.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

11—5046

Figure 3

QUES.—What is the approximate time required to make a dot?

ANS.—About 1-15 of a second (or in other words, the contacts of the key just touch for the shortest possible moment).

QUES.—What is the length of a dash?

ANS.—The length of about three dots or 1-5 of a second.

QUES.—What should be the spacing between the signals which form the same letters.

ANS.—Approximately equal to the time of one dot.

QUES.—What should be the space between two letters of a word?

ANS.—About the time required to make two dots.

QUES.—What should be the space between two words?

ANS.—Approximately the time required to make five dots.

QUES.—What letters of the alphabet should have the particular attention of the beginner?

ANS.—Such letters as C, J, P, Q, X, Y, Z.

QUES.—Why is this precaution necessary?

ANS.—Because if care is not taken to make the dots and dashes in such a way that they follow closely, the letter will be split up anl will form two letters.

To illustrate: C if improperly sent might easily be construed to read N, N; J might be made A, M; P might be made to form A, N and so on. The letter Y may be found particularly difficult and if improperly sent would easily make T, W.

The dots and dashes for a particular letter must be conjoined, equal spacing being used between them so that the listener can easily distinguish a single letter or numeral.

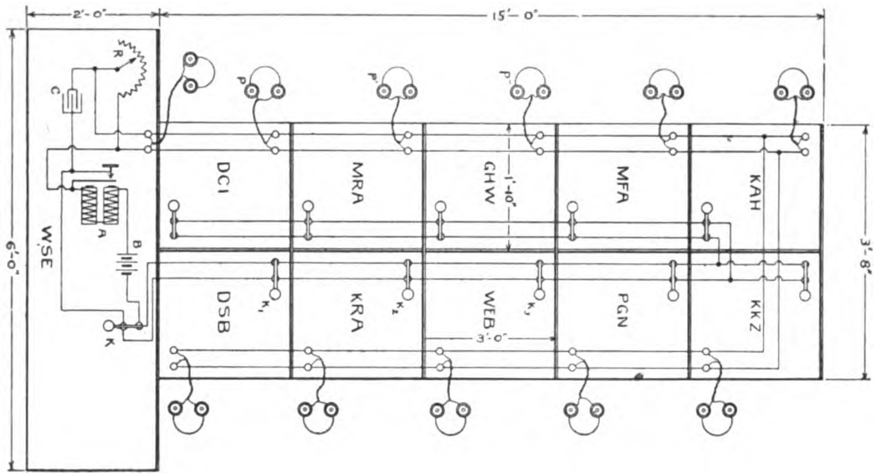


Figure 4

OBJECT OF THE DIAGRAM.

To show how a buzzer practice table may be wired up to accommodate several students at a time.

PRINCIPLE.

The counter electromotive force of the bell buzzer at the master table energizes several head telephones connected to binding posts at the learner's table. The instructor sits at the master table and dispatches traffic individually to the learner or to the class as a whole.

DESCRIPTION OF APPARATUS.

The electrical equipment is the same as Fig. 1 with additional telephones and keys.

The learners' telephones are connected in shunt to the instructor's telephone; likewise the learners' keys are connected in shunt to the instructor's sending key.

The learners' table is divided into several compartments allowing sufficient room for free movement of the arm of each student. Call letters are assigned to each operating position.

OPERATION.

The function of this apparatus is the same as Fig. 1.

Only one student can send at a time.

The instructor sits at the master table and calls stations individually, dispatching traffic to and from, after the manner at commercial land stations.

SPECIAL REMARKS.

Interfering or "jamming" is to be avoided. Buzzer signals should be cut down to a point where they can just be heard, in order to train the ear of the student to receive weak wireless telegraph signals.

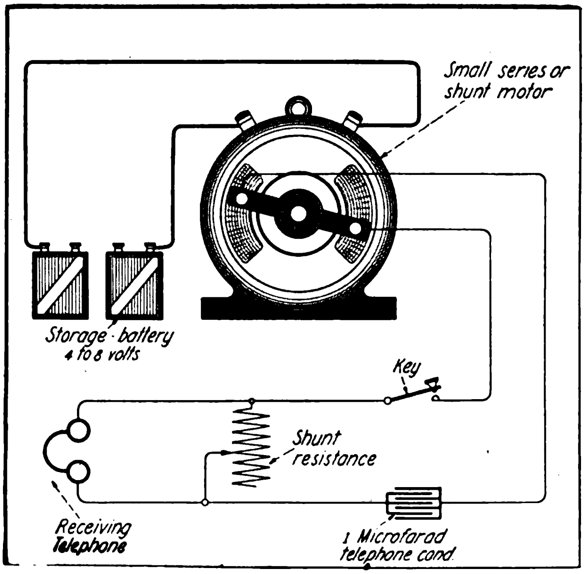


Figure 5

OBJECT OF THE DIAGRAM.

To show how a small series battery motor can be used to produce artificial wireless telegraph signals.

PRINCIPLE.

The counter electromotive force of the armature windings charges the condensers, the condensers flowing in and out of the condenser, setting up a buzzing note in the head telephone.

DESCRIPTION OF APPARATUS.

A small 4, 6 or 8-volt battery motor energized by storage or dry cells.
One small Western Union telegraph key connected in series with the head telephone.
One ½ to 1 microfarad condenser connected in series with the head telephone.

SPECIAL REMARKS.

(1) If signals in the head telephone are too loud, a small variable resistance can be connected in shunt. The resistance should be adjusted until the note is just heard.

(2) For instruction regarding the transmission of wireless telegraph traffic consult "Traffic Rules and Regulations," particularly rules 74, 75, 76, 77, 78 and 79. Also note punctuation and other signs in rule 80, and particularly the method of asking for a repetition of a message or sentence as shown in rule No. 99.

(3) The instructor is advised to familiarize students with the methods of traffic procedure immediately they are able to copy at a rate of from 8 to 10 words per minute. The "Q" signals should be included at the beginning; querying by telegraph among students should be reduced to a minimum, as the "Q" signals cover all requirements under ordinary operating conditions.

ELEMENTARY ELECTRICITY AND MAGNETISM.

In order that the student may understand the operation and manipulation of wireless telegraph apparatus, it will be necessary for him to have a knowledge of:

(1) The magnet;
(2) The production of electrical currents;
(3) The phenomena surrounding electromagnets;
(4) Construction and operation of motor generators;
(5) Construction and functioning of transformers;
(6) Functioning, care and maintenance of storage batteries.

QUES.—What is the final object of this elementary instruction?

ANS.—To lead, step by step, to an explanation of the apparatus for the production of radio-frequent currents.

QUES.—What is meant by a radio-frequent current?

ANS.—An alternating current which, in commercial wireless telegraphy, covers all frequencies from 10,000 to 1,000,000 cycles per second.

QUES..—What is the use of such currents?

ANS.—When made to flow in a properly "tuned" or "synchronized" vertical conductor such as a copper wire suspended from a mast, which is connected to earth at one end, they will set into motion electric waves by which wireless correspondence is conducted from point to point.

QUES.—Name the principal parts of the apparatus for the production of radio-frequent currents.

ANS.—(1) The motor generator; (2) the step-up voltage transformer; (3) the high voltage condenser; (4) oscillation transformer; (5) spark discharge gap.

QUES.—What does this apparatus compose?

ANS.—The principal elements of a transmitting set for the production of what are termed damped electrical oscillations.

QUES.—Name some of the qualities of an electrical circuit, with which the functioning of wireless apparatus is particularly concerned.

ANS.—The qualities of capacity, inductance and resistance, each of which will be discussed in their proper order in the text to come.

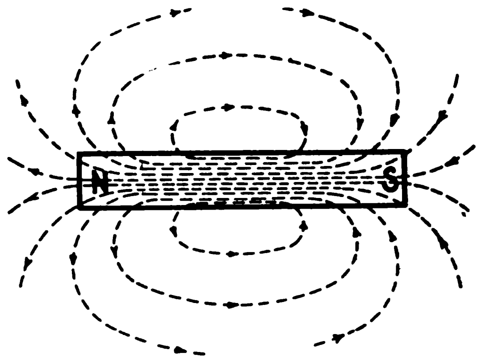


Figure 6

OBJECT OF THE DIAGRAM:

To show a simple bar magnet and the assumed direction of the magnetic field.

PRINCIPLE.

Only iron and steel manifest the property of magnetism to a marked degree.

Steel when once magnetized retains its magnetism permanently.

Soft iron loses its magnetism when the magnetizing influence is removed.

The magnetic field of a bar magnet is more strongly evident at the ends of the bar, which are called the magnetic poles.

If a bar magnet is suspended by a thread, one end will point toward the north magnetic pole of the earth. This end is called the *north pole,* the opposite end the *south pole.*

The general direction of the lines of force can be shown by sprinkling iron fillings on a piece of paper under which is placed a bar magnet. The filings will arrange themselves into a series of well-defined lines which are called *magnetic lines of force.*

The space subjected to this strain is called the *magnetic field* and the total lines of force crossing a given space are termed the *magnetic flux.*

Magnetism may be induced in the bar by placing an external magnet near to the bar or in actual contact with it.

SPECIAL REMARKS.

(1) If an iron bar is plunged into a pile of iron filings, the majority of the filings will adhere to the ends of the bar and there will be little attraction at the center. It is therefore evident that the magnetic field of a bar magnet is more dense at the ends than at the center.

(2) No matter how soft iron may be when it has once been magnetized and the external magnetizing influence is removed it will retain a certain number of lines of force. These are called the residual lines of force and the iron is said to possess residual magnetism.

QUES.—What is a permanent magnet?

ANS.—A magnet which retains its magnetism when the external magnetizing influence has been removed.

QUES.—What is a temporary magnet?

ANS.—A magnet which exhibits the property of magnetism when under the influence of an external magnetic field and which loses it immediately the outside influence is removed.

QUES.—How is the capability of any substance for conducting magnetic lines of force expressed?

ANS.—By the term permeability.

QUES.—What is the base from which the permeability of various magnetic substances is rated?

ANS.—Air is taken as unity. Steel possesses much greater permeability than air and iron greater permeability than steel.

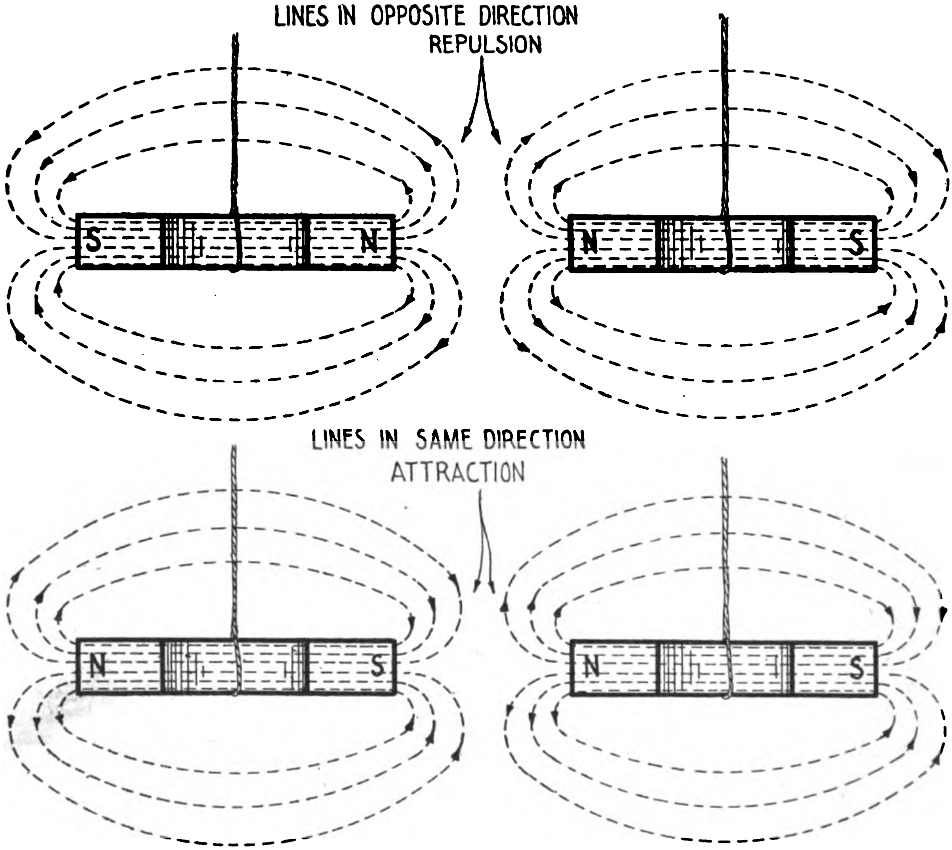


Figure 7

OBJECT OF THE DIAGRAM.

To show the attraction and repulsion of "north" and "south" magnetic poles.

PRINCIPLE.

Like magnetic poles repel; unlike poles attract.

DESCRIPTION OF THE APPARATUS.

In the upper half of the diagram (Figure 7) two bar magnets with two north poles adjacent are suspended by a string, and when brought near to each other they are found to repel. On the other hand, in the lower part of the diagram, two bar magnets, with north and south poles adjacent are suspended by a string, and they are found to attract each other.

SPECIAL REMARKS.

(1) If a magnetic substance such as a bar of iron is suspended free to move in a magnetic field, it will tend to turn and lie parallel with the field, or as is more often said, will take such a position as to accommodate through itself the greatest number of lines of force.

(2) If a permanent magnet is suspended free to move in a magnetic field (such as suspending a bar magnet above a stationary magnet) it will tend to take a position parallel with the field. but in a particular direction, that is, its internal lines of force will be in the same direction as those of the field.

QUES.—What use is made of this phenomenon?

ANS.—Advantage of this fundamental principle is taken in the design of many electromagnetic devices and in electrical measuring instruments. In fact, this phenomenon is encountered in practically all electrical apparatus where mechanical movement depends upon a magnetic field.

QUES.—What is meant by a magnetic circuit?

ANS.—It is the path the lines of force take in passing from pole to pole of a magnet.

QUES.—What is the general direction of the lines of force in a magnet?

ANS.—It is assumed to be from the south to the north pole inside the magnet and from the north to the south pole outside the magnet.

QUES.—What is the best conductor of magnetic lines of force?

ANS.—Soft iron.

QUES.—State a use of the bar magnet.

ANS.—The original navigator's compass is the best example of its use. The compass needle will take up a position parallel with the magnetic field of the earth and will point in the direction of the earth's north magnetic pole which is located in the vicinity of Hudson Bay, and which is several hundred miles south of the north geographical pole.

The compass needle can also be used to detect the presence of electrical currents in a conductor and will, in fact, show the direction of the flow of current.

(*To be Continued.*)

The Last Voyage of the Sibiria

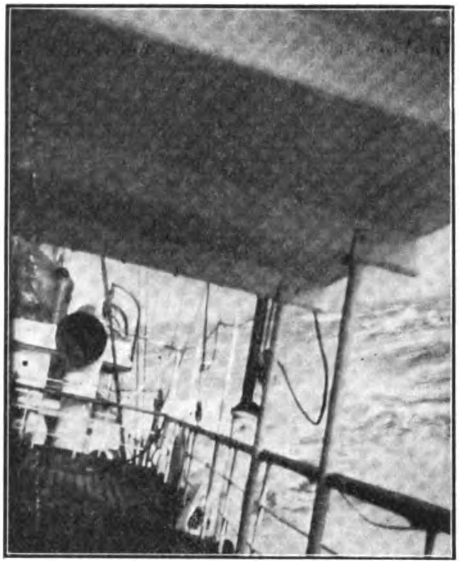
By H. LAWTON POTTS
Second Operator


The author as he was snapped by a camera man on board ship

THE Sibiria was an old Hamburg-American liner, built twenty-five years ago for the China trade in which she became notorious as an opium smuggler. Finally she became a tramp steamer and veritable stormy petrel, with her log books filled with entries as interesting and thrilling as fiction.

Prepared for a six weeks' voyage. the vessel steamed away from New York last August, bound for France. She was loaded with sugar and when she was unloaded at Havre it was found that her bilge pipes had been hacked open by a German sympathizer. As a result the water had seeped through the cargo throughout the voyage, causing thousands of dollars' worth of damage. She struck bottom twice in the mine fields of the English Channel, bringing about considerable trepidation among the members of the ship's company, for they believed that she was about to be blown up In consequence of the bumps she received she went into dry dock when she arrived at Plymouth, England, remaining there for twelve days.

Then this vessel of varied history pointed her nose seaward again and for twenty days the North Atlantic churned us about until we reached the snow-covered shores of Labrador. Through the Straits of Belle Isle and up the St. Lawrence we steamed, touching at Montreal and Sidney, Nova Scotia. At the latter port we filled our bunkers with coal and took on a cargo of grain and benzol, after which we began our voyage to London, where it had been planned to turn the vessel over to the British Government. Once fairly out in the Atlantic, we found ourselves tossed about in the teeth of a typical November storm. Our path was a continuous succession of scenic railway dips and we were compelled to ride waves that threatened to overturn the Sibiria and smash it to pieces. Sleep was impossible and it was necessary to lash down or stow away all articles that were movable. It can be related as an example of the violent manner in which the ship



A photograph taken in a storm from the deck of the Sibiria

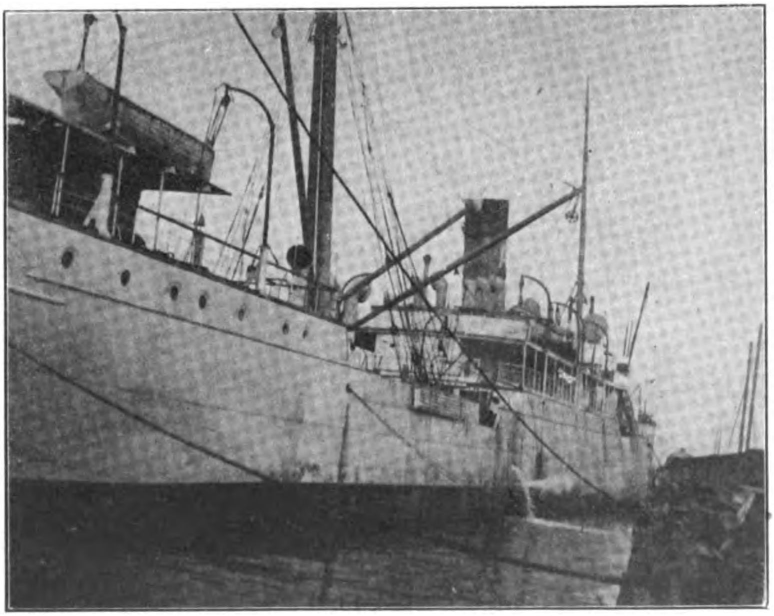
pitched about that when the vessel's pet cat wanted to cross the wireless cabin she either fell head over heels against the wall, or, if she wanted to go in the opposite direction, she had to climb up, inch by inch, as if she were ascending a slanting board.

It was not until the Scilly Islands were sighted that the high seas diminished. We were then within about two days' voyage of London and I looked upon our adventure as practically at an end. In this view, however, I was mistaken, for the day before we expected to reach our port of destination the ship stranded. She instantly began to pound dangerously and great seas which swept over her added to the peril. Word came from the captain to send the S O S and the appeal was answered by all of the French and English shore stations as well as a considerable number of war vessels and merchantmen. Two British torpedo boat destroyers came to our aid and stood by for a day and a night. They could not approach us, however, because of the danger of grounding.

Meanwhile, the great seas had swept the decks clear of all articles that were unsecured and the engine rooms filled with water a half hour after we struck. The situation was not without an element of considerable danger. Huddled together in wet clothes on the boat deck, we were completely at the mercy of the chill November gale. None of us expected to leave the ship alive and some of the Spanish oilers and firemen, in a desperate attempt to seek safety, lowered one of the lifeboats. The heavy seas permitted it to live only a few minutes, however.

The life-saving crews from Deal and

(*Concluded on page* 686)



The ship of varied history about which this narrative is written

Cape May's New Station

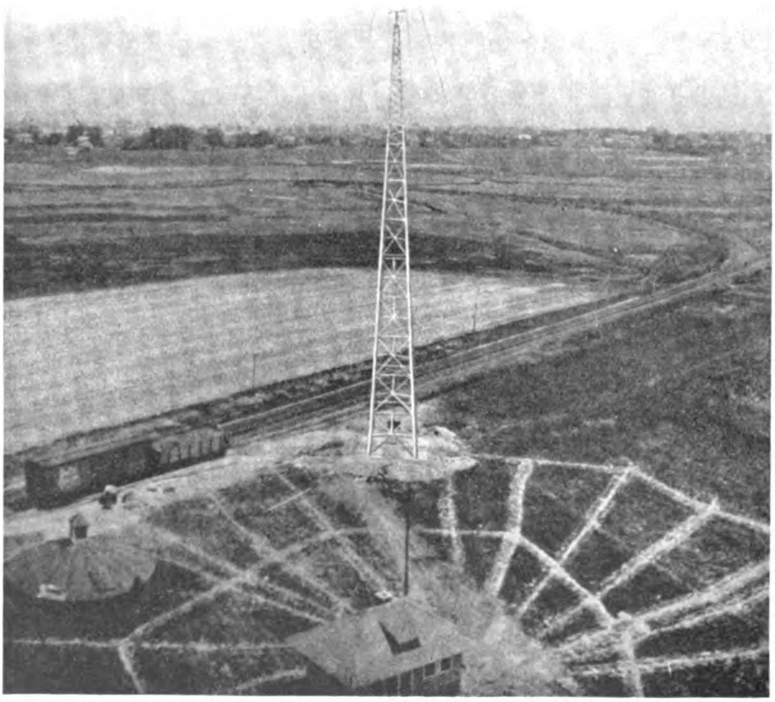
A Description of the Equipment and Some Extracts from the Log Book

"MARCH 18th, 2:30 A. M.—s. s. Proteus, off Key West, Florida, calls us and says our signals are very fine. (Distance approximately 950 miles air line.)"

"March 18th, 3:15 A. M.—PJC (Willemstad, Island of Curacao), calls and says our signals very good, through static. (Distance approximately 1,300 miles air line.)"

These extracts from the log book of the American Marconi Company's new Cape May (N. J.) station, attest the efficiency of its equipment and operation. The station was opened for service on March 12th.

The first Cape May station was built in 1910 atop the Hotel Cape May. A few years afterward another station was erected on a plot of ground owned by the Pennsylvania Railroad, near the beach. This station was housed by a modest building and a wooden mast, 180 feet in height, was erected. The mast



Effective view of 150-foot tower at Cape May, showing the trench marks of the new ground system. The tower carries an aerial of four silicon bronze wires which enter the receiving station from the center of a 350-foot span

Station building with Manager E. M. Hartley in the door

was wrecked by a storm in 1915 and plans for a new station were made.

Located about a mile from the old station and one-half mile from Cape May, the new Marconi link is built on the property of the Cape May city waterworks. A two-story frame structure, the plans for which were drawn by John B. Elenschneider, construction engineer of the Marconi Company, houses the equipment. On the first floor is the operating equipment, containing a transmitter and receiver. The top floor, or attic, is used as a storage room.

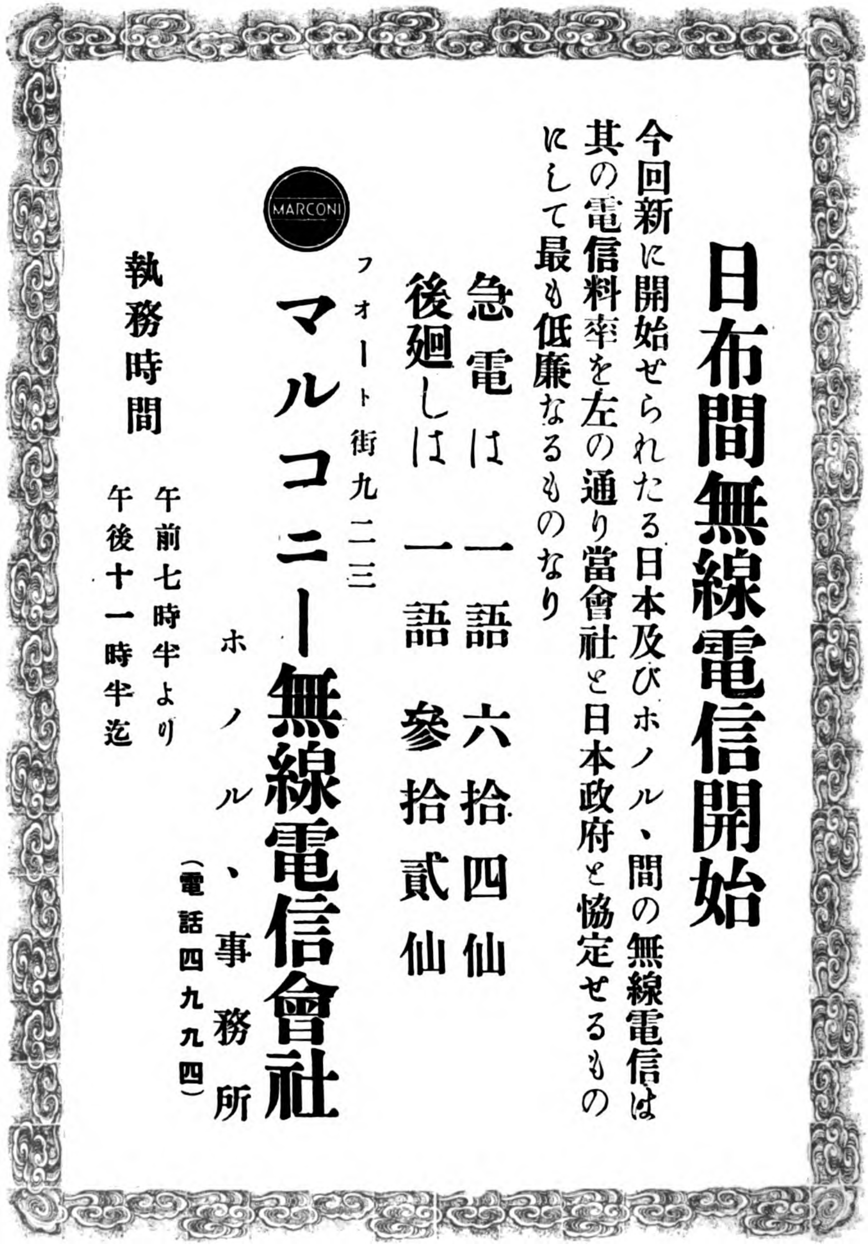
The transmitter is a Marconi new type panel set, which is employed in shore stations where 60-cycle single phase current can be obtained from electric light companies' plants. The spark gap is of the non-synchronous type, with an approximate frequency of 1,100 per second, which gives a high, clear note, different from that of the quenched spark gap. As a result the signals are distinctive and easy to read through interference by other stations.

The transmitter is tuned for three wave-lengths, 300, 450 and 600 meters. By throwing a switch which actuates the primary and secondary circuits and the coupling, changing the primary, secondary and coupling simultaneously, the operator can shift quickly from one wave-length to another. In the case of the 300-meter wave, the operator inserts a short wave condenser in the antenna by opening a jumper which is ordinarily across this series capacity when working on the longer wave. The transmitter can be easily adjusted for any power from 1½ k. w. to 3 k. w., this being accomplished by an adjustable transformer reactance. Ordinarily the set is worked at 2.4 K. W. power, which gives an antenna current of twelve amperes when operated at a wave-length of 600 meters.

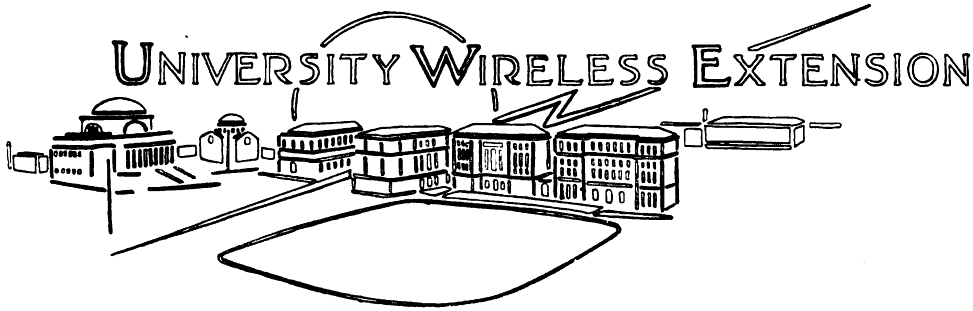
The receiver is of the 101 Marconi type. The antenna, of the four-wire T type, is suspended between the new galvanized steel tower erected by the Marconi Company and the Cape May City water tower. Each of these towers is 150 feet in height. The natural period of the antenna is 398 meters. This pe-

New Cape May station, showing the antenna and towers riod was chosen because of the fact that the station can operate on a wave-length of 450 meters without inserting a series condenser in the antenna. The capacity of the antenna is .00062 microfarad. A large wire netting connected to a great number of galvanized pipes which run vertically into the earth to a considerable depth, makes up the ground.

The installation was under the supervision of the construction engineer of the Marconi Company. Tests with different Marconi stations along the Atlantic coast took place following the installation.



Reproduction of advertisement in newspapers of Japan announcing the opening of the Marconi wireless service between that country and the United States



Radio Telephony

By ALFRED N. GOLDSMITH, PH.D.

Director of the Radio Telegraphic and Telephonic Laboratory of the College of the City of New York

ARTICLE VI

(c) **VACUUM TUBE OSCILLATORS.** There has arisen within the last few years a new and important type of sustained radio frequency generator, namely, the hot cathode vacuum rectifier, usually with three internal electrodes. As will appear, the ease and certainty of control of currents formed by pure electron streams in a vacuum has rendered these devices suitable not only for use as generators, but also amenable to telephonic modulation and control of the radio frequency output. In the following discussion, however, we shall consider only tube construction and the associated circuits enabling the generation of radio frequency currents. The modulating methods for radio telephonic purposes will be considered together with the station apparatus under a later heading.

Since the mode of action of the devices described here is still, in many cases, under judicial consideration in the courts of this country, we shall confine ourselves to giving without comment the explanations advanced by the various investigators.

We shall consider first electron currents through a vacuum. If the filament *FF* in Figure 61 is heated to bright incandescence by the filament battery *FB* (regulated, if necessary, by a series rheostat in the battery circuit, not shown) there will be emitted from the filament a copious stream of negative electrons that is, small charges of negative electricity. A definite number of these are emitted from the filament per second for each centimeter of length of the filament. The number emitted depends markedly on the temperature, increasing excessively rapidly as the higher temperatures are attained. For example, Dr. Saul Dushman of the General Electric Company found that

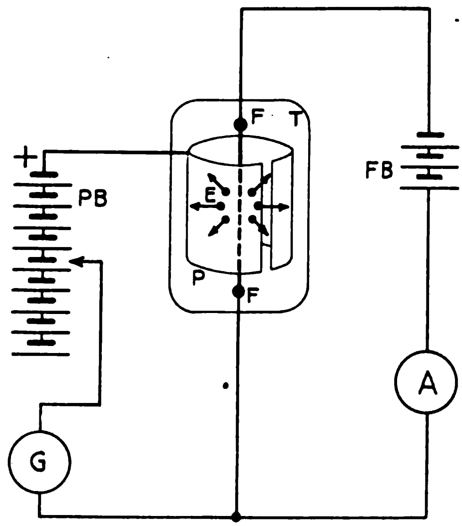


Figure 61—Thermionic currents

the current per square centimeter of filament surface increased from about 0.14 ampere per sq. cm. at 2,300° absolute to 0.36 ampere per sq. cm. at 2,400°. The values for 2,500° and 2,600° were respectively 0.89 and 2.04 amperes per sq. cm. It is quite obvious that the highest temperatures of filament consistent with not burning out the filament and a reasonably long filament life are desirable if large currents are to be passed through the tube.

Suppose that the cylindrical metal plate be placed around the filament as indicated at *P*. Suppose further that a battery, *PB*, and galvanometer *G* be connected in series between plate and filament. If the negative side of the battery be connected to the plate, practically no current will flow through the galvanometer. If, on the other hand, the positive side of the battery be connected to the plate, negative electrons will be attracted to the plate, returning to the filament at the lower point, *F*. Using the ordinary convention for the direction of current flow (which is opposite to the direction of flow of the electron stream), we say that a current flows from the plate to the filament. The device is therefore a rectifier, since it permits the flow of current from plate to filament, but not vice versa. This form of the device has been used by Fleming since 1906 as a detector for radio receivers. In a highly evacuated form, it has recently been developed into the new Coolidge X-ray tube and the so-called "kenotron" or high voltage, high vacuum rectifier of the General Electric Company.

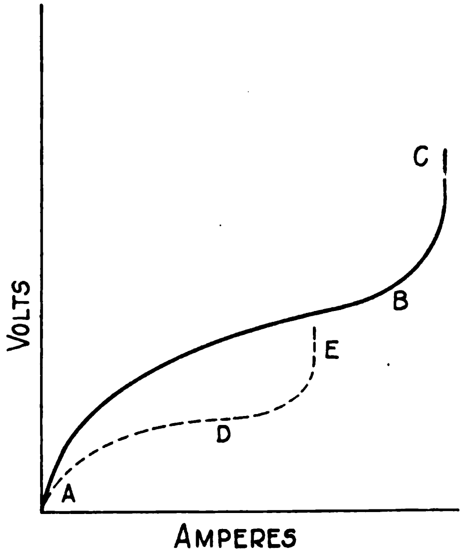


Figure 62—Relation between voltage and current for pure electron rectifier at a given temperature

The current through such a device in the plate circuit obviously depends on the plate potential. In general, the more positive the plate, the higher the electron velocity across the space between filament and plate, and the greater the plate current. There is, however, a clear limitation to this increase of current. At any given temperature, only a given number of electrons can be emitted by the filament per second, and when all of these are drawn to the plate per second, no increase in plate voltage will cause an increase in plate current. This is called the *temperature limitation* of plate current. In Figure 62, it is illustrated at *B*. In the lower portion of the curve the current increases (as can be shown by mathematical analysis) with the three-halves power of the applied plate voltage, but at *B* we reach the limiting current value at the given temperature and the curve bends sharply to *C*, whereafter the plate current remains constant unless the temperature of the filament is raised. In the portion *AB* of the curve, the current from the plate to filament is actually given by the equation:

$$i = 14.65(10)^{-6} \frac{l}{r} e^{3/2}$$

where i is the current in amperes in the plate circuit, l is the length of the filament in centimeters, and r the radius of the cylinder in centimeters. The curve *ADE* is for a lower temperature, and therefore also for a lower limiting current.

There is a second type of current limitation at a given plate voltage which may prove very serious in practice in high vacuum tubes. This is the so-called *space charge limitation*, and depends on the following considerations. If the plate voltage has a given value, increase of filament temperature will increase the plate current to a point *B*, but not further. This is due to the following effect: The cloud of negative electrons surrounding the filament at any time act as a large negative charge in its neighborhood, and consequently repels all electrons which are or tend to be emitted by the filament, thus choking back the electron current stream. If the charge in the space surrounding the filament becomes sufficiently great, no increase in temperature at a given voltage will produce any further current. Either the plate voltage must be increased or the bulb construction altered so as to diminish the space charge. Bringing the plate and filament close to each other will diminish the space charge effect. The effect is indicated at *B* in Figure 63; and, for a lower applied plate voltage, at *D* with the dashed line.

In considering the current-carrying capacity of vacuum tube rectifiers, Dr. Dushman gives data as to the current in milliamperes per centimeter of filament length at a safe working filament temperature. Thus, with a filament 0.005 inch (0.012 cm.) in diameter, 0.030 ampere can be safely emitted per centimeter of length. Under such conditions, the filament heating current will represent 3.1 watts of power per centimeter of length. For a filament 0.01 inch (0.025 cm.) in diameter, these figures become respectively 0.10 ampere and 7.2 watts per unit length. This gives an indication of what may be expected from tubes of ordinary dimensions based on these thermionic currents.

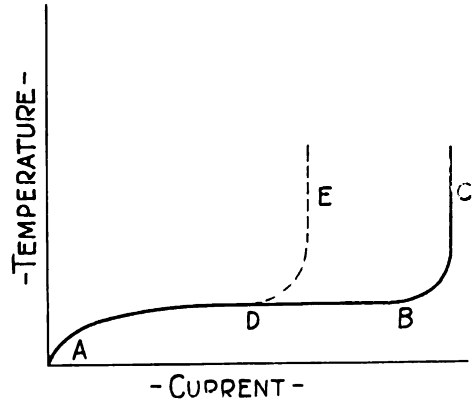


Figure 63—Space charge limitation of thermionic current at a given plate voltage

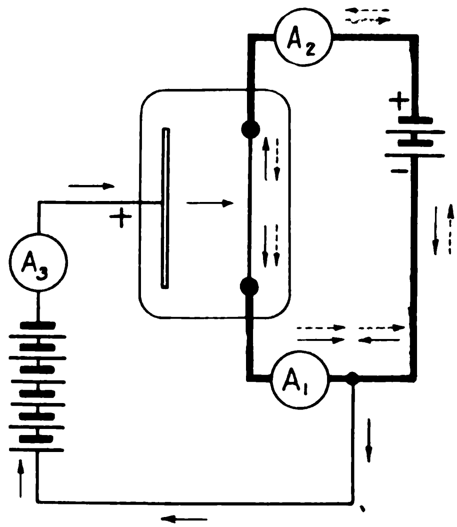


Figure 64—Illustrating combined lighting and thermionic currents

A curious effect is encountered when the joint filament heating and thermionic (pure electron) currents are combined. In the filament heating circuit shown in Figure 64, the current circulates in the direction indicated by the dotted arrows. Under normal conditions, therefore, the ammeters A_1 and A_2 read the same. If, however, the plate circuit is closed, and a current indicated by A_3 appears in that circuit, its direction of flow will be as indicated by the full line arrows. (It is understood that the direction of current flow is opposite to that of the negative electrons, in accordance with the commonly accepted convention). It will be noticed that the plate current, A_3, will flow *outward* from *both* ends of the filament. Consequently, at the lower end it will assist the lighting current, while at the upper end it will oppose it. So that, if *A* is the true lighting current, the readings of the ammeters will be given by $A_1 = A + A_3$ and $A_2 = A - A_3$. With small tubes, such as might be used for receiving, this effect is of no practical importance, but on larger, heavy plate current tubes (with filaments already worked near the burn-out point) it may become serious.

This effect has been ingeniously minimized by Mr. William C. White, to whom much of the recent development of the pliotron is due, through the use of the circuit shown in Figure 65. Here the filament is lit by the alternating current from the secondary of the transformer *T*. The connection of the plate circuit is made to the middle of the supply secondary winding. A similar method might be applied to connection to the middle point of a storage battery (or three-wire direct-current generator) used for the supply of lighting current.

We have assumed so far that the vacuum within the bulb was practically "perfect"; that is, a few ten-millionths of a millimeter of mercury or less. Furthermore, by the use of elaborate exhausting and internal heating methods, it is assumed that the electrodes have been thoroughly freed from any occluded gases so that the tube will remain constant in operation. (See Dr. Langmuir's paper appearing in the September, 1915, issue of the "Proceedings of the Institute of Radio Engineers.") Such perfection of vacuum is not easily obtained or maintained, and tubes containing or evolving gas will show markedly different effects from those described. In the first place, the current between plate and filament will be much increased. The reason for this is the following:

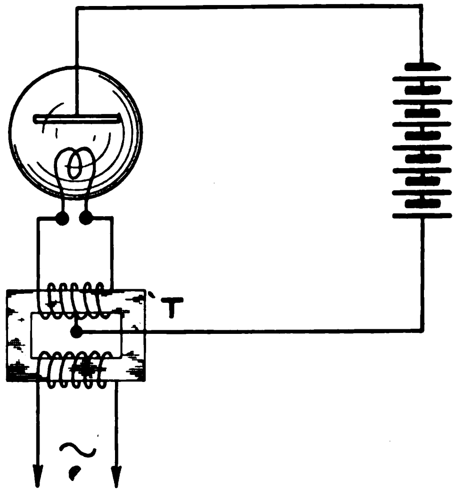


Figure 65—General Electric Company-White method of plate circuit connection

The rapidly moving electron stream will ionise by impact the gas molecules; that is, dissociate the atoms into negative electrons *and positive ions*. These positive ions will recombine with the "electron cloud" surrounding the cathode, thus neutralizing and destroying the effects of the space charge. In consequence, tubes in which gas (and consequently positive ions) are present will pass greater currents at low plate voltages than with the extremely high vacuum tubes. Among tubes having present positive ions and diminished space charge effect) are the original de Forest audions and the von Lieben-Reisz oxid filament tubes. At first sight, it might seem that the presence of positive ions and increased current in the plate circuit was an unmixed advantage, and there is no doubt that it constitutes a convenience in ordinary detector tubes in that it permits the use of comparatively low plate voltages. On the other hand, it has at least two marked disadvantages.

The first of these is the fairly rapid filament deterioration of such tubes when any considerable plate current passes. The presence of positive ions leads to ionic bombardment of the negatively charged filament. The positive ions are comparatively massive (in relation to the negative electrons); and when they strike the filament at fairly high velocities, the surface is rapidly damaged. This is not at all the case for the high vacuum "pure electron discharge" tubes, where positive ions are not present. Furthermore, when used to pass any considerable amount of plate current, the gas-containing tubes may become dangerous in that the gaseous ionization may rise to the familiar "blue glow" point. At this point continuous and progressive ionization of the gas occurs together with greatly increased plate current.

While they may not be much more than an inconvenience with small tubes, with large tubes at high plate voltages it may lead to disastrous currents and consequent violent tube destruction. For these reasons, very high vacua are desirable in tubes, except possibly for small-sized detectors.

It is a fact, though not well known, that the usual Fleming valve or rectifier can be used to produce sustained oscillations when shunted by a circuit of large inductance and small capacity without any third electrode or control member. This method is not used in practice because of the high voltages required, the troublesome large resistances in the feeding circuit, and the very rapid deterioration of the tube and its irregular operation.

For the production of sustained radio frequency oscillations from vacuum tubes, a third or control member may be employed. This may be in the form of a perforated plate or a grid of wire placed between the plate and filament so that the electron stream must pass through the meshes of the grid. The remarkable mobility of the electron stream permits of ready control of the current between plate and filament. Dr. Langmuir has stated that the current between plate and filament with the control member inserted is given by the equation:

$$i=14.65(10)^{-6}\frac{l}{r}(e+k\,e')^{3/2}$$

where i is the current in amperes in the plate circuit, l the length of the filament in centimeters, r the radius of the surrounding plate (of cylindrical form) in centimeters, e the voltage in the plate circuit, e' the grid potential (relative to the filament), and k a constant. The constant, k, is dependent on the spacing of the grid wires, the distance of the grid from the plate and filament, and the construction of the tube. Roughly speaking, the finer the spacing of the grid wires, the larger the constant k and the smaller the grid potential variations which will completely control the plate current. The danger with fine grids is that small positive potentials will produce excessively large plate currents. With a coarse grid, the control voltages must be larger, but the danger mentioned above is minimized.

The control energy required for producing the requisite grid potential variations is quite small and herein lies the remarkable amplifying (and oscillating) power of the device. Aside from grid leakge and grid charging currents there are no sources of energy loss in the grid circuit inside the bulb.

A typical grid potential-plate current curve is given in Figure 66. It will be seen that for large negative grid potentials (at *A*) practically no current flows in the plate circuit. From *B* to *C* the current through the plate circuit varies practically linearly with the applied grid (negative) potential, and it is in this range that the tube should be worked for radio telephonic oscillation or control. At *C*, the plate characteristic begins to flatten, until at *D* practically no further increase of plate current can be produced by more positive grid potential. The flattening of the curve at *D* may be caused either by temperature or space charge limitation of the plate current and determines the rating of the tube.

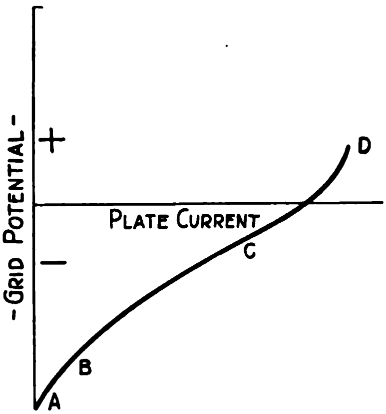


Figure 66—Relation between grid potential and plate current for pure electron amplifiers

In Figure 67 is illustrated the mode of action of the electron relay as an amplifier of alternating current. The alternator, *A* (which may, of course, be replaced by the oscillating circuit condenser terminals), is connected to the grid and filament of the tube. The plate circuit is supplied by the Battery *B* which, we shall assume, readily permits the passage through it of alternating current. If this last is not true, a large condenser must be shunted across the battery, thus by-passing the alternating current without interfering with the direct plate current. In series with *B* are connected the direct current ammeter A_1, the alternating current ammeter, A_2, and the primary of the transformer, *T*. It is assumed that A_1 does not impede the flow of alternating current in the plate circuit; otherwise it may have a condenser placed in parallel with it. The secondary terminals, *X*, *Y*, of the transformer *T* constitute the output terminals of the amplifier or "repeater."

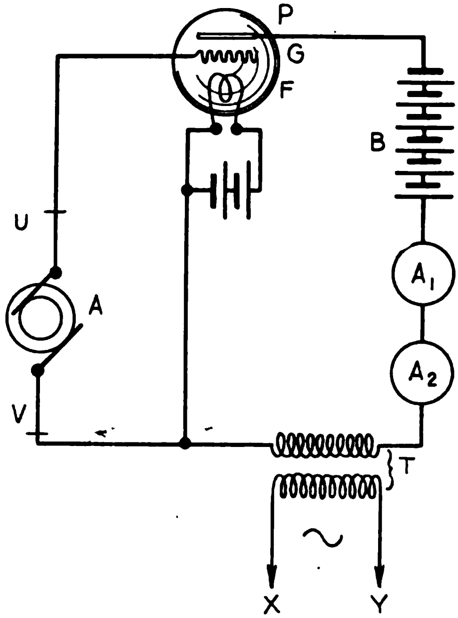


Figure 67—Amplification of alternating current energy

Under the conditions shown, the plate current will remain at the steady value indicated by *AB* in Figure 68 so long as the alternator, *A*, is not running. The effect of closing the alternator circuit is shown at *BC* in Figure 68. In the figure the median value of the portion, *BC*, is taken as equal to that of *AB*; that is, it is assumed that the fluctuating current swings up and down around an average value equal to the original direct current. This is generally not the case; since grid circuit rectification, flattening of the grid potential-plate current characteristic, or occasional positive grid charges may cause the average plate current to go up, remain fixed, or drop when the alternating potential difference is applied to the grid and filament. In any case, however, the pulsations in current in the plate circuit will be marked if the grid potential variations are sufficient, and there will be available at the terminals, *X*, *Y*, the amplified energy. As shown, the device may obviously be used as an audio or radio frequency amplifier, and is indeed so employed respectively in the transcontinental wire telephone lines and in ordinary receiving radio sets.

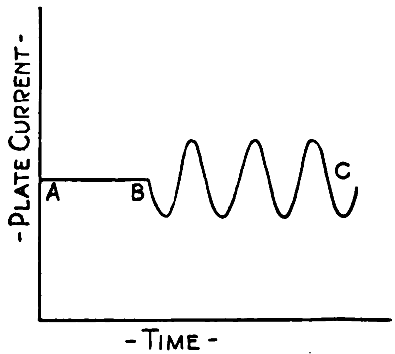


Figure 68—Plate current-time curve

It has been pointed out that the energy delivered at the terminals, *X*, *Y*, is many times greater than that required at the terminals, *U*, *V*, of the alternator. For example, there may be available at *X*, *Y*, 10 watts, while only 1 watt is required at *U*, *V*. It would immediately seem that if one of the 10 watts available at *X*, *Y*, were transferred back to *U*, *V*, by coupling or otherwise, the alternator might be removed, but the system would continue to sing or oscillate steadily as a generator of alternating current. A typical circuit arrangement, shown by E. H. Armstrong, for securing this so-called "regenerative coupling" is given in Figure 69.* It will be seen that the arrangement is similar in principle to Figure 67, except that the alternator, *A,* has been replaced by the oscillating circuit, *L L′ C,* or rather by the condenser terminals of *C*. In addition, there has been added the coupling, *L′ L″*, between

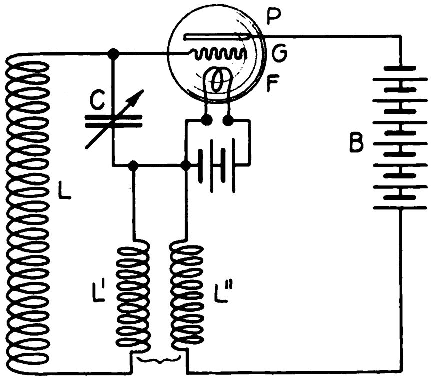


Figure 69—*Oscillating circuit*

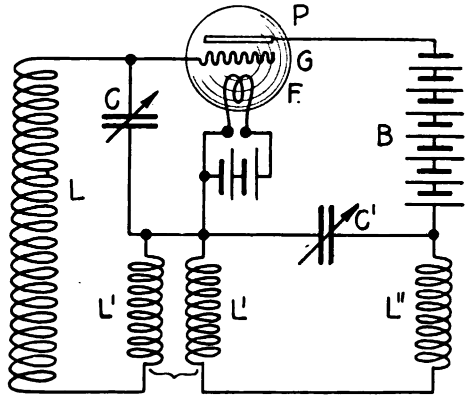


Figure 70—*Plate circuit tuning in oscillating circuit*

the grid circuit, *L L′ C,* and the plate circuit, *L″ B*. A system such as that shown will oscillate vigorously if the circuit constants are properly chosen. The output energy is in general obtained by coupling to a coil inserted in the plate circuit. It is this type of oscillator, which, used as a detector also, is so directly applicable to long distance beat reception; and has accordingly been widely applied for that purpose.

An improvement on the simple circuit of Figure 69 has been shown by Armstrong, and is given in Figure 70.* It contains an added inductance, *L″*, in the plate circuit and a condenser, *C′*, across the terminals of *L′* and *L″* whereby the plate circuit may be tuned to the same frequency as the grid circuit or approximately so. The efficiency and output of the oscillator are generally increased by such an arrangement; but, on the other hand, the complexity of apparatus and difficulty of adjustment may sometimes become undesirable.

In working with the various types of oscillating circuits to be shown, it is quite essential that the grid connection shall be to such a point of the conjoint grid and plate circuits that the electromotive forces placed on the grid are in the proper phase relation to the alternating current produced in the plate circuit, otherwise the system will not persist in oscillation.

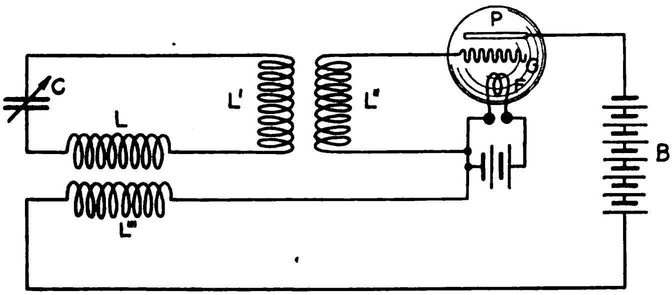


Figure 71—*Meissner oscillating circuit,* 1913

A form of oscillating circuit of simple electrical nature, due to Dr. A. Meissner of the Telefunken Company, and invented by March, 1913, will be next considered. The circuit is shown in Figure 71. It will be seen that the grid and plate circuits are coupled, but indirectly through the tuned circuit *L L′ C*. The inductance, *L* of this circuit is coupled to the plate circuit, while the inductance, *L′*, of the same circuit is coupled to the grid circuit. In consequence, sus-

* "Proceedings of the Institute of Radio Engineers," Volume 3, Number 3. September, 1915.

tained alternating current will be produced in the circuit, *L L′ C*, as previously indicated. In practice, resistance can be inserted in the circuit, *L L′ C*, for absorbing the output of the system; and in fact, the capacity, *C*, (and the resistance just referred to), are replaced by the antenna when radiation is desired. Another form of circuit used by the same company, and the joint invention of Count Arco and Dr. Meissner in 1914 is shown in Figure 72. It differs from that previously shown in that the intermediate coupling circuit is replaced by a direct inductive coupling between grid and plate circuits. This coupling, *L L′*, links the grid circuit to the tuned, absorbing plate circuit, *L′ L″ C*, which, as before, may either contain the antenna or be coupled thereto.

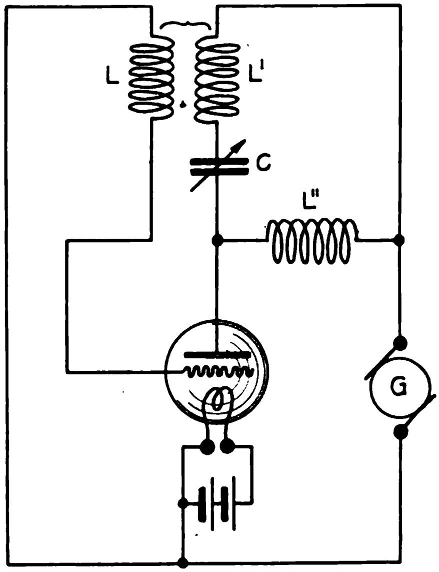


Figure 72—Arco-Meissner oscillating circuit

An interesting type of bulb was used by Dr. Meissner in his experiments; and a photograph of this bulb is shown in Figure 73. Bulbs of this sort give current amplifications up to thirty times. It must be at once mentioned that these are *not* high vacuum bulbs, an atmosphere of mercury vapor being purposely provided by the small piece of mercury amalgam shown sealed into the small side tube at the bottom of the tube. The result of this vapor and the oxide-coated Wehnelt (heated) cathode is that the tube in operation shows a continuous blue glow.

As has been stated, the filament is a platinum strip, about a meter (3 feet) long in all, 1 mm. (0.04 inch) wide, and 0.02 mm. (0.002 inch) thick. It is thinly coated with a mixture of calcium and barium oxides, and is brought to a bright red heat by a current of about 2 amperes from a 28 to 32 volt storage battery, the current being regulated by a 5 ohm variable series resistance. Considerable heating power is, therefore, required; and the source of this power must be an extremely constant one.

The plate circuit is fed from a 220 volt source which may be an ordinary dynamo with choke coils in the supply leads to cut down the incidental noises. The plate circuit current is about 0.01 ampere, and the dark space interrupting the blue glow above the grid can be used for rough indication of the current through the plate circuit. As will be seen, the plate itself of heavy aluminum wire.

The grid is a perforated aluminum wire, the size of the perforations being about 3.5 mm. (0.14 inch). It will be noted that all connections to this bulb are made through the

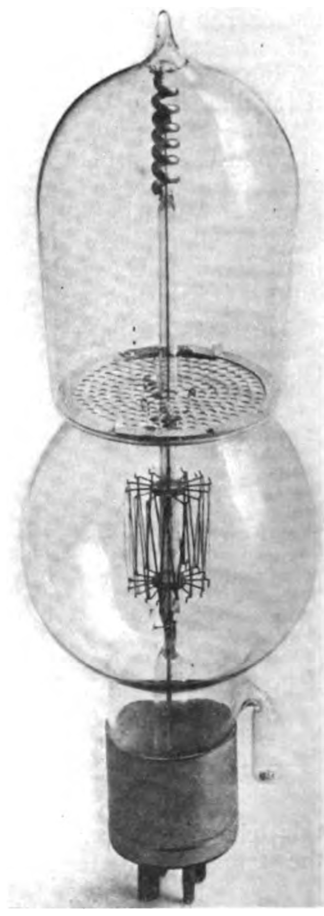


Figure 73—Lieben tube of Telefunken Company

bayonet socket in the base, this being so arranged that the bulb can be placed in its socket only in the correct position. The lives of these tubes are claimed to be 1,000 hours or more.

When used as an oscillator, wave-lengths as short as five or ten meters have been obtained, and with great constancy. Using a plate voltage of 440 (instead of the usual 220), twelve watts has been transferred to an antenna, corresponding to an antenna current of 1.3 ampere in a 7-ohm antenna at 600 meters wave-length.

This is the sixth article of a series on "Radio Telephony," by Dr. Goldsmith. In article VII, in the July issue, he continues the discussion of vacuum tube circuits in radio telephony and describes the 1914 Franklin circuit used by the English Marconi Company, also noting another form of transmitting circuit. The de Forest experiments are described and the pliotron or three-electrode tube is discussed. The use of banks of tubes is reviewed and the construction is described. A modified vacuum amplifier and oscillator, the "dynatron," is presented, its combination with the pliotron is noted and the development thereby of the four-electrode device, the pliodynatron.

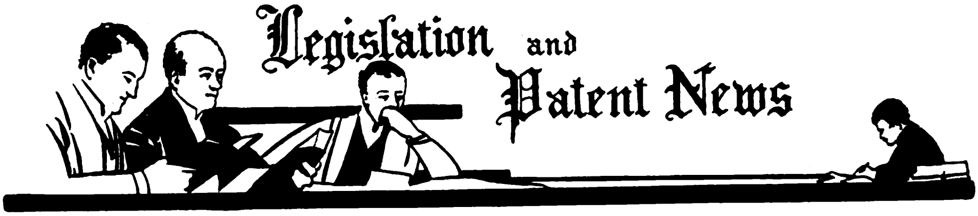
BOOK REVIEW

THE WIRELESS TELEGRAPHISTS' POCKETBOOK, by J. A. Fleming, M.A., D.Sc. The appearance of this little volume by Dr. Fleming brings home to us an appreciation that radio-telegraphy has established its right to rank as an exact and practical science.

In the early days all adjustments and improvements had to be effected by trial and experiment, and these empyrical methods were slow, laborious and costly. All that for many years past investigators have been accumulating in formulae and methods of calculations for practical wireless telegraphy, with a minimum of labour, and leaving nothing to chance, Dr. Fleming has collated and set forth with the clarity of diction for which he has attained a wide reputation.

For the benefit of those who have allowed their mathematical knowledge to "rust," the mathematical notes to which the first chapter is devoted will prove of great assistance. Without diving too deeply into the "Science of Figures and Formulae" this chapter gives exactly what is necessary for the intelligent appreciation of the more peculiarly radio telegraphic chapters which follow. Next in order is a section devoted to units, dimensions and systems of measurement. All the units and every kind of measurement needed by the wireless telegraphist, engineer or investigator are carefully and clearly set forth, the instruments themselves and the principles on which they are based coming in for treatment both valuable and interesting. Features of all systems are dealt with, the Arc system of Wireless Transmission, the Goldschmidt High Frequency Alternator, the Fessenden Heterodyne Receiver, and so on.

The third chapter—one of the most valuable in the book, as far as wireless engineers are concerned—deals in masterly style with high-frequency resistance and inductance measurement. The difference between high-frequncy resistanc and steady resistance, the caluculation of high frequency resistance of wires, self and mutual inductance with its calculation and measurement—all these form subjects of the greatest importance, and the numerous formulae provided will be found of the greatest use. Further chapters treat of high frequency current and voltage measurements, capacity measurement and predetermination, methods of measuring wave-lengths and decrement, and numerous other vital subjects.



Fleming Valve Sustained Over "Audion"

THE Circuit Court of Appeals, for the Second Circuit, New York, handed down on May 8th a unanimous opinion in favor of the Marconi Company, in its suit brought against the de Forest Radio Telegraph and Telephone Company for infringement of the well-known Fleming patent.

The case was originally brought in the United States District Court of the Southern District of New York by the Marconi Company on this Fleming patent, alleging that the de Forest Company's so-called "Audion" was an infringement.

The defendant, the de Forest Company, set up a counter claim, alleging that the Marconi Company's apparatus infringed some six or more de Forest patents. In the Trial Court Judge Julius M. Mayer held that the Marconi Company's Fleming patent was a patent of great merit and of value, and was valid and had been infringed by the de Forest "Audions"; he also held that the Marconi Company's apparatus did not infringe the seven patents of the de Forest Company. The Marconi Company confessed that two other de Forest patents were good patents and that the Marconi Company had used them to a slight extent.

In affirming the decree of Judge Mayer Judge Hough, speaking for the Circuit Court of Appeals, said:

> "Utilization of the Edison effect does not mean that the use of Edison's apparatus or any modifications thereof as a detector was easy or simple. The admitted fact that years passed, and detectors of various kinds, from the coherer to the crystal, acquired vogue before anyone thought of using Edison's curiosity of electricity for the discovery or translation of Hertzian waves, has proved enough on this point. Fleming was the first to disclose an apparatus for this purpose."

And again Judge Hough, speaking for the Court of Appeals, said:

> "Therefore the first question (as stated by appellee) is substantially this: Was it invention to use 'as a detector of wireless waves, an Edison hot and cold electrode lamp'? This is a question of fact and we arrive at the conclusion of the Lower Court, that at the date of Fleming's application it was not known to men skilled in the radio art that a rectifier would act as a detector, or that anything that would rectify oscillations of low frequency could rectify waves of the order used in radio communication.
>
> "Edison's patent stated a fact and suggested a tantalizing mystery, because even he did not pretend to state, or assert that he knew, why his 'effect' took place. His disclosure remained (so far as we can discover from this record) a laboratory problem until Fleming applied it (whether with a wrong theory or a right one is immaterial) to a new and very practical field of usefulness."

Summarizing, Judge Hough said:

> "We have no doubt that Fleming's patent displays invention, and of a very meritorious device."

As to the patents which the de Forest Company alleged that the Marconi Company had been infringing, the Court of Appeals held that six of them were not infringed and that the seventh was void. The result, therefore, of this opinion seems to be that the Marconi Company has underlying or basic patents for what are called "vacuum" detectors, and that the de Forest Company has two patents for improvements of the Marconi-Fleming patents for these devices.

The Control of Wireless

Federal Government Monoply or Private Enterprise?

A Complete Summary of the Arguments Made for and Against the Proposals

An Informative Guide for Those Who Wish to Gain a Clear and Concise View of the Subject

PART I.

Shall the United States Government monopolize the means of wireless communication throughout the country, or shall private commercial enterprise be permitted to encourage and develop the art as it has done in the past?

Herewith is given a concise resumé of the arguments for or against the proposals as brought out in the recent hearings before the Committee of the House of Representatives as to the merits of the bill contemplated for the regulation of radio communication. They are so arranged as to give the reader a clear and lucid understanding of the subject and enable him to arm himself with the telling weapons of the highest expert opinion.

The Government side was presented by naval officers and leading members of the administration.

The side of the commercial interests and research workers was presented by the foremost wireless experts of the country, scientists, and trained officials of the companies engaged in the business of wireless communication.

Whose arguments were the more convincing?

The testimony of Government witnesses is printed in Roman.

The testimony of those favoring the maintenance of private control of wireless enterprise is printed in italics.

JOSEPHUS DANIELS, Secretary of the Navy, said, in advocacy of Government monopoly of radio communication, that the Navy Department as the principal user and the most extensive buyer of radio apparatus in the United States, had the strongest influence in developing apparatus since the early days of the use of radiotelegraphy in this country, by constantly requiring manufacturers to incorporate new ideas which the department found necessary. The Navy Department was convinced that Government operation and control of all stations used for commercial purposes, other than those on board merchant ships, was necessary on account of the mutual interference between stations and for other reasons. He reasoned that to permit the greatest amount of business, Government and commercial, being done through consistent changes in apparatus, through systematic apportionment of and prompt and frequent changes of wave-lengths, and through standardized methods of operating, one management was necessary.

Radiotelegraphy, said Mr. Daniels, had been regarded as a natural Government monopoly for other reasons, since only by the closest regulation could the best use of this art be obtained, not only for commerce and safety at sea, but for military purposes. Radiotelegraphy was a strict Government monopoly with the larger number of foreign nations, and in these foreign countries where commercial stations were permitted, the Government control was generally so strong as to amount to a monopoly. The department strongly recommended that the committee provide for the purchase of all stations used for commercial purposes.

Thomas Ewing, United States Commissioner of Patents, informed the Committee that he was personally not in favor of complete Government ownership.

The big power stations would not be numerous, he said, and they could be controlled under regulations which could instantly be put in force in emergencies. The question, he thought, that Congress had to take into account was where it was going to draw the line. There was a present situation and there were future possibilities. The present situation was that we had an instrumentality for communication that was of great importance to the Government and to commerce, and we should get the benefit of it. The future possibility was that it might be made very much better. "My theory, and my objection to the theory of Government ownership," said Mr. Ewing, "is that if the Government takes over the wireless business, it will largely be the end of the development of wireless. I am opposed personally—I do not speak for the department, because the department is not interested, but I happen to be the Commissionr of Patents and am interested in that way—to the idea of shutting out or seriously limiting, or limiting any more than is necessary, the field of operation or of private enterprise in the development of wireless."

Mr. Ewing added that there was one other thing he would like to say somewhat by way of apology. Ever since he had been on the committee that drafted the bill under discussion, he had been rather in an attitude of opposition to the Navy Department, which had always been strongly for greater control, and, in fact, for Government ownership, and he wished to say that it was not at all from lack of appreciation of some splendid work the Navy Department had done in this field. But he did not think that the Navy Department, or any department of the Government, was organized for purposes of investigation and development of the sciences and arts such as wireless, and that if the Navy Department got control of it, it was not at all probable that the advance would be such as would eventuate if the field were left open largely to private enterprise.

Representaive Rufus Hardy of Texas, of the Committee, at this point asked Mr. Ewing whether any private monopoly in wireless had yet been established in this country.

"No, there is no monopoly," was Mr. Ewing's reply.

Representative Hardy inquired whether, if the Government were taken out of the wireless business, there would not be made an effort for commercial uses especially, by a large enterprise, to monopolize the wireless industry. Mr. Ewing expressed the opinion that such a situation might result in a single wireless company controlling the entire business, and that if such a result ensued, it would be because such an eventuality was eminently desirable. If a private company won out, it would be because the wireless field lent itself to that method of development.

Representative Hardy asked Mr. Ewing whether his objection to Government ownership was based on the idea that if the Government became the owner, then all future development would stop. "I think it would check all future development," was the reply. "My reason is," continued Mr. Ewing, "that the private owner, whether monopolistic or otherwise, is in business to make money. It is a commercial concern and the problems are treated as commercial problems. Where development is possible, if it pays it will be financed. The men who have displayed talent will be employed for that purpose and will not be assigned to other duties. If the Navy Department has control of the wireless, men will be selected according to Navy discipline; a man who has succeeded in one particular line will be transferred to another line simply because of Navy discipline. The men are not selected because they are investigators; they are selected to make naval officers and the thing is treated as a Navy matter, not as a matter for the development of wireless."

Mr. Ewing instanced the case of Captain Bullard, who was formerly the head of radio work, his successor now being Commander Todd. Captain Bullard, he said, had been ordered off to other work, which supposedly was not wireless, since, he said, the Navy does not pick out a man who distinguishes himself in wireless, saying, "You devote your life to wireless." The navy man has to be *trained primarily as a naval officer, while in private life the wireless man devotes his life to the art. Mr. Ewing repeated that he was not criticizing the Navy Department, but that, as a matter of encouraging scientific investigation, the Government was not a shining success in comparison with private enterprise.*

Government Ownership Definitely Proposed

Newton D. Baker, Secretary of War, said in behalf of the measure that the features which were of especial interest to the War Department were those which looked to Government control and supremacy in the field of wireless operation. He said that the War Department was as one with the Navy in believing that the time had arrived for the establishment of the complete supremacy of the Government in the wireless field.

Representaive Rufus Hardy of Texas, a member of the Committee, remarked that there was a general disposition to shy at the term "Government ownership," and he asked the Mr. Baker whether, in his opinion, the only complete control would be ownership.

Secretary Baker replied that he did not shy at the word, but he preferred to deal with ideas rather than words, and when a word had obtained a bad reputation which it did not deserve, he sometimes avoided it. When asked by Mr. Hardy whether it was possible to frame a bill so as to permit progress outside of the Government and at the same time to give the Government complete control, Mr. Baker replied that that would be very much like having two companies running railroad trains on the same track without complete control by one of the companies. He added that in his opinion unfortunately the transmission of wireless messages was a matter in which interferences were so destructive that unless someone controlled the means of transmission, nobody could succeed in it.

Mr. Baker said that he did not think it absolutely necessary to forbid private use of the wireless, but he thought the proper plan was to make the Government establishments supreme in the field and to make the advantages of the Government facilities so great that private agencies would desire to withdraw in favor of the Government. "As I understand the purpose of this bill," he added. "it is to provide for operation, through the Navy Department, of the coastal stations, placing the Navy Department in a position where private agencies will desire to transfer their operations to that department, ultimately leading to a monopoly in wireless transmission in the Government through the Navy Department."

Professor Alfred N. Goldsmith, director of the Radio Telegraphic and Telephonic Laboratory of the College of the City of New York, stated his belief that Government ownership and competition in a field like the radio field, where returns are at best very limited, would effectively strangle all private enterprise and cause this country to drop rapidly back into an inferior position in this art. The Government, he said, had never shown any tendency toward constructive improvement in commercial lines and had rightly left these to individual initiative.

This policy had been amply justified in other communication lines. It was now proposed, suddenly, to alter entirely the formerly successful policy, and to take over a partially developed field, just when those who had devoted their lives to its development were beginning to reap the fruits of their labor. The futility and injustice of such an attitude, he thought, were equally marked. He added that it could be safely asserted that not one per cent of the improvements in the field of radio communication had originated with any Government department. The advances had all been due to the commercial companies and their research engineers.

Federal Capital to Force Commercial Withdrawal

Commander D. W. Todd, United States Navy, strongly supported the point of view of the Navy Department that the Government should own all the radio stations of the country, not only the coastal stations but also all high power stations and others that handle commercial business. The commercial stations, he said, must withdraw from the field because they could not compete with the Government. The latter was a monopoly, backed by tremendous capital, and the Government stations were furnished, through the liberality of Congress, with the best apparatus, and must take over the whole wireless field in the end.

Commander Todd stated that the Navy Department, and the War, Commerce, Labor and Treasury Departments, had gone beyond the proposed bill in advocating Government ownership. The bill suggested in a mild way, such ownership, but now they felt strong enough to come out flatfooted and say that they believed in total enforced Government ownership, with the result that exceptions should apply only until exceptions were all eliminated by purchase of the privately owned stations in the excepted localities. The stations in Alaska should be bought; those in Hawaii and those in the West Indies should be bought, very unquestionably and positively, as an urgent military measure of prime importance. He hoped to see the bill amended to effect a complete Government monopoly within two years.

Two Viewpoints on Practice of Other Nations

Foreign Governments, said Commander Todd, had been farsighted to establish wireless monopolies from the first. In the European countries, where the Governments did not maintain a complete monopoly, the commercial stations were regulated so carefully that it was practically Government ownership. The Navy Department, he stated, proposed to handle the commercial work of the country better than the commercial people were doing at the present time, in that the Navy Department would be able to work in their communications with its own, and there would be no further correspondence about interference, and disputes between operators and stations, and questions of where stations should be located, and how they should be operated. He added that the ultimate result of the bill under discussion would be complete Government ownership within five years.

Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, stated that it was impossible to formulate legislation which would forsee and provide for the future usefulness of radio communication. It was just as impossible to formulate legislation which would place on the Navy Department or any other Government organization the responsibility for increasing the commercial use of radio communication in its present state of availability. He reasoned that if the Navy Department had been given a monopoly of the telephone when that means of communication was first developed, the United States would not have today, as it has, the greatest telephonic development of any country. And yet the telephone had not supplanted the telegraph. It occupied an entirely new field created for it by the persistence of private enterprise.

The Government, Mr. Nally pointed out, has not the experience to be gained only in business getting. The Government's sole function is to spend; it does not have to earn money before it can spend it. Its method is a complete reversal of business methods. It can spend money that it does not earn. Commercial companies must earn so that they can spend. Other great nations recognized that commercial companies have contributed to the value of the art, and while England, and Germany, and France, and Italy, and Canada, and other countries had made and were making the most of radio possibilities, still they had left the development of the art to commercial companies, even assisting them by subsidy, and financial allowance.

Mr. Nally called attention to the fact that radio communication was in the very infancy of its possibilities, yet there was already an investment of $40,000,000 *in its commercial development in* *the United States. Rightly considered, all this investment, representing the latest and most powerful stations, and trained organizations, was an adjunct to the Government in times of military necessity. If opportunity for development were left open, this investment—this equipment and the personnel—would increase, and all were completely at the disposal of the Government in times of need. In view of these considerations, it would seem that where the development of an industry which lent itself naturally and completely to the possible military necessities of the country, and over which the Government was exercising complete control, there did not exist a single valid reason for making such an industry a Government monopoly.*

The abandonment, said Mr. Nally, of the ideal of the universal intelligibility of wireless was to abandon its future development, but such abandonment was inherent in a Government monopoly of the art, as could readily be seen from the limitations of the jurisdiction of a Government, and the cumbersomeness of its international representation. A good deal had been said, Mr. Nally commented, at the hearing by the proponents of the bill as to the need for taking over existing high power stations. It was not clear whether they wished them solely for Government work or to do a commercial business in competition with the cables. If, for example, this Government were to take over the Marconi's New Jersey stations, he did not see how it could operate them for commercial service with Great Britain, except through a connection with the Marconi Company of England, which owns the corresponding stations in Carnarvon and Towyn. If it takes over the Sayville and Tuckerton stations, now the property of private companies in America, would they continue to work with the privately owned stations in Germany? And in what way would the Navy or the Government benefit through such an arrangement?

From every possible point of view, held Mr. Nally, there was not a sound reason for placing the Government in the commercial radio business. There were controlling reasons of every character why this should not be done.

Deliberate Intention to Ruin Commercial Business

Captain W. H. G. Bullard, United States Navy, said that he regarded as one of the strongest points for the so-called Government control the fact that the proposition was quite different from the general proposition of Government ownership of other public utilities, in view of the fact that the means by which communication was effected, the atmosphere, was a medium to which title could not be given by anybody or to anybody, and in that respect it was quite different from any other form of communication, such as the telegraph, telephone, or cable, where distinct title could be given to the right of way and to the cables themselves, and the material features which could be turned over and deeds given to the owners. But this was an impossible proposition with regard to the use of the atmosphere. It was free to everybody, and thus being free to everybody, it seemed to him that it should be under the control of one management, and the only management that was in position to control it was the Government.

Captain Bullard said that as a matter of fact, the Navy Department stations now were well ahead of the art. The department had not been stifling the art in the past, but had been encouraging it, and was encouraging it every day. So the department could never fall behind, and if the radio were all under one control—as he believed the Government only could and should be in control—all the inventors in the art of radio and all the engineers working at it would know that there was one central office where they could go with their ideas and obtain encouragement, and where they would feel they could be assured of encouragement.

Captain Bullard added that he had made thorough investigations abroad of wireless conditions, both through written reports and his personal tours in Europe, and his impression was that most of the leading countries owned their coastal stations and that their high-powered stations were operated by the Governments, or apparently, not directly by the Government, but by Government help to such an extent that the Government controlled the operation. It might be private capital that built them, but they were controlled by the Government, and when it came down to the last word it meant Government ownership. They tried and tried to explain that such was not the case, but, as a matter of fact, it was the case.

When asked by Representative George W. Edmonds of Pennsylvania, a member of the Committee, whether, when the Government had taken possession of the coastal stations, the next thing would be a request for authority to take possession of all the high-power stations, Captain Bullard replied: "I believe so, eventually. Yes. It is all tending to that, in my opinion."

"In other words," suggested Mr. Edmonds, "it virtually tends to Government monopoly and the elimination of commercial wireless absolutely?"

"Absolute Government monopoly for all purposes. Yes," replied Captain Bullard.

"The only point, then," commented Representative William S. Greene of Massachusetts," is that you would practically ruin their business."

"Ruin their business," assented Captain Bullard," and that is the reason that the offer is inserted to buy their stations at a fair valuation."

"Who is going to make it fair?" asked Mr. Greene.

"Some commission or somebody who would be appointed by Congress," was the reply.

"It would not have any value after it was ruined," suggested Mr. Edmonds.

"Of course not," replied the Captain.

Government Subsidy Suggested for Art's Development

Professor M. I. Pupin stated that things were within the reach of those who were studying the whole situation which would transform the entire aspect of the wireless art. These things were being done because the Government did not own the wireless. And if the Government owned the wireless they would not be done. "I will tell you the reason why," said Professor Pupin. "I have a great many friends among the officers of the Army and Navy and I would not for the world do anything which would hurt their feelings. I maintain that the Government is not and never will be in a position to develop a new art. That must be left to private enterprise and private initiative. It is a question of psychology, and there is no use arguing about that. It is a fact well understood everywhere that a new art is not developed and cannot be developed by the Government. Even the German Government has not taken possession of the wireless art and will not take possession for some time to come. Because the German Government understands that this is a young art, and should not be intrusted to the Government for its development, it leaves it to private enterprise. And I should say that if the United States Government is anxious to prepare this art for the national defense, the wisest thing for it would be to subsidize private enterprise to develop the art for the national defense as much as possible and as soon as possible. That would cost a great deal less and give very much better results than Government ownership."

Professor Pupin asserted that if the Government in the past had decided to take the then new art of electro-magnetic telegraphy into Government ownership, there would probably have been a regulation that no telegraph wire should be near another telegraph wire—no nearer than, say a mile or two miles, in order to overcome the interferences from which telegraphy suffered at that time. Had that policy been pursued in 1845 and 1846, up to 1860, it would have been necessary to place the telegraph wires at a distance of a mile apart or perhaps ten miles. But that was not done, thank God! The inventive genius of the American mind and American enterprise went on and solved this problem in a most satisfactory way by the Wheatstone automatic system, which en-

abled the wires to be placed right alongside of each other, within eighteen inches, so that one could have any number of wires on a one-pole line today. Professor Pupin then pointed out that in the proposed bill the Government insisted that wireless stations should not be placed except here and there in order to overcome interference. The heads of Government departments were to be called upon to decide the matter, while the wireless engineers, experts and men capable of building up the wireless art would have nothing to say. He called attention to the fact that Government officials had testified that wireless telegraphy was different from other methods of electric signaling, since radio uses the air, the ether, while in telegraphy and telephony each man has his own circuit. This theory, Professor Pupin contended, was wrong. So far as magnetic force was concerned, the same medium was used in ordinary telegraphy and ordinary telephony as in wireless. They all used the atmosphere; they all used the infinite medium. There was no distinction between the two methods at all, and for that reason, so far as interference by the acts of man and the acts of God were concerned, both had the same difficulties and had to go through the same history of development.

Arbitrary Rules Fatal to Progress

If the Government, argued Professor Pupin, meant to take possession of the wireless art and establish industrial research laboratories and go into the art of manufacture, then all would be well and good. But the proposed bill as it stood, with the other laws existing and the other historical conditions of Government work existing, meant nothing else than a blow to wireless telegraphy. If the Government intended to impose arbitrary rules upon wireless operators, upon private enterprise operating wireless stations, that control would kill the art in his opinion, even without ownership. If it were found necessary to control the transmission and reception of wireless signals, the Government should do it in conjunction with recognized electrical authorities—wireless authorities.

Secretary Redfield of the Department of Commerce, advocating the acquisition of private stations of the commercial companies by the Government, said that the principal features of the bill under discussion were the provision in section 5 by which all Government radio stations were to be open to the transaction of general commercial business in competition with radio stations operated by private commercial companies, and the provision in section 6 by which the Navy Department was authorized to purchase at a reasonable valuation any coastal radio station which the owner might desire to sell. These two propositions must be read together, stated Secretary Redfield, as the department would not favor, and assumed that the Committee would not care to consider, a proposition to put the Government of the United States as a permanent policy into competition with private corporations in the business of exchanging commercial radio messages between ships at sea and coastal stations in the United States. The two propositions taken together, he said, contemplated the establishment of a Government monopoly under the Navy Department in the exchange of radio messages between the coasts of the United States and ships at sea through the exclusive ownership and operation of all coastal stations by the Navy Department except in so far as the other departments of the Government were required to maintain and operate radio stations. The department was disposed to believe that the bill should also provide for the purchase and operation by the Navy Department of very high-powered stations used for transoceanic radio communication between the United States and foreign nations.

The two systems of coastal stations, stated Secretary Redfield, one owned and operated by the Navy Department and the other by private companies, not only involved an economic waste to the people of the United States but they also at times and in places interfered with each other and prevented each other from efficient operation owing to the imperfect development of the art of radio communication.

The Service to Shipping in Commercial Operation

The Hon. John W. Griggs, President of the Marconi Wireless Company of America, pointed out that for fifteen or sixteen years the Marconi Company had been operating to develop the wireless art for the purpose of making a profit for the investors—the stockholders. It had developed what is known as a ship to shore business, so that in connection with its manufacturing of apparatus which was carried on at its factory, it was making at the present time a trifling profit over and above its expenses, but not enough to justify a dividend upon its stock. The coastal stations, Mr. Griggs said, served not only as points of communication with ships going up and down the coast and in order to transmit intelligence to or receive intelligence from the mainland; but they also served as supply depots for the Marconi Company; and the lessees of the apparatus, when they signed a contract, were assured by the company that with these stations at designated points along the coast, at any time they put into the ports where these stations were located, they could get any new parts for their apparatus which they might need, or get their apparatus repaired. Also they could, in the event of an accident to or the illness of their operator, obtain a new one.

"I may say right here," emphasized Mr. Griggs, "that if the Navy Department were allowed alone to carry on these coastal stations, they would not be able to provide supplies, make the repairs, and furnish the additional operators which the Marconi Company does, and which it is part of the latter's contract to give the lessees, of which there are now about 500 sailing the Atlantic, from one port to another. In addition to this development of the ship-to-shore business, in connection with the legislation that requires it, the ultimate large purpose of the company from the beginning has been to establish trans-Atlantic communication in competition with the cable lines for the benefit not of the military department of the Government, but for the benefit of the commercial people of the United States—not to the exclusion of the Government, but for its benefit as well as for the larger benefit of business and commerce of the American people. It took a long period of experimentation; it took a long period of preparation and construction to reach that point where we were ready to do that business. The company has expended nearly $5,000,000 in the construction of stations on American soil prepared to carry on the transoceanic business with foreign countries.

"Now, what good has the Marconi Company done for the world since it was organized?" said Mr. Griggs. "Read the list, an enormous long list, of lives that have been saved from sinking ships at sea. The benefits to mankind and to the world, in saving property and life, of the Marconi Company, are enough for the Government, if it had a right to recognize those things, to give it an enormous bounty. And yet it has had nothing in the way of profit. And why do people invest in a stock company, in a new enterprise like this, similar in its character to the Bell telephone? Is it not because after years of preparation they expect to see a time come when they will reap a profit for their long waiting? And that is the position of the stockholders of the Marconi Company. They have reached a position where, prior to the European war, they could see before them great profits, and where in the ship-to-shore business they are already reaping a measurable profit from a by-product, as we call it.

Public to Bear the Burden of Development

"This is an American commercial enterprise, entered upon in good faith, with good money behind it, reached almost to the point of satisfactory profits. And now you are asked to pass a bill under which the Government, directly or indirectly, can force us to let the Government take our property, and you are providing a method by which we can go to the Court of Claims, and at the tail end of a judgment, ask Congress for an ap-

propriation to pay the judgment, and get what? Merely the material value of our stations. Is that just? Is that just treatment of those stockholders who have put their money in and developed this business and developed this art until it has attained its present dimensions and present great degree of usefulness?

"What is to be done? Why, when they have appraised the value of these stations, with proper depreciation for wear and tear, and have paid two or three millions of dollars, or five millions of dollars, into our treasuries and the business of the company is gone, we can declare a dividend among our stockholders. We always have money enough to pay our debts, thank Heaven, and we can divide up what is left with the stockholders, and they can go off with 40 *cents on the dollar, or* 50. *But they ask, 'Where is the balance we paid into this company?' 'Why we spent it in getting it in shape for the Government to take it over at the cost of the material which we had on hand at the present time.' And do you think that the answer to that suggestion will be complimentary to the bill that enforced that result?*

Alleged Desire to Sell Coastal Stations Repudiated

"That that is in contemplation appears from the evidence that has been brought out before this Committee. Commander Todd, I think, and some of the others said. 'Why we estimate we can get all of these stations, long distance and all of them, now at an appraisement of $5,000,000. *But if you wait a few years they will be worth twenty.' Why will they be worth twenty millions? Because of the appreciation of the material? No; but because the company will have realized its hope and expectation in bringing these stations to an earning point. And then if the company attempted to tear them down when they were showing an earning capacity on* $20,000,000, *the very stones would cry out in protest against it."*

Captain W. H. G. Bullard, United States Navy, said that the proposition as it stood at present, was that the Government stations should be open to commercial business, which meant that the Government stations would then be legally and lawfully competing with the present commercial stations. The latter could go along and operate just as long as they pleased, so long as no interference took place, but from Captain Bullard's experience, he said, the commercial companies would in a very short time come to the Government and ask that the stations be taken off their hands, since it was a well known matter that the coastal stations were kept up and operated at a loss simply because they were necessary parts in a chain of transmission.

Representative Edward W. Saunders, of Virginia, a member of the Committee observed that the theory of the bill evidently was not to forcibly or by any manner of compulsory process take over the wireless. But he thought that it created conditions under which private operators in the course of time would have to give up operations.

Captain Bullard admitted that the private companies would have to give up. If the provision as proposed by the bill were approved by Congress, the Government could then cut the rates so much under the commercial companies that no one would patronize them.

Mr. Nally, on behalf of the Marconi company, observed that much had been said during the hearing given by the Committee to the proponents of the bill, about the willingness, even the anxiety, of the commercial companies to dispose of their coastal stations to the Government. So far as the Marconi Company was concerned, said Mr. Nally, no one had been authorized to make any such statement, and he could only think that with the Navy Department the wish was father to the thought.

It was not stated, Mr. Nally pointed out, who should determine on the reasonableness of the valuation which the Navy Department might wish to place on property belonging to commercial interests. The values which had already been stated by the spokesmen for the Navy before the Committee were perfectly ridiculous in the light of the Marconi Company's investment, and the figures which they mentioned as being *adequate for the purchase of the coastal stations and the high power stations of the entire country represented far less than the investment of the Marconi Company alone.*

The Marconi Company's principal business, Mr. Nally stated, was that of selling service. While it did manufacture some apparatus for sale, yet this branch of its business was merely collateral and was not its principal object, which, he repeated, was to sell service. For this reason it did not sell apparatus to ships, but it sold to ships certain service for a certain sum per month, just as the telephone company or electric light company sold its service to a customer. In order to give perfect service and to make the apparatus which it installed on ships serviceable in the greatest degree, it had erected and maintained land or coastal stations from the most northerly point on the Atlantic coast to the most southerly point; on the Gulf, on the Great Lakes, and on the Pacific coast to northerly Alaska. These stations were erected and were maintained as the essential, and indeed vital, link in ship and shore service, and the long list of rescues at sea and of lives and property saved because of the ready response which ships in distress at sea had been able to obtain by reason of these coastal stations, co-operating with other ships at sea, made a long and honorable record of which any company might well be proud. And this tremendous service in the salvation of life and property already rendered by wireless had earned for it at least the right to be developed and made useful and available to the fullest possible extent. Such development, he maintained, could come only through private enterprises.

This is the first of a series of articles on the important subject of radio control which will appear regularly in this magazine.

SECRET STATION DISCOVERED

When a dismantled wireless set and numerous volumes written in German were discovered in the room of a man in Bridgeport, Conn., April 25th, he was placed under arrest. He told detectives that he had lived for some time in Berlin and belonged to a club there.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of "The Wireless Age," published monthly at 42 Broad St., New York, N. Y., for April 1, 1917.

State of New York, County of New York:

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared J. Andrew White, who, having been duly sworn according to law, deposes and says that he is the editor of "The Wireless Age," and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit: (1) That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Wireless Press, Incorporated, 42 Broad St., New York, N. Y.; editor, J. Andrew White, 233 Broadway, New York, N. Y.; managing editor, none; business manager, A. Fogal, Jr., 42 Broad St., New York, N. Y. (2) That the owners are: Wireless Press, Inc., owner; John Bottomley, 233 Broadway, 851 shares. (3) That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none. (4) That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) J. ANDREW WHITE

Sworn to and subscribed before me this 17th day of April, 1917.

J. BOTTOMLEY, Notary Public.

(My commission expires March, 1918.)

Radio Science

Military Engineering Study

HOW the strategic conditions of our coasts and our naval inadequacy place a heavy bond of obligation on American engineeers was the subject of an absorbing address recently delivered by Prof. W. L. Cathcart of the University of Pennsylvania. The keynote of the address was that war today is largely engineering. Beginning with the single fighting vessel, it is immediately seen that it is a monstrous power plant representing the highly specialized skill of marine, mechanical, metallurgical, steam, electrical, chemical and radio engineering. Both in construction and operation these ships depend on skilled personnel, working with the high efficiency of long training. The engineer is, therefore, cautioned to give thoughful consideration to our military problems and consider his individual ability to safeguard the national welfare.

It was pointed out that we need a great navy because:

First, with unequalled wealth inviting spoliation, this Republic is the most vulnerable and ill-defended of all the great Powers. Second, our territory is immense, stretching from Eastport, Maine, to Manila, more than half around the world. Third, there is the factor of distance with regard to that territory, which factor has no parallel in Europe. Fourth, the fact that the United States Navy is really a "Disunited States" navy, since, like Russia with her Baltic and Black Sea littorals, we have two widely separated coasts, linked in our case by a canal which may fail us in a crisis either by slides, or by treacherous or direct attack with high explosives on its locks.

It is bad enough to be helpless, but to provoke attack is worse, was the professor's contention. While we have been militarily negligible, we have staggered diplomatically under national policies such as the Monroe Doctrine which, though just, are as war-breeding as any that history has known. Engineers, in considering how important is the supplementing of their technical knowledge with its military application, are reminded that our immunity from attack, thus far, because of this Doctrine, has been due chiefly to two conditions: the lack of means for the swift transfer of fleets and armies across the Atlantic, and the extreme delicacy of the balance of power in Europe. The progress of steam navigation has swept the first of these away, and as for the second, who dare predict political conditions in Europe when this war closes? Prof. Cathcart quoted Elihu Root, former Secretary of State, as follows:

"Our danger is not now, but later, when peace has been made and the great armies are free, when rulers and governments look about for ways to repair their losses, and when the great spaces and ill-defended wealth of the new world loom large on the horizon of their desires. . . . Then must be determined whether the Monroe Doctrine has behind it the sincerity and courage of a great nation, or is to be surrendered as an idle boast."

Accepting definitely the consensus of military opinion that invasion can be repelled only by an adequate and mobile navy, we have to consider that, lacking naval bases in both the Caribbean and the Pacific our fleet is tied to our shores, and our naval arm is cramped and palsied. Under such conditions as these, the General Staffs of the strong military powers of Europe and Asia must smile sardonically at our guarantees of independence and our virtual protectorates of the weak West Indian lands. At this time the United States is too feeble to defend itself. Its declarations as to the protection of these southern republics are, in effect, but "scraps of paper."

The New York navy yard is taken as an example of our amazing naval unpreparedness. Owing to its strategic position and its unlimited resources, this yard should be our greatest naval station. Instead, it is, in its approaches, not only a nuisance to the navy in peace, but in war might readily prove a fatal trap for ships caught in it under certain conditions. The reasons are: First, its water front is congested, and it cannot receive even a moderate fleet. Second, its single approach, that from the Bay, has channels so shallow that large battleships can reach the yard only when wind and tide serve, and in war a damaged battleship, down by the head or stern, could not reach it at all. Third, when ships get there, they must stay after their repairs are completed, until wind and tide combine to let them out again. Fourth, when thus trapped, these ships might readily be sunk by gun fire in war, since a superior enemy fleet could easily get near enough to the coast to shell the yard.

The Kiel Canal has been of vital service to Germany during this war. Without it, she could not have held her Baltic coast against British dreadnaughts convoying troop transports. Every dollar of the ninety-four millions she spent on it has been repaid a thousand-fold in her defense. Now, we could have a largely similar waterway from Sandy Hook through Long Island Sound to the open sea between Montauk Point and Block Island, if the channels through New York harbor and at Hell Gate were deepened. This waterway would not only add incalculably to the effectiveness of our fleet in war, but would keep the New York yard from being a dreadnaught-trap under hostile fire. Our ships could at least flee from it up the Sound.

At Norfolk, our other great coast yard, the channel abreast the dry dock is but 525 feet wide. The 600-ft. Pennsylvania has been docked there, but only by canting her across the channel at an angle to the dock, and at imminent danger of serious damage to the ship. It is not pleasing to think of war conditions there, with half a dozen great ships vitally needed outside the Capes, and yet all crowded in that narrow channel waiting their turn to twist into that dry dock.

As to the conditions south of Hatteras, Rear Admiral Edwards says:

"There is not a dry dock, owned by the Government or by anyone else, on the South Atlantic and Gulf coasts which will take any of our superdreadnaughts. There is not a single stationary or floating crane on these coasts which will remove from, or install in, a battleship either a modern turret gun, a Scotch marine boiler, or an assembled low-pressure turbine of the kind now fitted in our large naval colliers, tankers, and battleships."

The situation as to dry docks is very grave. To date, we have a total of twenty-one dreadnaught battleships built, building, or authorized. Of this total, all but the four oldest are too large to be docked at any navy yards, except those at New York, Norfolk and Bremerton on Puget Sound, and that at Pearl Harbor in Hawaii when the dock now building there is completed. And, further, the Naval Act of 1917 also authorized four battle cruisers, and the pending Naval Bill will probably appropriate for two more battle cruisers and four battleships. Of these ten ships, the battle cruisers certainly, and the battleships probably, will be too big to enter any of our existing naval drydocks. At present, with our larger ships limited thus to but two naval docks on our eastern coast, the possibilities, after but one great battle there, seem appalling.

It is true that the dock at Balboa, which is large enough for any ship that can pass through the Canal, is now available, and that two naval docks have been authorized recently, one at Philadelphia, the other at Norfolk. But heretofore the average time for building a naval dock has been seven years. In fact, for so deep a dock as battleships require, this time is always uncertain. Time and again the character of the soil and the hydrostatic pressure of its entrained water have sprung costly surprises on the builders.

So, an adequate dry dock system to meet the exigencies of early war is at this time virtually impossible for our navy. The hazard of a dreadnaught fleet costing nearly half a billion dollars for lack of a few dry docks at three or four millions each, will scarcely commend itself to the business sense of this nation.

The point of the question discussed is that, after a possible battle, a battered dreadnaught may have to limp its slow way through many miles of perilous waters, with imminent danger of foundering, of destruction or capture. A damaged ship, which may be saved by quick docking after battle, will have to sink, as matters stand, unless she can be beached in some near-by harbor of refuge and coffer dams built.

The measures to provide adequate communication facilities under these conditions is an engineering problem of obvious interest to workers in the radio field. So, too, is the equipment of the enormous fleet of small craft needed to engage submarine flotillas and maintain communication with the strategical land bases.

As a conclusion to the appeal for members of the engineering profession to study the needs of defense, Rear Admiral Fiske is quoted:

"There are no other men in the United States so immediately and directly powerful in developing the fleet and naval stations as the engineers. While the strategist estimates the general situation, and determines the application of the general principles of strategy to each situation as it arises, and while the tactician handles the units of personnel and material in actual battle and in preparation for it, it is the engineer who provides the strategist and the tactician with the mechanisms with which to carry out their respective and collective aims."

It is the engineer who enables the strategist and the tactician, and who often forces the strategist and tactician, to put his art abreast the developments of the physical arts and sciences, and to take advantage of them.

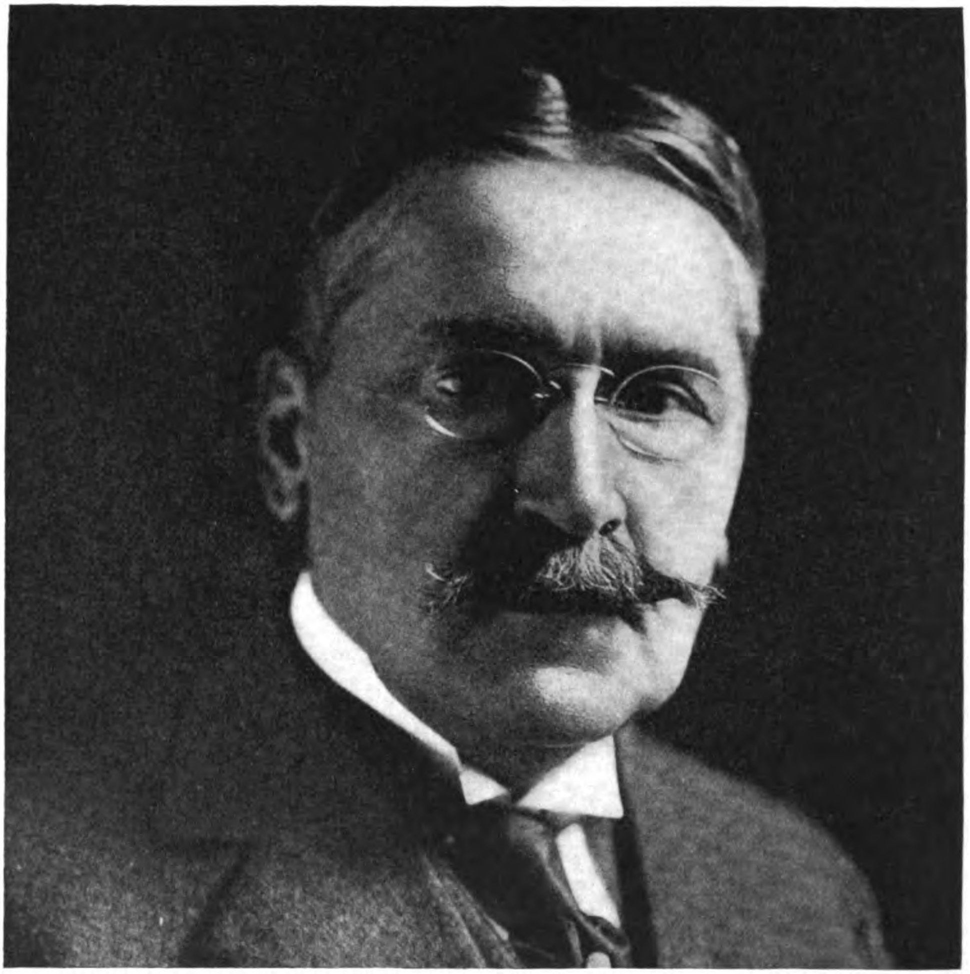
DUMMY ANTENNAE FOR TESTING

The Electrical World notes that when electrical engineers test a dynamo machine they are not likely to disturb engineering operations in other buildings, or even in other parts of the same building. When, however, they test a radio plant of considerable power they are likely to disturb the ether for hundreds of kilometers in all directions. A need arises, therefore, for a dummy antenna, or a radio load for testing radio generators, which shall not seriously stir up and vex the ether in the vicinity. The problem is to load the generator but to suppress the output beyond a short range. This is a problem in radio inefficiency, and is just the reverse of the ordinary problem of the radio engineer, which is to load his generator as efficiently as possible, so that the effects may be manifested at a great range.

A dummy antenna is then described. which consists evidently of a bed of horizontal galvanized iron wires in five layers, so arranged as to be capable of forming an air condenser of adjustably variable capacitance up to about one-thirtieth of a microfarad. With such a capacitance carrying 250 amp. at 20,000 cycles per second, the voltage, neglecting all losses, would approximate 64,000. Sixty-four kilovolts driving 250 amp. in quadrature would develop 16 megawatts of reactive power. An active power rating of 200 kw. would thus only demand a little more than 1 per cent of dissipation factor.

Michael I. Pupin the Man

The Story of His Rise from Immigrant Boy to World Renowned Scientist



Perhaps there is no more interesting personality in the wireless world than that of Professor Michael Idvorsky Pupin of Columbia University. In addition to being the inventor of the art of electric tuning and the electrolytic detector, he is professor of electromechanics at Columbia University, and president of the Institute of Radio Engineers. He is also connected with various scientific societies. His arrival in the United States as an immigrant boy, his struggles to gain a livelihood and an education and the details connected with his rise to the pinnacle which he now occupies are graphically told in an article in the Columbia Alumni News by Dr. Cary T. Hutchinson.

A STOCKILY-BUILT immigrant boy of fifteen landed at Castle Garden in the fall of 1874. Having lost his hat on the way over and coming from a semi-oriental country, he walked up Broadway wearing a red Turkish fez. This excited the mirth of the newsboys in the neighborhood of the Battery, and they pounced upon him. A ring was formed by onlookers and a fight ensued, and the newsboy was soundly thrashed. This was young Pupin's introduction to the United States; he started here with a fight and he has been fighting in good causes ever since. The sky was at this time darkened by a maze of overhead wires, and the boy, engaged in his hereditary occupation of fighting, little dreamed that a few years subsequently his great invention was to be the means of putting these wires underground.

Pupin came from the town of Idvor (hence his name), in Hungary, on the Danube, across the river from Belgrade. His family, with some thirty-five thousand other families, all pure Serbs from old Serbia, had been settled there by Austria in 1690, for the purpose of defending the military frontier of Austria against the incursion of the Turks. They were given land in return for which their sole duty was to give military service to Austria. So Pupin's readiness to fight is easily explained. He ran away from Austria, with another boy, attracted by the alluring advertisements displayed by the steamship companies of a free land across the seas. His family still are there—several were in the service of the Austrian Empire at the outbreak of the war—but being Serbs, they seized the first opportunity to escape and were of the regiments that deserted the Austrian cause and joined with Russia.

After this fight, he returned to Castle Garden (with his red fez), whence he was taken by a foreman looking for sturdy laborers, and carried to Delaware City, Maryland, to drive a mule team; subsequently, he worked on other farms in Maryland, New Jersey and Delaware, finally ending in the service of a pious Baptist farmer in New Jersey, who took him to church. Suspecting an attempt to convert him to protestantism, he ran away one Saturday night; to hide his tracks, he ran through fields and woods, and the next morning, very tired, crossed a bridge leading over a canal and entered a large town, exhausted by hunger and exertion. After buying a loaf of bread, he seated himself under a high tree near some academic buildings and under the genial influence of the spring sun, and physical fatigue, he fell asleep, and had a dream—that the academic institution, in whose shadow he had fallen asleep, had conferred an honorary degree upon him for distinction in science. This institution, Princeton, has not yet risen to its unique opportunity, and other institutions of equal prestige, such as Columbia and Johns Hopkins, have forestalled it.

Young Pupin gradually worked his way to New York, doing anything that came to hand: from 1875 to 1879, he was busily engaged in earning his living and gradually picking up a knowledge of the language, principally through the reading of newspapers and signs on buildings. He had an omnivorous curiosity; his encyclopedia was the Sunday issue of the New York Sun, then under Mr. Dana. He worked in a cracker factory, in a grocery store, as a shipping clerk, running errands—doing anything that came to his hands to earn a living. At the same time, he attended night school, at Cooper Union and elsewhere, studying at every opportunity that presented. By 1879, he had managed to save up $311, enough to permit him to enter Columbia, so he took the entrance examination and passed with high honors, getting free tuition, which was essential to him. He was attracted to Columbia, rather than to some other college, by the Columbia victory at the Henley Regatta—again the love of physical prowess.

During his freshman year, he had a very monotonous time socially, owing to poverty and too serious attention to his studies: he knew few of his classmates, as he worked all the time, the result being that at the end of the freshman year, he received two first prizes, in Greek and Mathematics, giving him one hundred dollars each, a matter of vital concern to him, but his classmates looked upon his distinction in studies with a certain lack of enthusiasm. This welcome money was supplemented in his freshman vacation by sweating for three months, cutting hay and fighting mosquitoes in the Hackensack meadows, his entire earnings being $75, over and above the living that was given him.

His sophomore year started under

more favorable auspices. In October, 1880, the class championship was to be decided between the freshman and sophomores by a wrestling match of representatives of the two classes. The freshmen selected as their representative a young giant, of a family famous in Columbia's annals, and the sophomores saw themselves defeated by the mere prestige of this champion. Pupin, however, volunteered to meet the giant and was reluctantly accepted by his classmates, despising a prize man in Greek and mathematics. The result was a quick and decisive victory for the sophomores; Pupin was carried on the shouldeds of his classmates to Fritz's saloon in Forty-ninth street, where a celebration was carried on all afternoon, of a kind that is left to the imagination.

From that time, he had no difficulty in getting on. He was made class president, and every opportunity was given him to utilize his scholarship by private coaching in Greek, Latin, mathematics, and even in wrestling. When he was graduated he had saved up enough money to permit going abroad to study physics and mathematics. Leaving this country then in June, 1883, after receiving his A.B., he went to Cambridge, intending to study under Maxwell, ignorant of the fact that Maxwell had died four years before. This, although he expected to become a student in physics, shows how little knowledge he had of the world of physics at that time. When informed of Maxwell's death, he was also told that a good substitute for Maxwell had been found in Lord Rayleigh, to which he replied that he had never heard of Lord Rayleigh. Nevertheless, he studied at Cambridge for a year and a half in Mathematics and Physics, and then went to the University of Berlin, where he remained until 1889, studying principally under Helmholtz, in what was then known as "physical chemistry," really thermodynamics.

While abroad, in 1889, he married a sister of Professor Jackson of Columbia. She died in 1896.

He was given the Tyndall fellowship in 1885 by Columbia, yielding $650 a year; he returned to this country in 1888, at the request of Columbia, to confer regarding the establishment of a course in electrical engineering, of which he was asked to become professor on the theoretical side—Professor Crocker being chosen to conduct the applied work. These arrangements went into effect in the fall of 1889 and Pupin and Crocker worked harmoniously for twenty years at Columbia.

Pupin knew little at that time of the theory of electricity and less of electrical engineering—yet he had the audacity, early during this period, to oppose the Edison interests, who were themselves fighting against the introduction of the alternating current into commercial use. Pupin sided with the advocates of the alternating current, believing them to be fundamentally right. As a result, strong representations were made by financial interests to Columbia, practically demanding his removal on the ground of his immaturity and crudeness. The method that he guessed to be right, was right; his engineering instinct guided him correctly in a matter of fundamental importance, regarding which he had no detailed knowledge.

Pupin took up research work at Columbia from the start of his career there. He first interested himself in electrical resonance and electrical currents in rarefied gases; the results of this work were the inventions in electrical tuning, practiced universally today in wireless telegraphy. These were patented, the Marconi Company buying the patents in 1902.

When wireless telegraphy became prominent in 1896, he invented a simple method of electrolytic rectification of high frequency oscillations at the receiving station; this general method of receiving wireless signals, that is, the rectification of high frequency oscillations, is now in universal use in the vacuum tube rectifiers. His work in electrical discharges in rarefied gases led him to take up the study of X-ray; he was the first in this country to repeat the Roentgen experiments and the first to use X-rays practically for surgical purposes, having made in January, 1896, an X-ray photograph of the late Prescott Hall Butler, who had over a hundred small shots in his brain, all of which were successfully taken out by the late Dr. Bull, guided by his photograph.

This X-ray work interfered with Pupin's health, so he abandoned it for the study of electric transmission of power and in particular the mathematical theory of sectional electric conductors. The outcome of this work is the well-known "Pupin-Coil," now universally used in telephony and telegraphy. This invention of Pupin's has done more to extend the sphere of telephonic work than all other inventions together, since the original invention of the telephone; it is known in France as the "Lignes pupinizé" and in Germany, as "Pupinizierte Linien." Striking illustrations of the value of this invention are the existing New York-San Francisco telephone line, the Boston-Washington underground cable line, and the submarine cable between England and Holland—all of these are impossible without the "Pupin-Coil." The American Telephone and Telegraph Company is now preparing to lay an underground cable between New York and Chicago—the cost of obtaining even a poor equivalent of this service in any other way would be absolutely staggering.

Pupin, as is well known, is an ardent Serb. His activities for years have been directed largely to helping the Serbs in this country, and since the war, to the assistance of Serbs both here and abroad. He has been for a long time President of the Slavonic Immigrant Society and President of the Serb Federation, a mutual benefit organization comprising the greater number of Slavs in this country, nearly all Austrian subjects, who have abandoned Austria for this country, and who hate Austria as cordially as does Pupin. He is also Honorary Consul-General of Serbia here.

One incident that his friends know of illuminates his character: In the early stages of the war, he personally guaranteed contracts for railway material and supplies for Serbia to the extent of $250,000, or more, without the slightest guaranty from Serbia or any other source that the money would ever be paid back to him.

Pupin has received many scientific honors; he is a member of too many scientific societies to enumerate, and an officer in several of them. Just now, he is President of the New York Academy of Sciences, and a member of the Council of the National Academy of Sciences. He received the Elliott Cresson medal for distinction in Physics, in 1906; the Herbert Prize of the French Academy in Physics in 1916; the gold medal of the National Institute of Social Science in 1917. He is also a member of the National Research Council and of its Executive Committee, and of the National Advisory Board for Aeronautics, established by the United States Government.

Although a devoted believer in the Serb race and its traditions, there is no truer American citizen than Pupin; none who would make greater sacrifice for this country in time of need—even though against the interests of the Serbs. Columbia honors herself in honoring him.

MARCONI IN U. S. WITH U-BOAT DESTROYER

Ferdinand, of Udine, Royal Prince of the House of Savoy, son of the Duke of Genoa, captain in the royal Italian navy, and first cousin of Victor Emanuel, King of Italy, entered the American Capital on May 23rd amid salvos of welcome and applause, bringing with him Marconi, inventor of wireless, and the distinguished War Commission which the Italian Government has sent to the United States.

Most inspiring among the suggestions which came with the Italian Commissioners is the buoyant promise that the murderous U-boat of the Germans has found its master. The invention is announced as Marconi's, to whose new "submarine killer" the Italian Commissioners credit the destruction of fourteen German and Austrian U-boats in the last month.

Marconi is modest, as always, but the Italian Commissioners are inspiringly enthusiastic over the remarkable achievements of the inventor.

It is reported that Marconi will go into executive session with Edison in the perfection of the weapon for which the world and civilization waits on land and sea, and the combined brains of the two wizards will be consecrated to the mighty task.

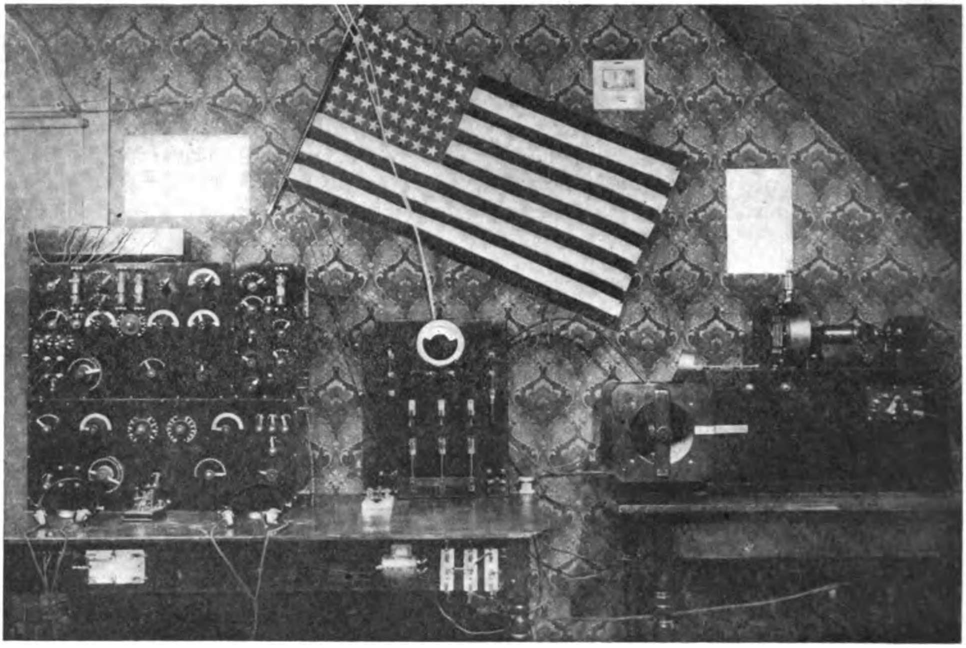
Amateur Department

9 ZF Winner of Efficiency Cup

By 9 XE

National Chief of Relay Communications

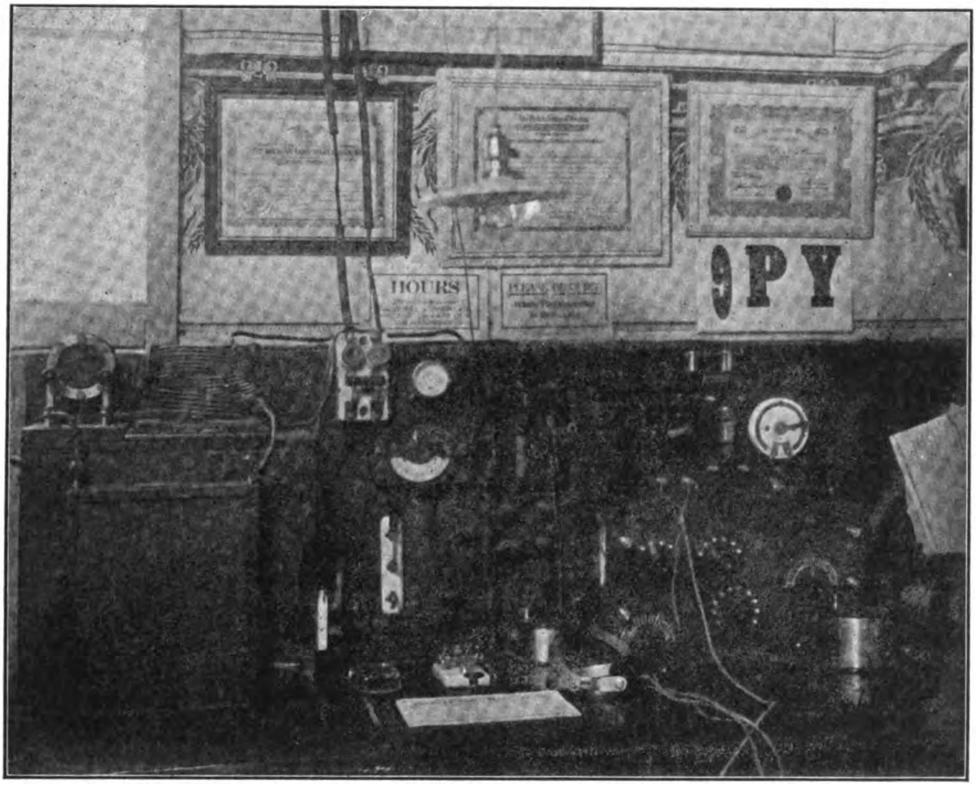
NATIONAL AMATEUR WIRELESS ASSOCIATION



Station 9 ZF, owned by E. F. Doig, who was awarded the trophy for efficiency and equipment

E. F. DOIG, of 848 South Emerson Street, Denver, Col., has been awarded the cup donated by 9 XE to be presented to the owner of the most efficient and best equipped amateur wireless station in the United States. 9 ZF, Mr. Doig's station, is embraced in the Colorado Wireless Association's chain. W. H. Smith is associated with Mr. Doig in the operation of the station.

A record of messages handled at 9 ZF from January 13th to March 18th shows that 251 communications were sent and received, a number of these being transmitted from coast to coast. This station had a strategic position in



Station 9 PY owned by S. W. Pierson of Carrollton, Illinois

the last Washington's Birthday Relay, held under the auspices of the National Amateur Wireless Association. In fact, without the assistance of 9 ZF, it would have been impossible to obtain the results which were achieved. Although the Denver station is on the membership books of practically all of the radio clubs its operators did not decline one message.

In the receiving cabinet of 9 ZF is a large loose coupler for the reception of signals from long wave stations. A smaller receiving cabinet is used for the smaller wave stations. Also included in the equipment are a short wave regenerative receiver and an amplifier which can be used in connection with each of the other sets. The station, which is of I. K. W. power, radiates from twelve to fourteen amperes on a wave-length of 425 meters. The oscillation transformer is made of edgewise-wound copper strips.

There are three towers, one of them being 90 feet in height, and the other two 75 feet. One aerial has six No. 12 aluminum wires, 150 feet in length, and the other is 200 feet in length and has four stranded aluminum cables with seven strands of No. 14 in each cable. Mr. Doig, assisted by Mr. Smith, made nearly all of the apparatus.

Mr. Doig's station recently worked directly with 2 PM in New York City, and it has frequently worked with 6 EA in Los Angeles, Cal. It has accomplished excellent results in the movement to interest amateurs in the United States Coast Reserve. Mr. Doig is secretary of the Colorado Wireless Association and Mr. Smith is chief operator. The cup will be held for one year by 9 ZF and if won again in 1918 will be retained by the Denver station for all time.

This Trans-Continental Relay a Record Breaker

Two N. A. W. A. Members Organize Successful Chain of Communication in a Night

By Willis P. Corwin (9 ABD)

RELAYING a message across the continent and receiving back the answer two hours later, is a record which will stand in the annals of amateur wireless as the pioneer achievement in the field. It will probably be of interest to all wireless amateurs to learn that this was accomplished on February 6th, when a message was relayed from New York City to Los Angeles, California, in record time. Not only was a message sent from coast to coast, but an immediate reply was relayed back to the New York station.

A trans-continental message had been planned for some time, and several tests had been made; but all efforts proved a failure until the night of February 5th and the following morning. In some instances the proposed routes were made up of stations that had never done any successful work, in others some one station would prove a failure, and when everything seemed substantial in the way of stations, atmospheric conditions would prevent any successful work. On the night of the initial success atmospheric conditions were ideal and we owe our achievement to old man QRN as well as to ourselves.

The author's station is in the center of the state of Missouri, approximately one-third of the distance from New York to Los Angeles. Amateur stations are heard as far East as the coast and as far West as Denver, Colorado, successful work being done with several of the Eastern stations and with stations as far West as Denver. As the Denver station had been working Los Angeles, a trans-continental relay seemed possible beyond a doubt.

At midnight, February 5th, I heard at my station, 9ABD, of Jefferson City, Missouri, Alfred J. Manning (8JZ) of Cleveland, Ohio, talking to 2PM in New York City, the station operated by Faraon and Grinan. As I had worked with W. H. Smith (9ZF) in Denver, the night before, and had heard 9ZF talking to the Seefred brothers (6EA), of Los Angeles, California, I saw the possibilities of a trans-continental message, and called 9ZF with that in mind. He answered and I told him that I had heard 8JZ talking to 2PM and asked him to try to get 6EA, while I got a message from 2PM, for 6EA through 8JZ. Smith said that he usually worked 6EA a little later, but told me to go ahead and get a message from 2PM, and he would try to get 6EA and QRX for the message. I immediately called 8JZ and told Manning, of Cleveland, of the possibility of a transcontinental relay and asked him to get a message from 2PM for 6EA. Manning agreed and called 2PM, and Faraon and Grinan gave 8JZ the following message:

Seefred Brothers, 6EA,

Los Angeles, Cal.,

Here's hoping you receive this message tonight. Best regards from the East.

Faraon and Grinan, 2PM.

8JZ gave the message to 9ABD. In the meantime 9ZF had succeeded in getting 6EA and both of them were standing by for the message. 9ABD gave it to 9ZF, who called and sent it to 6EA, but the latter was bothered with QRM from Government and commercial stations and asked 9ZF to QRX till they quieted down a little. They waited for some time, but the commercials must have been sending press for they never let up, so 9ZF repeated the message several times until 6EA had it O. K.

The message left New York at exactly one thirty A. M. eastern time, and arrived at Los Angeles shortly before midnight western time. A reply left Los Angeles at midnight. It read as follows:

Faraon and Grinan, 2PM,
New York City.
Thanks. Same to you from the West.
Seefred Bros.

The stations that handled the West bound message were all standing by for the QSL and no trouble was encountered on the return; 2PM had the reply at three thirty A. M., two hours after the first message had been forwarded. As the reply was filed in Los Angeles at midnight it took an hour and thirty minutes to get the first message to the Western coast and about thirty minutes to relay the reply back. The time between the two terminals has a difference of four hours and is a little confusing, esespecially as the writer is going by Central time, so these figures are only approximate. I am sure, however, that the return message did not take over fifty minutes at the most, as I heard 9ZF give 6EA his O. K. and heard 8JZ give the message to 2PM and also heard 2PM's O. K.

It will be noticed that no previous arrangements had been made. The first time that two minds met in regard to this relay was when I asked 9ZF to try to get 6EA and hold him till a message was secured from 2PM. No special instructions were followed, the operators just acted naturally and handled the messages as they would handle any other message, and as each one gave the first message to the station west of him, the western station gave him an O. K., and asked the latter to QRX for the reply, "even if it takes till daylight."

The Eastern stations deserve a little extra credit as they stood by for two hours. 6EA and 9ZF also deserve special credit as the distance between them is over 1,000 miles. The other distances covered were approximately 800 miles each, with the exception of the distance between Cleveland and Jefferson City, which is a little over 350 miles.

This relay shows the good work that the amateurs of the country are doing. Although a trans-continental message had never been relayed before in such a short time, a great many have been handled since the first of the year. This is due to the good work of Smith, of Denver (9ZF), who has handled practically all the coast to coast messages. On the night of the relay 2PM heard 9ZF and 9ABD, and 9ABD heard 2PM.

This first real transcontinental message relayed in one night is the beginning of a new era in the history of the amateur wireless stations. We amateurs are indebted to Uncle Sam for his generosity and now in a time when he needs our services we will show our appreciation, I am sure.

MARLBORO CLUB'S ANNIVERSARY

The Radio Club of Marlboro, Mass., recently celebrated its first anniversary in its club rooms. Messrs. Wallace, Williams, Brigham, Bailey and Temple addressed the members of the organization.

WAR WILL NOT INTERFERE

It has been announced that the members of the St. Paul (Minn.) Radio Club will continue their study of wireless, despite the dismantling of its set by the Navy Department as a result of the war.

Resolutions in which members of the Connecticut Valley Radio Club, of Springfield, Mass., agreed to volunteer their services to the United States Government were adopted at a recent meeting of the Club.

It has been announced in St. Paul, Minn., that students of Macalester College have formed a class in wireless telegraphy. Preparedness was the prime motive for organizing the class.

James Clifford delivered a lecture on wireless at a recent meeting of the Evansville (Ind.), High School Wireless Club.

From and For those who help themselves

Experimenters' Experiences.

FIRST PRIZE, TEN DOLLARS

The Construction of Light Supporting Masts Made of Metal

I have constructed a mast for the support of antennae built entirely of metal, the total cost of which was just a little more than $5. The material complete with the guy wires, weighed a little more than forty-five pounds.

The most striking advantage of a mast constructed along the lines I am about to describe is that it has no parts likely to suffer from the weather except the aerial hoisting rope which can be replaced at a cost of about eighty cents. This mast in its present form was designed by C. H. Ziesenis. A mast of the same construction was in use at an early date at station 9 DM, owned by Harry Ziesenis. At the suggestion of the latter, a slight change was made in the construction of my mast and, as it is considered an improvement on former types, a description of it may be of interest to the readers of THE WIRELESS AGE.

The mast itself is a piece of common, 27 gauge, galvanized corrugated leader pipe, 2 inches in diameter, such as is used to carry water from the roof gutter to the cistern. The 2-inch size is recommended not only because it is less expensive, but also because it is very much stronger than the larger sizes. It is highly important that corrugated leader pipe be used, as the smooth type has considerably less strength. In fact, the corrugated pipe is so stiff that a 10-foot section, laid across a couple of supports, will hardly bend with the weight of a 100-pound boy, while thirty feet of the pipe may be pried up into a horizontal position over a support 2 feet from one end. As many readers are probably aware, no gas pipe or timber of similar size would withstand such a strain.

In order that the mast may be rigid, the sections of the pipe are connected together by lock-jointed sleeves of

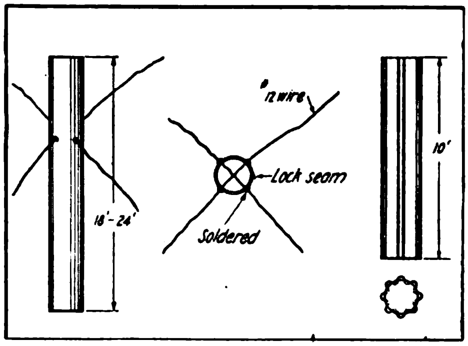


Figure 1, First Prize Article *Figure 2*

galvanized iron, approximately 2 feet in length. A tight fit is necessary; in fact, the sleeves should be so tight that they can be forced on only by throwing one's whole weight on them.

As will be seen from Figure 1, four nail holes are punched through the sleeve at the center and a couple of 36-inch pieces of No. 12 galvanized iron wire are crossed through the holes and soldered into place. These wires serve a double purpose—they keep the pipe from telescoping and also provide fastening to keep the guy wires from sliding down.

At the end of each section, a disc of

galvanized iron is soldered fast to keep the pipe from cutting into the section below. The disc, which is

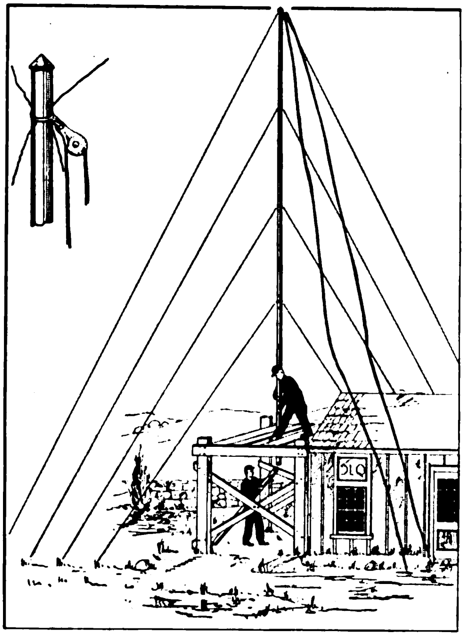


Figure 3, First Prize Article

shown in Figure 2, is essential and should be of heavy gauge metal.

This work having been completed, 3-foot pieces of No. 14 galvanized wire are now attached to the sleeves by passing them twice around and twisting the free end and one of the "tails" tightly together with the long end. A one-piece porcelain wiring knob is now attached to the long end to act as a strain insulator. It is important that the joints be well made as they cannot be re-made later.

The next step in the order of construction is to force the sleeves on the lower ends of the section, giving particular attention to bringing the end of the pipe into contact with the cross wires. If desired the top of the sleeve may be "crimped in" and soldered to the pipe to exclude rain. As shown in Figure 3, the top section is also capped by a sleeve supplied with a small conical roof soldered on water tight. The top guys and the pulley are attached to this sleeve.

The position of the guy anchors should be located in advance and in so far as possible they should be set 180 degrees apart if three sets of guys are used, and 90 degrees apart if four sets are employed. It is also recommended that they be placed not nearer than half the height of the mast, that is, thirty feet from a 60-foot mast. In fact, it is better to place them farther out at a distance equal to the height of the mast. Guys longer than this, however, are not desirable as they must be excessively tight to prevent violent vibration on windy days. One set of guys should be placed straight back of the aerial.

If guys are cut by mere guesswork, a needless amount of wire is wasted. By drawing a plan of the mast, the back length can be calculated in advance. The constructor should draw the mast to scale, letting ⅛th of an inch equal one foot, and he should drop lines from the points on the mast, which represents the joints, to the points on the ground which represent the guy anchors. The length of these lines is then measured in eighths of inches which correspond to feet. To this should be added four feet for making fastenings to the anchor. All this will be clear from Figure 4.

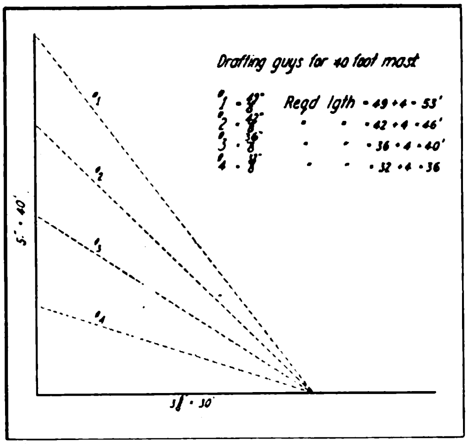


Figure 4, First Prize Article

If the anchorages are at different distances from the mast, a separate drawing must be made for each. This may seem a needless amount of labor, but it takes only about fifteen minutes and is likely to save hours in erecting the mast.

In order to carry on properly the work of erection a scaffold, 12 to 13 feet in height, should be constructed with room enough to allow two people to stand on it. In my experience I found thirteen feet a desirable height, as it readily permits one to put the ten-foot sections into place. The opening in the center of the scaffold should be about two feet square and must be directly over the place where the mast is to stand. A good-sized rock or piece of 2-inch plank should be laid first to act as a mast foundation. Any building contractor in the neighborhood will lend the lumber for the scaffold.

The guys are now laid out for the top of the mast, while the other guys are coiled up and laid in order so that no time will be wasted in pawing them over in order to free them and clear them from twisting and tangling.

The first three sections of the mast are now put together, the top end pushed through the opening in the scaffold and the top guys attached. The rope is put through the pulley and the ends firmly tied together. Then the mast is shoved up at a slant till the second set of guys can be attached, after which it is "up-ended."

In order to complete the erection of the mast at least two assistants are required, one or two to hold the ends of each set of guy wires (in fact three to six people are required for a mast with three sets of guys) while a helper unrolls the guys and brings up the sections as they are needed. The person in charge of the work stands at the base of the mast under the scaffold and inserts sections, attaches guys and directs the guy-holders.

The safety of the whole mast now depends upon the person in charge, and it must be distinctly understood that he has control and that no one is to argue with him. All unnecessary conversation should be avoided in order that his commands may be understood. These orders may be simplified by numbering the guys so that "North! number two!" means that the holder of the north guys is to tighten the second wire from the top. Similarly, "South! slack three!" means that the south guy No. 3 is to be given more slack.

As they are required, new sets of guys are unrolled by the helper and passed over the edge of the platform, down through the opening to the chief, who attaches them to the insulators. Then the mast is lifted till he can get another section underneath, while the helper distributes the guys to the holders.

Given a good helper at the bottom of the mast, a pair of lifters who can do their work without straining and above all, a calm day and helpers who will attend to orders without "back-wash," an 80-foot mast can be erected in a couple of hours. My mast was erected, in fact, with a strong and a very cold north wind blowing. Matters were delayed while frozen fingers were thawed out, but notwithstanding the erection took no more than an hour and three-quarters.

Since that time we have erected 45 and 50-foot masts of this sort in half an hour. Very short masts of three sections can be erected without a scaffold in about fifteen minutes.

As to the guys for the mast, I believe No. 16 galvanized steel wire to be of ample strength, although at stations 9 LQ and 9 DM No. 14 wire was used. The guys are not to be made tight as their purpose is to balance the mast rather than to hold it rigid.

Reverting again to the strength of the mast. Last February we had a severe sleet storm. One mast of this type "stayed put" although the aerial finally gave way after it had accumulated more than 60 pounds of ice. All the guys were sheathed in ice half an inch thick, while the 70-foot mast itself carried an inch of ice. According to my calculations the horizontal pull at the top of the mast was over 300 pounds, while the dead load was not far from 400 pounds. The showing is the more remarkable as the mast was not guyed at all joints, but only at 15-foot intervals.

It is quite likely that a metal mast will

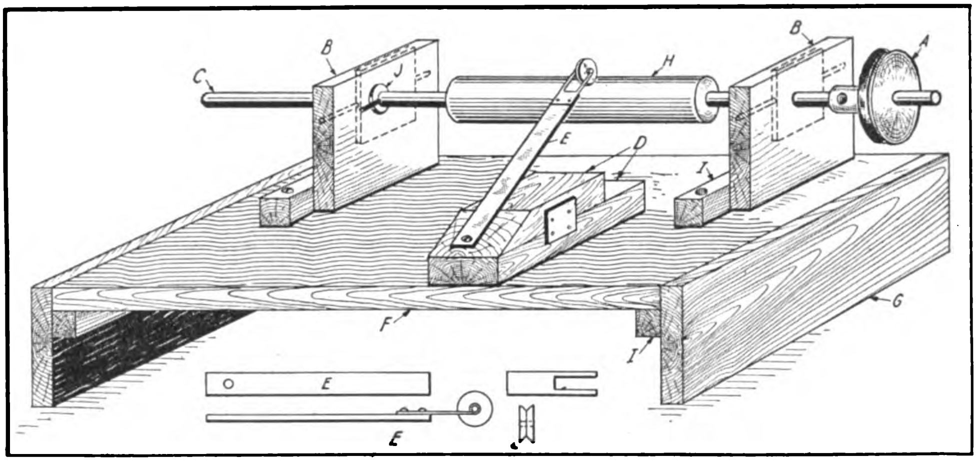


Figure 1, *Secon d Prize Article*

be viewed with distrust by some who fear induction losses. The losses may be minimized by breaking up the guys by means of porcelain knobs (using four in the two upper sets of guys and three in the lower sets) and by insulating the whole mast from the ground by means of a paraffined plank or a marble slab, such as a piece of table top which has been well boiled out in clean paraffin. I have found by experiment that when using an umbrella aerial the insulation of the mast from the ground is especially important.

Both in my station and at station 9 DM marble slabs are used under the mast and, while there are considerable fireworks at that point, the loss does not seem to be important at staion 9 LQ. The latter has a fairly constant winter range of 400 miles when using 225 watts, while station 9 DM has repeatedly covered distances of 950 miles with 870 watts input.

It should be taken into account that the strength of the mast is due entirely to the shape of the pipe and damaged pipes are worthless. Even a small dent, except very near the end, is sufficient cause to throw away the entire section or joint, while rust spots, if severe, would have a similar effect. If the zinc has just peeled, further rusting can be prevented by a touch of asphaltum varnish or paint. To prevent rusting at the point where the cross wires pass through the sleeves the wires should be soldered at these points but not with zinc chloride. The constructor should use "Nokorode" or Allen's soldering paste. If these precautions are observed there is no reason why a mast of this sort should not last for years with no attention beyond the semi-annual renewal of the rope for hoisting the aerial.

In the event that any of the readers of this article decide in favor of this mast, I should like to hear the results of their experiences.

S. KRUSE,
1,538 Kentucky Street,
Lawrence, *Kansas.*

SECOND PRIZE, FIVE DOLLARS

A Winding Machine for Transformer Coils and How to Make It

Although I have seen published several constructional sketches for hand winders for winding secondary coils and tuning coils, none of them have been really practical for the amateur. The one that I have designed is to be used in connection with a sewing machine without any alterations whatever except lengthening the driving belt.

This machine has been used by myself and others for several months, and we have been able to wind one section of a 3-inch spark coil with No. 38 wire in a couple of hours. With the aid of the guide shown in Figures 1 and 2, the experimenter will have no difficulty in winding the layers perfectly even without overlapping. This is a matter of great importance in the winding of transformer coils.

The drawings accompanying this article are largely self-explanatory. However, a little explanation of the operation may not be amiss. Place the left hand on the coil to regulate the speed, and the forefinger of the same hand to assist in guiding the turns evenly, using the right for the operation of the guide "E."

To mount this device, simply place the winder on the sewing machine without fastening, according to Figure 2, allowing some play in the strap for the regulation of speed. It is also to be noted that no machine work is required in the making of this device unless such construction is desired. If the builder is unable to secure the pulley, A, the ends of two large spools, sawed off and nailed to form a V, will answer the purpose.

The dimensions of the various parts follow:

A—1½ inches or 2 inches in diameter (any size will be suitable); B—5 inches by 2½ inches wide by ¾ of an inch (standards); C—10 inches by ½ inch or ⅝ of an inch diameter (shaft); D—Two pieces, 2½ inches wide by 1½ by 7 inches long, cut as shown, and fastened to permit shifting of piece holding guide in or out; E—6 inches by ¾ of an inch wide by 1-16 of an inch thick sheet iron. A thin piece of brass or tin turned over to receive a nail forming a shaft for the small guide pulley and then fastened to sheet iron as shown; F—15 inches by 8 inches by ¾ of an inch thick (base); G—8 inches by 4 inches (sides); H—Piece of broom handle bored to fit over shaft; I—¾ of an inch square.

The standards, B, are nailed to the pieces, I, and they in turn are screwed to the base so either end can be removed whenever it is necessary to remove the coil. Also the dotted lines on the standards represent borings which permit hot lead to be poured around the shaft after it has been lined up. These make good bearings. Two small holes bored in the shaft inside of the standards to receive a small nail are backed by a washer which will keep the shaft in perfect alignment.

No shear or difference in diameter is shown in the arbor, H, for the reason that I have found it more advantageous as shown and have made allowance in the diameter to permit winding a thin piece of cord the entire length of H and fastening it into place.

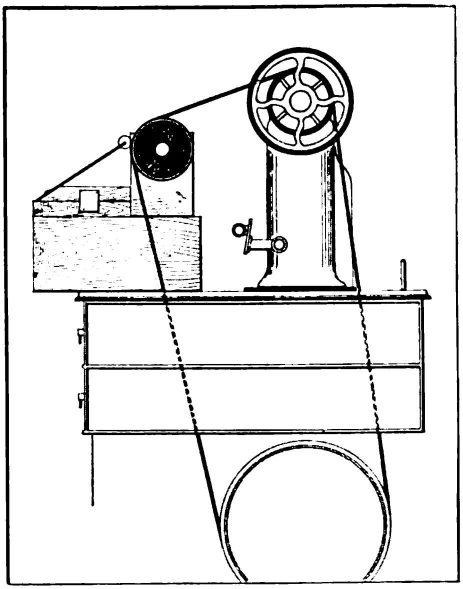


Figure 2, Second Prize Article

If the core is built upon that, it is only necessary after it is completed, to reverse the machine unwinding the cord. This will permit whatever is being wound to be removed without danger of pulling it apart.

LATTIMER W. REEDER, *New York*.

THIRD PRIZE, THREE DOLLARS

A Long Distance Receiving Set Which Has Proved Successful

I have described in this article a simple long distance receiving set which can be constructed by any experimenter at a minimum of expense. The fundamental idea of this receiving transformer is shown in the accompanying photograph. It will be noted that there are three tuning coils. The center coil is the primary winding of the oscillation transformer, the one at the right is the secondary and the one at the left the regenerative coil, which is connected in series with the local telephone circuit of the vacuum valve.

Excellent results can be obtained by the use of this receiving tuner. Connected to an aerial 250 feet in length, 30 feet in height, which was shielded by buildings and a hill, the two German stations at Nauen and Hanover have been heard and their signals read except when atmospheric electricity has been severe. On one occasion the Eiffel Tower station in Paris was heard.

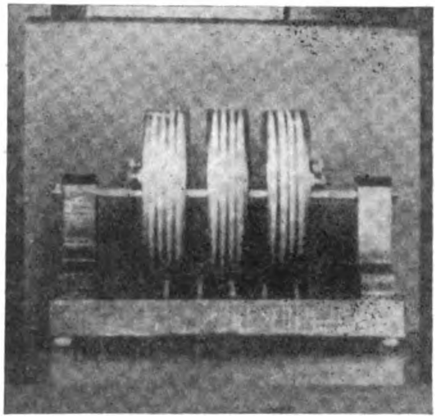
In the construction of this tuner the three cores for the coils should be made first. They are made of wood and are first cut out roughly on the band saw. Then they are turned down upon a lathe. The grooves, which are ¾ of an inch in depth, may be cut with a small round nose chisel. When the grooves are cut the cores should be taken from the lathe and a ¼-inch hole bored through the center of each. Next, the holes where the binding posts are to be mounted should be laid out and drilled. They should be countersunk so that the head of the binding post screw will not protrude below the surface of the wood. The depth of the countersink, of course, depends upon the length of the screw the builder has on hand. Five holes should be drilled along the edge of the disc through which the taps are brought from the coils. These holes may be drilled with a No. 40 drill. This work having been done, the cores are ready for winding.

The winding is easily accomplished by mounting the cores on a lathe. The core can be clamped between two nuts on a threaded piece of ¼-inch rod inserted in the hole at the center of the core and the rod held in the chuck of a lathe. The lathe should be run slowly and the wire fed into the slots by hand. When one slot is completely filled up to within about 1-16 of an inch of the top, a tap should be brought out through one of the holes drilled for that purpose, after which the next slot in order can be wound. A tap is then brought out from this and the next slot filled with wire, taps being brought out from successive windings until all are completed. Particular care should be taken to wind each coil in the same direction. In the tuner which I constructed the No. 30 double cotton-covered B. & S. wire was used.

The base and end supports are now to be made. The base is cut out of a piece of wood and sandpapered and finished. The choice of wood rests with the builder. The end pieces can be laid out on a piece of wood and cut with a hand saw. After this they should be sandpapered and finished and when they are thoroughly dried they may be screwed to the base.

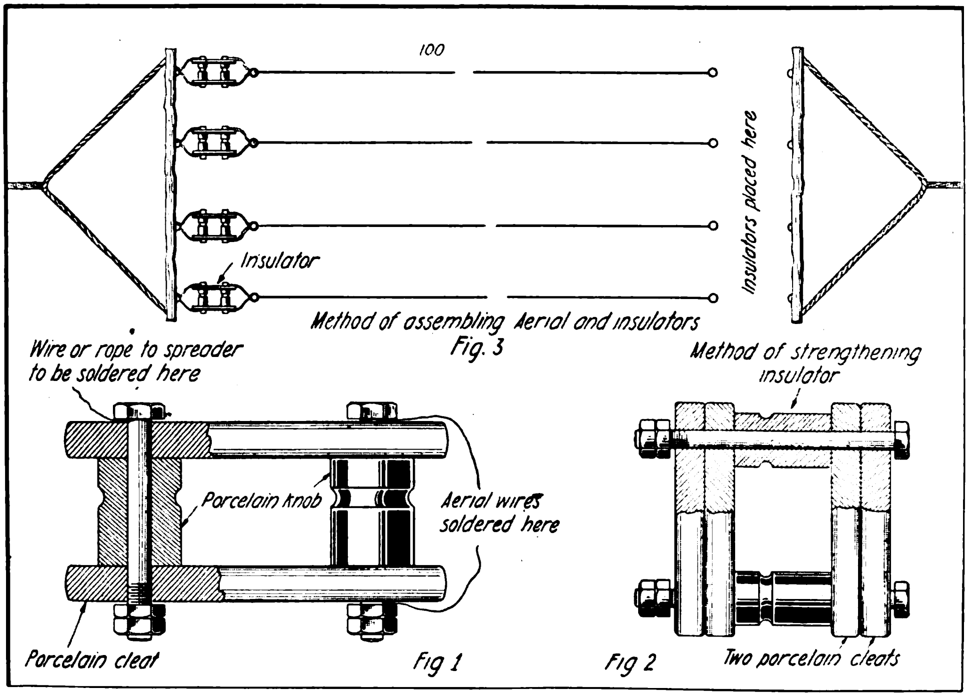
The rod on which the coils slide is of ¼-inch brass, threaded for one-quarter No. 24 brass nuts at the ends. Quarter-inch holes should be bored in the end pieces to mount the rod.

The various parts of the tuner may now be assembled. The taps from the center coil are taken through small holes bored in the base and fastened to the binding posts. These taps keep the center coil from moving along the rod. The binding posts used upon the tuner shown in the drawing were taken from ordinary battery nuts and thumb-nuts. As will be noted, small rubber feet were fastened to the base of the tuner.



Illustration, Third Prize Article

When this apparatus is first connected up, there may be trouble in making the bulb oscillate, but by changing the connections of the coils until the right combination is found the bulb will be found to be a persistent oscillator. Nearly all of the tuning will be done by variable



Drawings, Fourth Prize Article

condensers and by varying the coupling between the coils.

It is the usual custom for one doing radio experimental work to look askance at any apparatus in which the wire is wound in layers, but the results obtained by this tuner would seem to show that in some cases at least the layered winding is not as inefficient as is believed. The writer does not claim to be the originator of this scheme of three coils in inductive relation to each other as this circuit is in use by many other experimenters, but he is positive that if the tuner is carefully made, first class results will be obtained.

F. N. Tompkins, *Rhode Island.*

FOURTH PRIZE, SUBSCRIPTION TO THE WIRELESS AGE

An Aerial Insulator That Will Stand the Test of Service

An aerial insulator can be made from porcelain cleats, knobs and bolts as shown in Figures 1, 2 and 3. Although this insulator when completed will not be as good looking as the manufactured article of to-day, I have found that it will stand much wear and strain and will afford a fair degree of insulation.

To a considerable extent, the drawings are self-explanatory. The builder will note that the only materials required are: One pair of porcelain cleats, two porcelain knobs and two bolts with two nuts on each end.

The insulator as assembled is shown in Figure 1 and as connected in the aerial circuit in Figure 2.

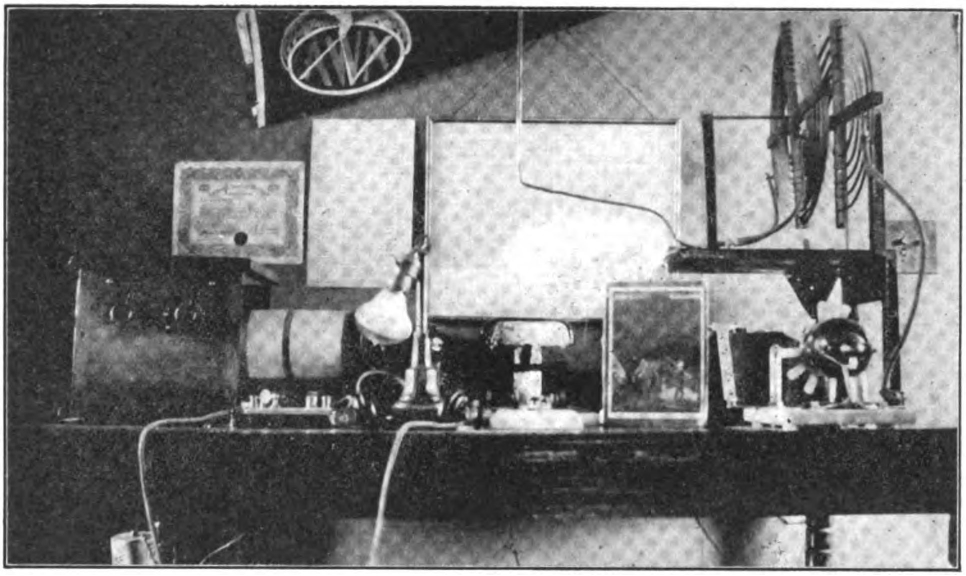
Insulators of this construction have been found strong enough to hold an aerial 100 to 200 feet long, consisting of four wires erected at a height of 100 feet. In fact, they withstood the strain during a sixty-mile an hour windstorm. A larger aerial may be employed by putting the knob between four cleats as shown in Figure 3.

Maurice Stephens Miranda,
New York.

HONORARY MENTION

How the Difficulties of Erecting a Mast Were Overcome

In this article I have presented my plan for erecting a mast. I believe this is one of the hardest problems with



M. M. Dye's station (Honorary Mention Article)

which the amateur has to contend, but I am glad to say that I have at last succeeded in solving it.

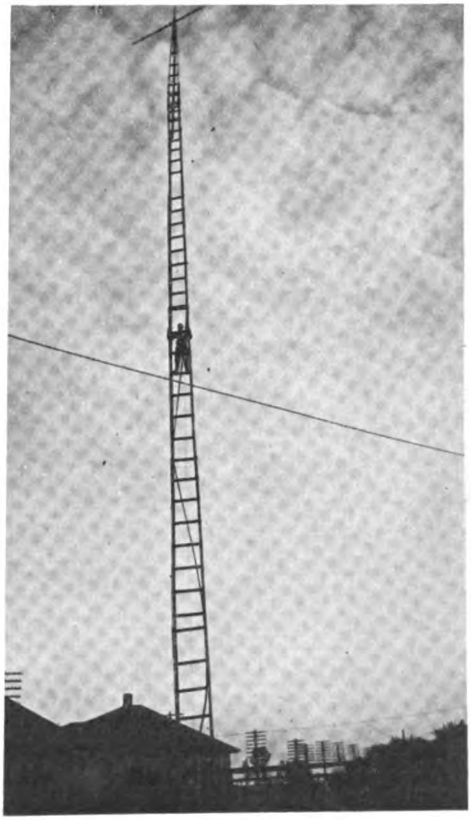
The mast and my radio station are entirely of my own construction. In fact, I raised the mast unaided. To explain briefly, I purchased 150 feet of 1-inch by 3-inch by 18-foot lumber for $2.75, two pounds of No. 8 nails and then constructed six ladders made in 18-foot sections, tapering them from 3 feet at the the bottom to a point at the top.

The mast was raised in the following manner: The first section was put into position and held there by four guys. I then used the top section for a boom and lashed it at the middle and to the top of the first section of the mast. Then I tied the second section to the halyard at the middle and in this manner the successive sections were raised into position and nailed and bolted together.

My mast has six sections, 18 feet in length with a 2-foot lap at the joints. I can go to the top of it without danger and also can extend it to greater height at any time desired. My call letters are 5 BJ.

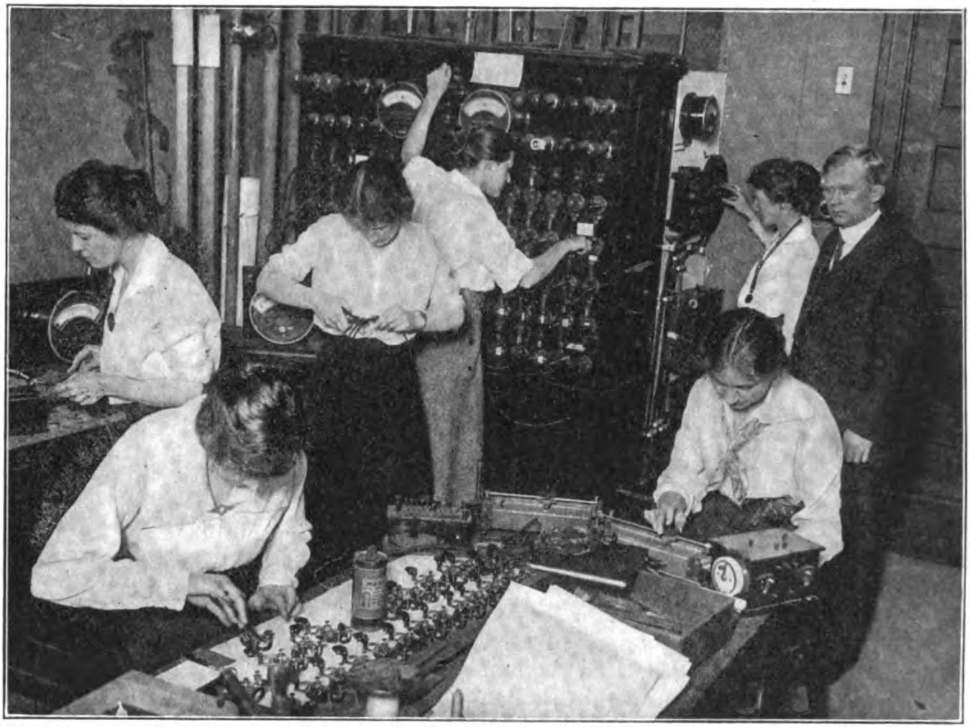
The entire cost of the mast totalled $10. I spent about $4 for the lumber and approximately $6 for the guy wire.

M. M. DYE, *Texas.*



The mast described by M. M. Dye

Woman's Work in Wireless



Girls at work in the laboratory of the wireless school at Hunter College

Plans have been completed for the amalgamation of women's wireless instruction by the organization of a Woman's Division, National Amateur Wireless Association. The self-training courses prepared for THE WIRELESS AGE are to be adopted by the National League for Woman's Service, to be supplemented by the advanced instruction described in this article.

ONE of the results of the entrance of this country into the European war has been the movement to fit women into occupations ordinarily filled by men. It has fallen to the lot of Mrs. Herbert Sumner Owen to supply the nation with women wireless telegraphers and a radio class has been established at Hunter College, New York City, to carry out the plan.

Mrs. Owen had for a considerable time been making attempts to establish a class for women students of wireless. With the change in public events came a distinctly favorable attitude toward the project. At the same time the National League for Women's Service was organized and Mrs. Owen laid her plans before Maude Wetmore, its president. Then the question of obtaining the necessary wireless apparatus was considered. Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, and David Sarnoff, commercial manager of the Marconi Company, were consulted and the wireless class was outfitted without cost. The apparatus is the same in every detail as that used at the Marconi School of Instruction in New York.

Doubt was at first expressed as to the attractiveness of this new field of work to the women themselves. Applications, however, were received in greater numbers than could be accommodated, and the first class, consisting of twenty-five women, was opened on March 12th.

The second-class of thirty was opened on April 2d, a third class April 15th, and a fourth class on May 3d. The sessions take place four evenings a week, from 7:45 to 9:45. Each class has one of the students as a commandant. At twenty minutes to eight the class is called to order by its commandant, the roll is called and the "salute to the flag" is given. The door is then locked and remains so for the entire period, so that the tardy members of the class shall not disturb the earnest workers.

The first hour is given over to technical work, the second hour to code. The class is made up practically of self-supporting women, school teachers, clerks, typists, stenographers. etc. There are a few who are of the leisure class.

In fixing the cost of tuition, it was kept in mind that the usual self-supporting woman gets less than a man doing the same work and has comparatively more responsibilities. She decided that $18 would be advisable as a fee for the course of six months. The class will go right ahead with this work, taking no vacation during the summer months.

"This is primarily a preparedness measure," said Mrs. Owen. "Women have shown what they could do in other fields of work. Even now they are signing up as motor drivers or enlisting as clerks or stenographers in the navy. Why, then, haven't we women wireless operators? They have proved their ability as line telegraphers. Why can't they do their bit in this field of work? There are, I believe, not more than a half dozen women radio operators. In time of war men who could do the work on shipboard or at the outposts would be kept at the little island stations attending to their machines. It was for this purpose that the school was opened—to let girls take the places of experienced men operators and release them for more urgent duty.

"Apart from being a war measure, the field offers great possibilities as a profession. In the fifteen years since Guglielmo Marconi sent his first message across the seas by radio telegraphy, the work has grown by leaps and bounds.

"After our girls complete their course they will take the same examinations that men take in the United State Navy. Compared to other fields now open to women, the prospects are good. They begin as assistants with a salary of $30 a month and board. A regular operator gets $60 and maintenance. This rises to a maximum of $120 a month. In those cases where operators are needed for greatly isolated spots, like the Philippines or the Hawaiian Islands, special inducements are offered. Of course, this will mean a new socialization. People will have to accustom themselves to the idea of a woman working alone, away from her immediate family."

The Advisory Board is composed of the following men: Professor Michael Idvorsky Pupin, president of the Institute of Radio Engineers, and professor of electro mechanics, Columbia University, New York City; Professor Alfred N. Goldsmith, director of the radio laboratory, College of the City of New York; Professor Lewis D. Hill, physics department, Hunter College, New York City; Edward J. Nally, of the Marconi Company; Gano Dunn, past-president of the American Institute of Electrical Engineers and president of the J. G. White Engineering Corporation, and John Stone Stone, vice-chairman Radio Engineers' Committee on National Defense. Mrs. Owen is in constant touch with these men. No step is taken without their approval and endorsement. L. R. Krumm, chief radio inspector of the Bureau of Navigation of the United States; lectures to the class. Professor L. D. Hill has charge of the laboratory work. Otto Redfern, also a member of the United States Navy Radio Bureau, and W. C. Hilliker are code instructors.

Mrs. Herbert Sumner Owen is chairman of the National Committee and also of the New York City committee, which has as its members: Mrs. Goelet Gallatin, Mrs. F. Hovey Allen, Miss A. E. Hickenbottom, dean of Hunter College; Miss Lilian M. Snow, registrar of Hunter College, and Mrs. Samuel Strauss.

David Sarnoff spoke before 100 women of the National Woman's Service League, at 38 West Thirty-ninth Street, New York City, at noon, on March 15th.

"There is nothing mysterious about wireless work, and there is no reason why a woman should not do it as well as a man," he said.

"When war comes, and it is, of course, not far off, a large fleet of small boats or yachts probably will be equipped to constitute the body known as 'the mosquito fleet' of submarine chasers. These will take their orders from shore and larger boats by means of wireless. At first utilization of the amateurs and boys probably will be made. Six months from the beginning of hostilities probably 4,000 to 5,000 vessels will be equipped with wireless.

"If the amateur supply is exhausted, and it is considered feasible, they will be apt to take men out of the telegraph or postal service and send them to sea. Women will come in here to fill vacancies. It is possible they will be sent to sea, if the necessity is great enough and their patriotism and courage permits."

The Marconi School has opened its doors to a limited number of the more advanced students for an intensive course of training. Ten of the young women are now taking advantage of this opportunity. Miss Helen Campbell, Miss Elsie Merz, Miss Elisabeth Rickard, Miss Georgina B. Davids, Miss Nell Van Hook, Miss Elise Von R. Owen, Miss Rebecca Parker, Miss Damian Thompson and Ellen J. Cook are among those enrolled.

From all over the United States and Canada Mrs. Owen found applicants for this radio training. Great care is taken to ascertain that the applicant is a loyal American and the oath of allegiance is administered to each student who becomes a formal member of the class.

While the United States has not specifically signified its need of these women's services, it is an open secret that expert radio operators, men or women, will be much sought after within a year. That these girls realize the opportunity placed within their grasp, has been commented upon by all who have seen the class at work; its enthusiasm, absorbed and concentrated attention, clearly indicates the earnestness of the students.

"I try to impress upon each woman who comes to me as a would-be member of our wireless class, that this is no pink tea," said the chairman of the National Committee. "It is hard, gruelling work. Each student must give me her personal pledge that unless something happens which makes it impossible, she will continue her work for the entire course and go up for her test.

"I think a very interesting and stimulating sidelight was thrown on the attitude of mind of these girls and women by a little happening the other day. It was when the parade of Lexington Day was suggested and we were invited to take part in it. The girls told me that if I wished them to do it they would, but that they hated to take the time from their class work and thought they could not spare it. One girl volunteered to take the part of Pauline Revere in the automobile assigned to our division and the others stayed in their classrooms and worked. Doesn't that seem to express a very fine spirit of earnest service? I tell them in my various minute addresses which I give at intervals, to peg away at their work, that every half hour which they give to concentrated effort they are practically giving to the service of our country. They are preparing in the truest spirit to lay their gift on the altar."

One of Mrs. Owen's deepest convictions is that she can not emphasize too much the necessity of serious work. She says "I have no patience with a slack piece of work. It is time and money wasted for anyone to dabble in wireless. Go the whole way or leave it alone. If you want something easy don't take up wireless, and if you do take it up make it worth while. Nobody will want you unless you are a crackerjack."

She also emphasizes the point that women radio operators will challenge the attention of the public and will be objects of criticism. "Look at poor Jeanette Rankin," she said, "One woman and forty-nine men voted the same way, but because she was a woman in a new position every newspaper in the United States held up to the public attention what she voted, how she voted and why she voted. This is the way it will be with the girls and women who go first into the field of wireless telegraphy. We must be extra good, for a mistake that no one would notice if committed by a boy or man, will be held up to ridicule if made by a woman in a new field. Naturally it is so because women have to show what their capabilities are under these new conditions."

Commander John B. Patton, U. S. N., of the Third District of the United States Naval Reserve, made some informative remarks recently on the subject of woman as wireless operator.

"There is this feature of the problem," he answered, "that after she has taken her preparatory work she may take her three months' confirmation, and if she chooses to remain in the reserve may for four years thereafter collect her retainer of two months' full pay annually without performing any service during the remainder of her enrollment if there is no war. In the event that she is a chief operator she would receive $132 a year."

WOMAN WIRELESS STUDENTS THANK THE MARCONI COMPANY

At a recent session of the Wireless Class for Women, National League for Women's Service, Hunter College, New York City, the following resolution expressing thanks to the Marconi Wireless Telegraph Company of America and Edward J. Nally, its vice-president and general manager, was adopted:

"Whereas, The Marconi Company has most generously presented to the Wireless Class for Women of the National League for Women's Service, the complete necessary equipment of apparatus for their training,

"Be It Resolved: That the undersigned members of the two classes now in session at Hunter College, New York City, offer their heartfelt thanks and keen appreciation of his kindness to Edward J. Nally, vice-president and general manager of the Marconi Company."

The resolution was signed by Mrs. Herbert Sumner Owen, chairman of the National Committee of the League; L. R. Krumm, Government Radio Inspector; Lewis D. Hill and Otto Redfern.

Mr. Nally acknowledged the resolution in a letter to Mrs. Owen which is in part as follows:

"It has been a genuine pleasure, as well as a rare opportunity to unite in the efforts being made by so many patriotic young women in the service of our country, and it is with the sincere hope that what they are doing will result not only in good to our country, but in increased opportunity to our young women that the Marconi Wireless Telegraph Company of America has been glad to co-operate with them and with you. Will you please, also, extend to the instructors, Messrs. Redfern and Krumm and to Prof. Hill of Hunter College, my appreciation and thanks for their untiring efforts, and my congratulations upon the success of their labors."

Police Wireless a Demonstrated Success

Views of Commissioner Woods Regarding the System Installed in the New York Department

Wireless telegraphy, which has won many triumphs on land and sea, has proved its worth in a new field—police work. In New York City Marconi stations have been installed at Police Headquarters in Manhattan and at Police Headquarters in Brooklyn, while a set on the police steamer Patrol facilitates the task of guarding the water-front and the craft in the harbor. The system has now been in operation for several months. That it is a demonstrated success is shown by the following statements by Police Commissioner Arthur Woods of New York regarding the use of the art in the department which he heads:

WIRELESS communication has been proven as dependable as the telephone or telegraph service and it has the added advantage of requiring less protection in time of serious trouble. Wires can be cut and communication stopped unless a large force is on hand as a guard. But if the radio station and its power supply are protected, communication cannot be interrupted.

This opinion is based on the practical application of the art in police work—its usefulness as a measure of protection in the event of flood, fire and earthquake, as a means of saving life and property, and in detecting and preventing crime.

Many things are possible in New York, and some of them spell "trouble." It was with this fact in mind that wireless was established in the Police Department. The San Francisco earthquake, the Baltimore fire, the Galveston flood—these disasters all provided illustrations of the value of an indestructible means of communication.

Great and unavoidable calamities visit every large city. Social unrest and economic stress cause some of them, while others are brought about by natural causes, such as earthquakes and floods. And the perils of great fires should not be forgotten. It is during such times that it is of vital import that order be maintained and that life and property be guarded. The responsibility for this rests upon the police and the wireless is an invaluable aid to them during these periods.

Perhaps no better illustration of the worth of the art could be pictured than its application during such disasters when it becomes necessary for policemen in large numbers to be dispatched to the points of danger and the means of communication commonly used has failed. By transmitting orders by radio, policemen can be summoned from headquarters to the scene of disaster even though the danger points be located at a considerable distance from headquarters. Meanwhile the officials at headquarters can keep constantly in touch with policemen at the danger points by means of wireless and give them the necessary orders and instructions.

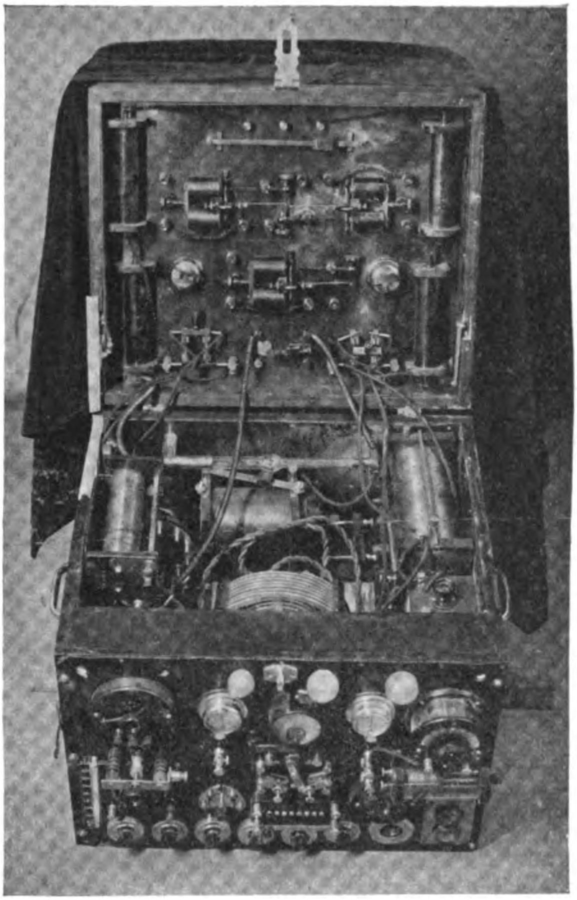
The introduction of wireless in the police department followed the appointment of a "Preparedness Committee" made up of the various police inspectors of the city. Consequent upon the instructions they received to recommend measures for the conduct of the police in time of emergency, a wireless telegraph department was established at headquarters and a class in wireless formed under the direction of Sergeant Charles E. Pearce, who is in charge of the police radio work.

A I K. W. quenched spark gap wireless set was installed on the fifth floor and an aerial was placed on the roof. Interest in wireless among the men in the department was aroused, their diligence in studying the art being shown by the fact that all of the thirty members of the police class have passed the examinations qualifying them to obtain Government licenses to operate stations of any class.

The putting down of mutiny and disorder on the craft in waters near New York is a phase of police work which wireless facilitates. In the past the chief difficulty connected with this work was the inability to quickly dispatch word of the events to headquarters, However, wireless has now been installed on the police steamer Patrol and headquarters is enabled to keep in communication with the steamer while she is cruising about. For instance, Police Headquarters in Manhattan received word recently that two coal barges were drifting, a menace to navigation, in the Hudson River off Fort Lee. Headquarters quickly notified the Patrol by wireless and the latter towed the barges out of the path of other craft. There is the instance also of the steamer D. L. Crowe going ashore on Romer Shoals, the sending out of an S O S by the stranded craft, the reception of the appeal by the station at headquarters, the dispatching of the police steamer Patrol to the rescue and the notification of the Brooklyn Navy Yard, which also sent a revenue cutter to the Crowe's aid.

At some future time arrangements might be made whereby wireless plants, owned or co-operating with Police Department authorities, surrounding towns and cities could aid in the capture of criminals and the recovery of stolen property. If, to illustrate, a stolen automobile has been traced to New Jersey a description of the machine could be broadcasted by wireless and relayed throughout that state.

I have cited only a few of the examples of the use to which the Police Department has put wireless. The future holds many possibilities, among them being the establishment of a wireless service in each of the borough headquarters of the city and the various police inspection districts. And, in my opinion, the efficiency of the nation's police would be increased by the establishment of a wireless police service in each city of the United States.



The wireless apparatus which a swindler used as a "money-making" box

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Following the arrest of a German in New York City recently, detectives took possession of a small black box which the prisoner in his representations to his dupes claimed would reproduce American bank notes placed in it for a day. When Sergeant Pearce, examined the apparatus he recognized it as parts of a portable wireless set capable of receiving messages from places as far distant from New York as Germany.

The set is made up of apparatus of American manufacture, similar to that in many amateur stations. Wireless men said that it could pick up messages from points 5,000 miles away with the proper connections made and the substitution of several missing parts.

An interesting feature of the case was the illustration it brought out of the progress made in police work. It is likely that the seizure of the apparatus by policemen five years ago would have resulted in considerable perplexity regarding its nature. However, the installation of wireless in the department and the training received by its members in radio work has given policemen knowledge of the art which they are able to put to use in various ways.

THE LAST VOYAGE OF THE SIBIRIA

(*Concluded from page* 637)

Walmer had not been idle, but their efforts to reach us were futile. The seas were as threatening as ever at ebb tide, but the ship had sunk farther into the sands and rode somewhat easier. One boat reached a point within a few hundred yards of the Sibiria, but was compelled to put back. We were quite cheerful for a time, despite the failure of life savers to effect a rescue, but in the evening when the tide began to come in and the ship gradually sank lower and lower in the sands some of the hardiest among the ship's company began to lose heart.

How desperate our plight was can be judged from the fact that a wireless message had been sent a few hours before to Dover, saying that if the lifeboats did not reach us that night there would not be any need for them in the morning. As the night wore on some of the destroyers near us began to play their searchlights on the ship and the surrounding waters. But we seemed as remote from safety as before until one of the engineers, who had been peering anxiously out of a port hole in the smoking room, where we had sought refuge, yelled that a lifeboat was in sight. There was a rush to the embrasures, and, in the glare of the searchlights, we could distinguish a small craft within a short distance of the ship. The rescuers had a difficult struggle to reach us, but their boat was of the self-bailing type and it battled valiantly with the seas. Notwithstanding, it took them almost an hour to get a rope to us. Then, as the waters tossed the boat toward the ship, the marooned men, one by one, jumped into the former craft.

But the danger was not past yet, for in this small boat sixty-eight men were crowded. The shipping of one of the waves would have capsized it, and so the next half hour was not without thrills, although the sense of danger was alleviated in a measure by the knowledge that we were in communication with the destroyer by means of signals in the Morse code. Senior Marconi Operator Blackstone transmitted the flashlight messages from the life-boats, using a pocket torch, and after we had cleared the sands a patrol boat was ordered to tow us to Kingsdowne, where we landed.

The Sibiria broke in two several days afterward, dying as she had lived—a stormy petrel to the last.

RACES TO PORT AFTER COLLISION

The Ward line freighter Sagua, with Marconi Operator F. A. Tierney in the wireless cabin, came into collision with the collier Binghamton off Barnegat, N. J., early in the morning of March 19th. Several vessels responded to the appeals for aid sent out by the Sagua and those on the freighter, with the exception of the captain, the wireless operator, mate, cadet officer and purser were taken off the damaged craft.

How Amateurs Are Responding to the Call to Arms

Organization of the Army Reserve Signal Corps

HOW well the National Amateur Wireless Association is carrying out its various aims is shown by the developments from day to day in the movement for national defense. One of the indirect outgrowths of the activities of the Association was the organiztion of the Army Reserve Signal Corps, a radio company, at a meeting in Chicago, conducted by Colonel Samuel Reber and Captain John C. Dillon, of the United States radio service. Colonel Reber is a member of the National Advisory Board of Vice-Presidents of the National Amateur Wireless Association.

When the idea of the National Amateur Wireless Association took practical form it was announced by the acting president of the Association that it would be possible to train a reserve force of competent wireless operators selected from the ranks of amateurs and that those ambitious to join the third line of defence could do so. Attention was called to the fact that in the event of an invasion of this country by an enemy the work of the wireless signaling corps would be of the utmost importance. The movement for preparedness among those active in wireless was given country-wide publicity through articles in THE WIRELESS AGE. Numerous military organizations were then established throughout the country in which members trained in accordance with army signal corps regulations.

The Chicago instance mentioned above is typical of the response. Twenty-two young men showed their sympathy with the movement by enrolling as members of the Army Reserve Signal Corps in Chicago. At the meeting, which was held in the Federal Building, Colonel Reber and Captain Dillon outlined the duties of the members of the company, pointing out what would be required of them both in time of war and during peace. About sixty persons attended the meeting. The first person to enroll in the company was Walter V. Benson. Others who joined were:

J. Lawrence Adams, William H. Ahrensfeld, Barney Baker, Albert Campbell, Charles E. Duncan, Edward P. Gerold, Richard J. Grant, J. N. Hinckey, James Hill, Sr., George V. Hillock, Robert E. Jelinek, D. V. Johnson, Manfred B. Krebs, Gustave Lov, M. R. McNeill, Irley Morrison, Joseph J. Novak, Charles G. Paxton, Henry M. Paynter, Millard Peachar and Raymond H. Perl.

There are many prospective members of the Corps. These include Edwin Werlein, Miron Pearsal, N. Miller, Harry Goldberg, Robert Gorrie, W. E. Carlson, L. E. Otwer, Robert Laidlaw, Raymond Eling, F. Fisher, John Born, L. Peterson, H. D. Stever, E. Brandt and J. E. Clark.

The Association announced recently that it would send its members, upon request, a form indicating the requirements and conditions for preliminary registration for possible Government service to be filled out and returned to the Association. The form will then be forwarded to the proper authorities in Washington for filing until such time as the service of the applicant may be needed.

Following this announcement, Joseph J. Novak, whose name is among those enrolled in the Army Reserve Signal Corps, wrote to the Association: "Noting your 'Call for Service,' . . . I wish to state that I, being a member of the N. A. W. A. . . . have already joined . . . the Army Reserve Signal Corps."

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

L. G. R., Buffalo, N. Y.:

The book entitled "Experimental Wireless Stations," by Philip Edelmann, will give you complete instructions for wiring up an amateur transmitting and receiving apparatus. Pertinent advice on this point is also given in the book "How to Conduct a Radio Club." Copies of these books can be purchased from the Wireless Press, Inc., 42 Broad Street, New York City.

* * *

N. C. D., Norfolk, Va., inquires:

Ques.—(1) I frequently hear the statement that the aerial circuit of a wireless station oscillates at a frequency between 30,000 and 1,000,000 cycles per second. Will you kindly explain how it is possible to obtain a current of such enormous frequency?

Ans.—(1) The statement is quite correct; in fact, frequencies of 1,000,000 and 500,000 cycles per second correspond to the 300 and 600-meter wave respectively. That is to say, when the current oscillates in the antenna circuit at a frequency of 500,000 cycles per second, the length of each wave radiated by the aerial will be 600 meters or approximately 2,000 feet. The length of the wave in any case, can be obtained by merely dividing the velocity of electricity, which is 300,000,000 meters per second, by the frequency of the antenna current. Bear in mind that each cycle of alternating current radiates one complete wave. Current of this frequency is obtained by periodically charging and discharging a Leyden jar through a coil of wire across a spark gap.

Current at frequencies up to 100,000 cycles per second can be obtained by means of high speed alternators or by means of a battery of vacuum tube bulb oscillators. The simplest method, however, of generating radio-frequency oscillations is to charge and discharge a Leyden jar from 300 to 1,000 times per second.

Ques.—(2) How is the frequency of the antenna oscillations determined?

Ans.—(2) By measuring the effective inductance, effective capacity and resistance of the antenna circuit. Usually the factor of resistance is ignored and the circuit treated as if it were practically a perfect conductor.

If the effective capacity and inductance of a simple open oscillator are known, we may use the following formula for determining the wave-length:

$$\lambda = 38 \times \sqrt{L \times C}$$

Where L = the inductance of the antenna circuit in centimeters, and C = the capacity in microfarads.

If a localized inductance is inserted at the base of the aerial, a certain correction factor must be introduced in this formula, which is fully embraced in the September, October and November, 1916, issues of THE WIRELESS AGE.

* * *

J. T., Lewiston, Mont.:

It would be well for you and other inquirers along this line to fully understand that a coil of wire does not possess wave-length in the sense which you have placed upon it. Of course any tuning coil has a natural time period of oscillation as an open circuit oscillator which can easily be measured, but to say a coil, for instance, has a wave-length of 5,000 meters and when connected in series with antenna circuit of 1,000 meters, the circuit will respond to 6,000 meters, is incorrect.

The possible wave-length adjustment of a circuit of this kind cannot be determined unless the inductance and capacity of the antenna system in series with which the coil is to be connected are definitely known.

* * *

D. N. R., St. Louis, Mo., inquires:

Ques.—(1) To what extent is the Marconi magnetic detector used as a commercial receiver for a ship?

Ans.—(1) It is used in the great majority of ship stations of the Marconi International Marine Communication Company, Ltd.

Ques.—(2) How does the sensitiveness of this detector compare with ordinary crystal rectifiers?

Ans.—(2) For waves of about 2,500 meters, this detector compares favorably with the best crystals of carborundum, but for the shorter wave-lengths, the carborundum rectifier is distinctly more sensitive.

* * *

D. S. H., Chicago, Ill., inquires:

Ques.—(1) Where can I obtain a historical

recount of the early development of wireless telegraphy, both in the United States and abroad? I desire this material for a college thesis.

Ans.—(1)—A historical resumé of the early development of radio telegraphy will be found in the "Year Book of Wireless Telegraphy and Telephony," on sale by the Wireless Press, Inc.

A fairly complete recount of the early work is also given in Chapter IX of the "Textbook of Wireless Telegraphy," by Rupert Stanley.

"The Principles of Electric Wave Telegraphy," by Dr. J. A. Fleming, sets forth this phase of the wireless situation in detail.

* * *

A. C. R., San Francisco, Cal., inquires:

Ques.—(1) I am a Marconi operator on one of the vessels equipped with a 2 K. W. 500 cycle panel type of transmitter, and I do not clearly understand how it is possible to construct a panel transmitter in a way that will permit the length of the radiated wave to be changed by merely throwing a switch handle. It has always been my understanding that in order to secure the maximum degree of efficiency with any type of transmitter, it is necessary to change the coupling for each change of wave-length. Am I correct in this?

Ans.—(1) It is not only necessary to change the coupling of the oscillation transformer for each change of wave-length, but this is actually done with the modern Marconi panel transmitter. However, instead of changing the coupling by shifting the relative positions of the primary and secondary windings of the oscillation transformer, the necessary change for each wave-length is effected by cutting in or out turns at the secondary winding. It has the same effect as moving the primary away from the secondary or vice versa. The correct number of turns for the proper coupling is found by experiment, but through skill obtained by practice, the inspector is enabled to tune a set of this type within one-half hour.

Ques.—(2) Why is a small reactance coil connected in series with the power circuits on this transmitting set?

Ans.—(2) To reduce the primary power to prevent arcing and excessive voltage at the secondary when the capacity of the secondary condenser is reduced. You, of course, understand that in the 300-meter position of this set only three jars are connected in parallel, but for 600 meters six jars are connected in parallel.

* * *

A. R. F., Schenectady, N. Y.:

Ques.—(1) Kindly explain the difference between spark frequency and oscillation frequency of a wireless telegraph transmitter?

Ans.—(1) The spark frequency of a transmitter is the term applied to designate the number of sparks discharging across the gap per second of time, and to a large extent it is a function of the frequency of the alternator which is charging the condenser; but in the case of an ordinary plain gap it is also governed by the length of the discharge gap, the capacity of the condenser, the voltage of the transformer and the design of the spark electrodes.

The oscillation frequency, however, is the term applied to the radio-frequent oscillations flowing through the condenser discharge circuit during the time of a spark discharge. The frequency of the oscillations in this circuit is governed strictly by the inductance, capacity and resistance thereof. Ignoring the resistance of the circuit, the frequency of the oscillations in such a circuit can be obtained from the following formula:

$$N = \frac{5,033,000}{\sqrt{L\ C}}$$

Ques.—(2) Is it possible for an amateur to construct an arc transmitter operated from 500-volt direct current, and would the fluctuations of the current on a trolley line prevent its practical operation?

Ans.—(2) An amateur could easily construct an arc transmitter, but it is found that ordinarily they do not operate efficiently on wave-lengths below 3,000 meters; consequently you would have to secure a special Government license even in times of peace for the operation of this set, and it is doubtful whether such permission would be granted.

Undamped short-wave transmitters have not proved a great success so far, although several systems which produce sparks in excess of 20,000 per second have been found to operate efficiently on the shorter wavelengths

* * *

F. R. A., Boston, Mass., inquires:

Ques.—(1) What is meant by the circular mil?

Ans.—(1) In wire measure, a mil is 1/1000th of an inch. The area of a round wire one mil in diameter is one circular mil. If a wire is three mils in diameter or .003 of an inch, then it has a circular mil area of nine circular mils.

* * *

A. D. R., Cleveland, O., inquires:

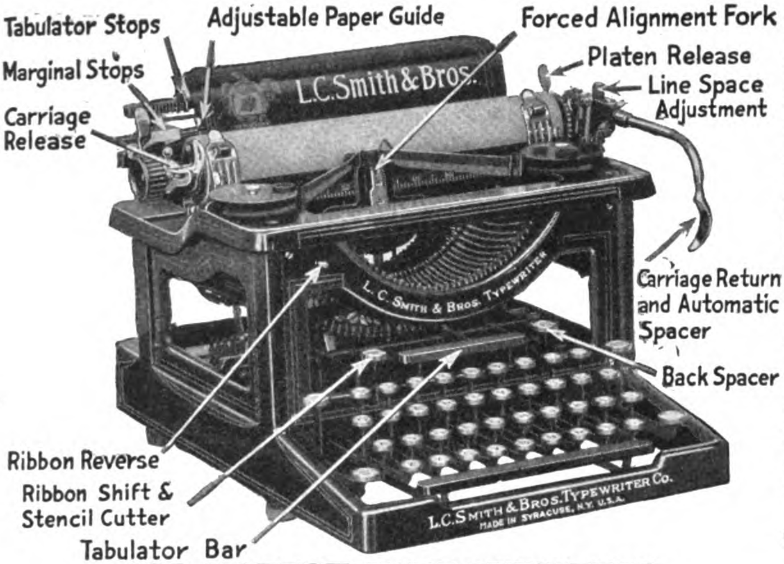
Ques.—(1) Where can I obtain a complete explanation of the Baldwin ampliphone which has been used so much of late in wireless telegraph work?

Ans.—(1) A complete description of the function of this telephone is given in the book entitled "Practical Wireless Telegraphy," copies of which can be purchased from the Wireless Press, Inc., 42 Broad Street, New York City.

* * *

N. I. D., Covington, Ky, inquires:

Ques—(1) In what respect does the so-called crystal crystaloi detector differ from ordinary crystal rectifiers?



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Ans.(1) It merely consists of a mixture of filings sealed up in a space between two metallic lugs. By means of a buzzer tester attached to the detector circuit, the filings are made to cohere and by several tests a sensitive point of rectification is found. Unlike ordinary crystal detectors this one requires a stopping condenser of variable capacity and if one of this type is provided, better results will be obtained.

Ques.—(2) What is the relative sensitiveness of this detector?

Ans.—(2) We have no data at hand. Some amateurs report very good results, but we have nothing to show that the detector is more sensitive than ordinary galena or silicon rectifiers.

Ques.—(3) What is the natural wave-length of an aerial, 90 feet in length and 40 feet in height, consisting of four wires spaced about 2½ feet apart?

Ans.—(3) The natural wave-length of this aerial is approximately 155 meters.

Ques.—(4) What is the wave-length of a four-wire aerial spaced 2½ feet apart, the lead-ins being attached to the center and the flat top portion being 240 feet in length and 30 feet in height?

Ans.—(4) The natural wave-length of this aerial is about 210 meters.

* * *

A. B. G., inquires:

Ques.—(1) How can I test the relative sensitiveness of various oscillation detectors?

Ans.—(1) The sensitiveness of a number of detectors can be compared by means of a shunt box, *i. e.* a calibrated resistance connected in shunt with the head telephone. The receiving detector can be connected in the secondary winding of a standard receiving circuit and the secondary inductance placed in inductive relation to the coil of a wave-meter. If the wave-meter is set into excitation by a buzzer, sounds will be produced in the head telephone, depending upon the adjustment of the receiving detector. By carefully regulating the coupling between the wave-meter and the secondary coil, very accurate resonant adjustment can be obtained.

With the buzzer in operation, the resistance in shunt with the head telephone is gradually reduced until the signals just disappear and if the resistance of a telephone is known, its resistance can be added to that of the shunt (for the least audible signals) and the result divided by the resistance of the shunt. The resultant figure will indicate the increase of strength of signal over the least audible signals in the head telephone. With the coil of the receiving set and the wave-meter in the same position, other receiving detectors can be inserted in the circuit and if the buzzer is heard with lesser values of resistance in shunt with the head telephone it, of course, indicates that the second detector under test is more sensitive than the first one. The ratio of sensibility can be obtained from the ratio of the relative audibility factors.

E. W. T., Sidney, Ohio, inquires:

Ques.—(1) What is the wave-length of an aerial, 85 feet in length, 47 feet in height at one end and 30 feet in height at the other?

Ans.—(1) The natural wave-length is approximately 150 meters.

Ques.—(2) Do you favor connecting the terminals of the primary winding of a receiving tuner across an anchor spark gap connected in series with the earth lead?

Ans.—(2) This connection is feasible if a rugged oscillation detector is employed. such as the Marconi magnetic or a crystal of carborundum. Care must be taken to keep the gap at a minimum length to prevent excessive potentials being set up in the primary winding.

Ques.—(3) Please state the maximum possible height of an aerial that will permit transmission at the wave-length of 200 meters.

Ans.—(3) If a coil of approximately 10,000 centimeters is connected in series at the base to act as the secondary winding of an oscillation transformer, the antenna may consist of four wires, spaced 2½ feet apart, with a height of 100 feet and flat top length of 40 feet, or it may be 80 feet in height and 60 feet in length.

An aerial 60 feet in height with a flat top portion 80 feet in length will have a natural wave-length, with a small coil connected in series at the base, of approximately 200 meters.

* * *

R. W., Portsmouth, O.:

Ans.—(1) You can probably restore your vacuum valve bulb to normal operating conditions by increasing the voltage of the local battery. It may be that you have a defective cell in the high voltage circuit and it would be well to test them individually with a voltmeter.

Ans.—(2) Regarding the regenerative short wave receiver described in the April issue of The Wireless Age: You are advised that the note of the incoming signals will be distorted under certain adjustments, but a fair degree of amplification also can be obtained without destroying the normal note of the spark transmitter.

* * *

S. W. S., Jefferson, Ohio:

You are advised to purchase a copy of the book, "How to Conduct a Radio Club," which contains complete wiring diagrams for the connection of two multi-point switches to vary the inductance of the primary winding of a receiving transformer.

The receiving tuner you have described is not exactly well proportioned. We believe you would obtain better results by winding the primary with No. 24 S. S. C. wire and the secondary with No. 30 or No. 32 S. S. C. wire. If the tubes you mention are wound with this size of wire, the tuner will easily respond to waves up to 4,000 meters.

The loading coil you mention would, of course, increase the wave-length to a certain extent, but just how much would depend upon the dimensions of the aerial.

Your diagram of connections showing the position of the inductance taps is not altogether approved, because it does not permit sufficient closeness of adjustment. One of the switches on the primary inductance should be connected to the first ten or fifteen individual turns of the coil. The second switch should be connected in groups of ten or fifteen turns throughout the entire length of the winding.

* * *

W. W., Wichita, Kan.;

We cannot undertake to answer queries regarding the origin of mysterious wireless signals, nor the call letters of stations which are not listed in the International List or in the Government Call List.

Your second and third queries are fully answered in the book, "How to Conduct a Radio Club." It is found that the average receiving tuner gives the best response when the variable condenser in shunt to the secondary winding is set near to zero values of capacity. This affords a maximum voltage across the terminals of the crystal detector and therefore gives greater response. The reason you cannot use larger values of capacity at the secondary condenser is probably due to the fact that your tuning coil already has sufficient dimensions for resonance with the incoming signal; hence the addition of capacity across the secondary turns merely throws the circuit out of resonance and therefore decreases the strength of the incoming signal.

In the book, "How to Conduct a Radio Club," the dimensions of an inductance coil for an amateur's wave-meter in connection with a Mesco variable condenser are given. We cannot undertake to calibrate for you a wave-meter made up of a condenser and coil of other dimensions.

* * *

D. B. M. C. G., Aurora, Ill., inquires:

Ques.—(1) Please state the approximate wave-length, inductance and capacity of an inverted L aerial 100 feet in length and 75 feet in height, consisting of four wires of No. 14 copper wire spaced about 2 feet apart.

Ans.—(1) The capacity of the aerial is approximately .0004 microfarad, the inductance about 76,000 centimeters and the natural wave-length close to 220 meters.

Ques.—(2) Could the wave-length of this aerial be reduced to 200 meters by use of a series condenser?

Ans.—(2) A series condenser consisting of three plates of glass, 8 inches by 8 inches, covered with tinfoil, 6 inches by 6 inches, all plates being connected in series, would reduce the wave-length of this aerial to approximately 200 meters if the antenna inductance were properly adjusted.

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

To operate a ¼ or ½ K. W. set at the wave-length of 300 meters, we advise you to employ a condenser of .008 or .01 microfarad. Each plate of glass 8 inches by 8 inches, covered with tinfoil, 6 inches by 6 inches, will have an approximate capacity of .0005 microfarad. Therefore twenty of these plates connected in parallel will have a total capacity of .01 microfarad. If a series parallel connection is required, you would need eighty plates, forty connected in parallel in each bank and each bank connected in series.

To operate a ¾ or 1 K. W. set at the wave-length of 600 meters, the capacity of the condenser should be about .015 microfarad and you will, therefore, require thirty of the small plates connected in parallel, or for a series parallel connection 120 plates. Sixty plates should be connected in parallel in each bank and the two banks should be connected in series.

* * *

W. T. R., Weymouth, Mass., inquires:

Ques.—(1) Would it pay me for the trouble to purchase a second-hand automobile spark coil for transmitting purposes?

Ans.—(1) The secondary output of the average coil of this type will not permit a transmitting range in excess of four or five miles.

Ques.—(2) Would you advise the use of a condenser in connection with this spark coil? What should be its dimensions?

Ans.—(2) Lacking knowledge of the secondary voltage, it will be difficult to answer, but ordinarily a condenser of .003 or .005 microfarad will be quite sufficient.

* * *

E. S., South Norwalk, Conn.:

It is quite likely that the power line which you mention will cause some interference with the operation of your receiving set.

Ordinarily, for receiving purposes, two wires will give as good results as four wires.

The average amateur's transmitting aerial has four wires, spaced about 2½ feet apart.

Complete data for the natural wave-length of wireless aerials appeared in the November, 1915, issue of THE WIRELESS AGE. Note carefully the wave-length curves given in that issue.

* * *

J. R. H., Winnipeg, Manitoba, inquires:

Ques.—(1) I have intended to construct a wave-meter for a considerable time past, but as I have no means of calibrating one I should like to know if it is possible to construct a wave-meter which does not require calibration.

Ans.—(1) In the book, "How to Conduct a Radio Club," the dimensions of an inductance coil which is to be fitted to a certain type of Mesco variable condenser are given. If the dimensions of the coil given in this book are carefully duplicated, the wave-meter will not require calibration. A complete table of wave-lengths, which will be accurate within two or

three per cent., is supplied. This will be sufficient for the average amateur's requirements.

* * *

C. T. P., Stryker, O.:

The current output of the average crowfoot gravity cell is rather low and consequently you would require a great number of cells connected in series parallel to operate an induction coil. A battery of the Edison-Lalande type would give a greater current output and would be more satisfactory for the operation of low-powered apparatus.

You, of course, understand that amateur stations throughout the United States will be closed during the war, and consequently an answer to the remainder of your queries would be of little value for the present.

The "Military Signal Corps Manual," by Major J. Andrew White, will be placed on sale by the Wireless Press, Inc., within two or three weeks.

* * *

G. D. T., Ala.:

Regarding your query about aluminum electrodes for the Clapp-Eastham transmitters: We do not know where these can be purchased.

* * *

C. D. M., Port Lauderdale, Fla.:

Your calculations regarding the wave-length of an aerial are totally wrong. You cannot state that a loading coil has a certain wave-length in meters, say, for example, 300 meters, and that when connected in series with an antenna of 150 meters, the possible wave-length adjustment will be 450 meters.

The effect of any loading coil upon a given antenna circuit depends upon the inductance and capacity of the aerial, and unless these values are known, the possible wave-length adjustment cannot be calculated in advance.

You would do well to study the book, "How to Conduct a Radio Club," which will aid you in solving the problem set forth in your communication.

* * *

N. G., Whitewright, Tex.:

Your 1½-inch spark coil can be operated from a 110-volt alternating current by connecting a small sized electrolytic interruptor in series. You may have to insert a ballast resistance in series so that the coil will not draw excessive current.

The book, "How to Conduct a Radio Club," contains complete data for calculating the wave-length of your aerial and also gives dimensions of an oscillation transformer suitable for a 200-meter transmitting set.

* * *

F. T. H., Waterbury, Conn.:

Your aerial, 120 feet in length with an average height of 50 feet, has a natural wave-length of 205 meters, and if you will attach the lead-in wires to the center instead of to the end of the flat top, you can work this aerial at the wave-length of 200 meters without a series condenser.

A half-pint Leyden jar should give good results with a 1-inch spark coil provided the length of the spark gap is properly adjusted.

The average small spark coil gives a better sending range by connecting the spark gap directly in series with the antenna. Many amateurs, however, contradict this statement and say that they have been able to transmit farther with an oscillation transformer. Our experience, however, has been the reverse.

In many localities the Government authorities (in times of peace) will not permit an amateur set to be operated with the spark gap in series with the antenna. An oscillation transformer is positively required.

* * *

C. F. M., Detroit, Mich.:

Mere knowledge of the number of feet of wire included in a tuning coil does not give us sufficient data from which to make a calculation of the possible wave-length adjustment of your receiving set.

The buzzing sound you hear is undoubtedly due to induction from nearby power lines.

* * *

R. E. G., Lowell, Mass., inquires:

Ques.—(1) Where can I purchase a vacuum pump and glass battery jars of large size?

Ans.—(1) They can be purchased from Eimer & Amend, 211 Third Avenue, New York City.

* * *

J. H., Sharon, Pa.:

The aerial you describe has a natural wave-length of slightly less than 200 meters, and consequently you will not require a series condenser.

The regenerative receiver is the type of vacuum valve circuit where the local telephone circuit is coupled back to the secondary winding of the receiving transformer through a small oscillation transformer. Connected in this manner the oscillations of radio frequency repeated in the local telephone circuit by the vacuum valve are reinforced upon the grid circuit through a small oscillation transformer and increased strength of signals is thus obtained. The circuits for this receiver are fully described in the book, "How to Conduct a Radio Club."

* * *

J. W., Dorchester, Mass.:

The actual receiving range of a given receiving station is in any case best determined by experiment. There are so many conditions effecting the reception of radio signals and the possible range that it will be difficult to answer your query directly.

In time of peace, when you are permitted to use your receiving station, you should tune up to stations within range and look up the stations corresponding to their call letters in the Government Call List. In this way, after a week or two of experimenting, you will be enabled to determine the range of your apparatus.

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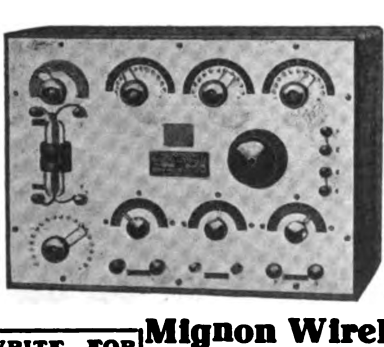

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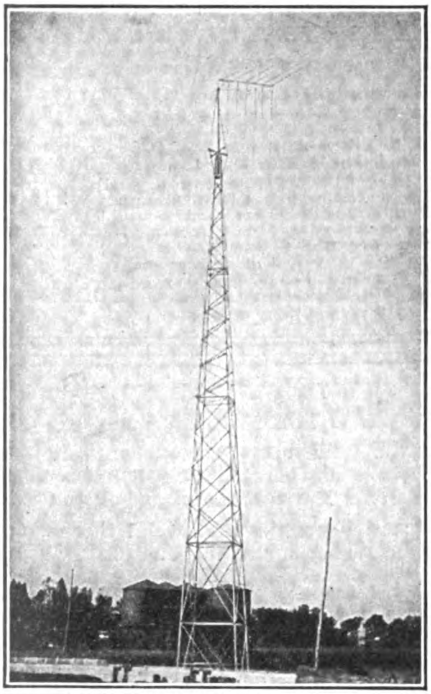

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