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THE WIRELESS AGE

November, 1916

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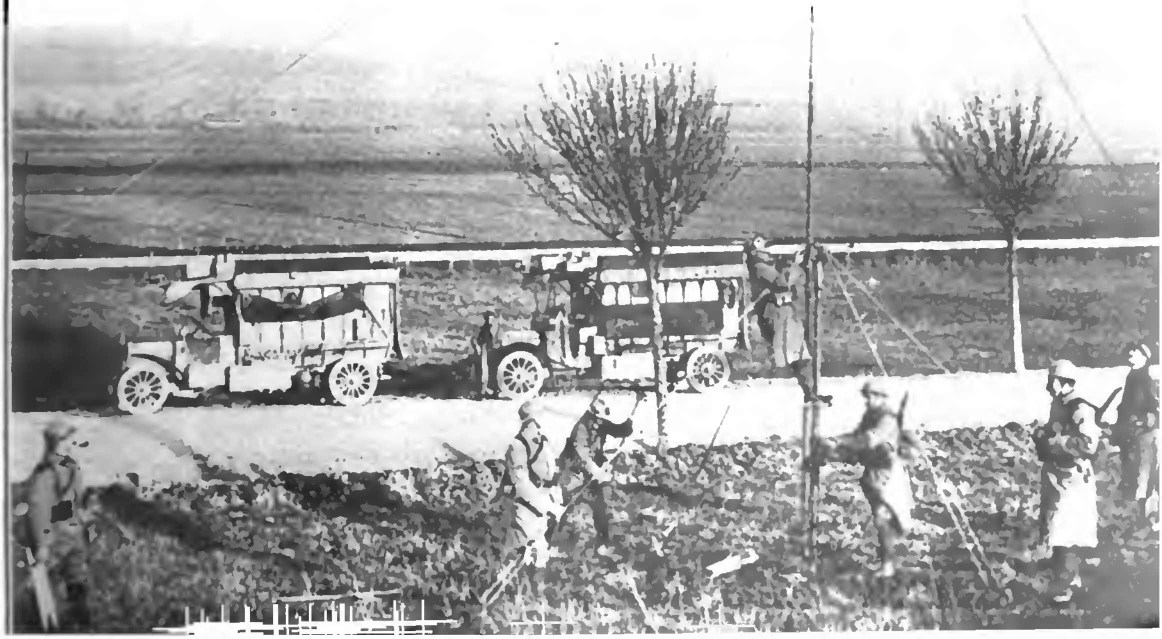

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THE WIRELESS AGE

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.

NOVEMBER, 1916

Nation Wide Relay for N. A. W. A. Members

Under Direction of National Chief of Relay Communications Members are to Send Messages Broadcast from President Wilson as a Preparedness Test

MEMBERS of the National Amateur Wireless Association are to take the lead in a nation-wide preparedness test to be held on October 25, 26, and 27. Under the leadership of W. H. Kirwan (9XE) of Rock Island, Ill., who has been appointed National Chief of Relay Communications of the N. A. W. A., the amateurs will be organized into a relay chain to broadcast throughout the country messages from President Wilson. The great organization of licensed amateur stations under N. A. W. A. control will be placed at the disposal of the National Chief of Relay Communications and selections will be made from the list to establish relay points.

The entire country will be divided into circles whose diameter will be the sending radius of the stations officially appointed, the circles overlapping and connecting up all the strategic points. The messages will be received in each city and town, whereupon each operator will file a copy of the message with the postmaster and receive a receipt which will insure him credit for the work.

The national relay chief's preliminary announcement to members states:

"Aside from the novelty of the thing, the plan has many advantages. I have served in the navy, and I am a strong believer in preparedness.

"The sending of the president's messages will serve to get every amateur station in the country tuned up and ready for work. Many of them are ready now.

"Think what an advantage it would be in case of invasion to have all of these stations ready to receive the first word of the intent.

"The diameter of each of the circles into which I have divided the entire United States is the sending range of the sender. Every circle overlaps, and the best station has been picked out as the most strategic point. In time of need, messages could be delivered to either the mayor of each town or the nearest fort.

"Among the stations which have been enlisted in the president's campaign work, are the big stations at the Illinois Watch Co., Springfield, Ill., Cornell, Harvard, the Georgia School of Technology at Atlanta, Iowa State University, Ames College, Washington University at St. Louis, University of North Dakota, University of Michigan, Catholic College at Corteau, La., and the University of Pittsburgh.

"Pittsburgh will work its new 5 k. w. set donated recently by Andrew Carnegie. Arrangements have also been made through this station and others for sending out during the winter Thanksgiving and New Year greetings from the city officials of Davenport to those all over the country."

Full details of the plan will appear in the forthcoming issue of the Association's Monthly Service Bulletin. Meanwhile, members whose stations have not yet been listed as relay points, may communicate with the New York headquarters of the N. A. W. A. or direct with the National Chief of Relay Communications, 508 Best Building, Rock Island, Ill., giving full particulars of equipment and other qualifications.

TALK OF WIRELESS AT TELEGRAPHERS' REUNION

MEN prominent in various walks of life attended the thirty-fifth annual reunion of the Old Time Telegraphers and Historical Association and the fifty-fifth anniversary of the Society of the United States Military Telegraph Corps at the Hotel Astor on September 26th, 27th and 28th. Letters of regret from Andrew Carnegie, president of the Old Time Telegraphers and Historical Association; Theodore N. Vail, Edward Lind Morse, Thomas A. Edison and others were read at the banquet which was held on the evening of September 28th. Edward J. Nally, vice-president and general manager of the Marconi Wireless Telegraph Company of America, a vice-president of the Old Time Telegraphers and Historical Association and chairman of the Committee on Banquet, was unable to be present, having sailed for England on September 1st.

John Bottomley, vice-president and secretary and treasurer of the Marconi Company, was among the speakers at the banquet, at which Melville E. Stone acted as toastmaster. Mr. Bottomley related the early history of wireless and called attention to the fact that Great Britain had recently passed a law requiring every vessel of 3,000 tons burden or over to carry a full radio equipment.

"It is estimated that in Great Britain alone nearly 2,000 ships not now equipped will in future carry wireless installations," said Mr. Bottomley. "Similar laws, or, at any rate, regulations, have been passed in Italy, and, it is believed, will be passed by all other nations."

In regard to modern developments in wireless, Mr. Bottomley said: "High-power stations have been erected in America, England, Italy, and Germany, and daily communication is had between San Francisco and Hawaii, Nova Scotia and England, New York and Germany; in fact, the wireless system has been the only one open for communication with the German Empire since very shortly after the outbreak of the present war.

"In addition to the communications above mentioned, which are being actually carried on today, tests are being made between the Marconi station near Honolulu, Hawaii, and the Japanese Government station at Funabashi, near Tokio. Test signals have been heard and messages passed between them, but, at the present moment, the stations are not yet ready for commercial business. In the immediate future, however, the United States will undoubtedly be linked up with the Orient by means of the Marconi wireless.

"Reference might also be made to the high-power stations which have been recently erected by the Marconi Company at Belmar and New Brunswick, these being duplex sending and receiving stations for the purpose of communicating with England, and also the high-power stations at Chatham and Marion, Mass., which have been erected for the purpose of communicating with Norway. These stations were ready for business at the opening of the great war, but as the corresponding foreign stations have been kept in use by the respective governments, no actual business has yet been accomplished. Extensive tests are now in progress, and as a result I may safely say that as soon as matters quiet down on the other side, communication both with England and Norway will be opened up with the general public in the regular commercial way."

David Homer Bates, who as a telegrapher sat at the side of Abraham Lincoln to receive the news of the battle of Bull Run, referred to wireless in his address delivered on the first day of the reunion.

"What is the meaning of our reunion?" he said. "Is it not that we may renew old friendships of our early days, make new ones, recount the marvelous achievements of the telegraph and its blood sister, the Marconi wireless, and its first cousin, the telephone, and get a new grip on life?"

Those attending the reunion journeyed to the Edison laboratory at West Orange, N. J., on September 27th, where Mr. Edison addressed them by telegraph.

Lee Lemon, superintendent of the Trans-Oceanic Division of the Marconi Wireless Telegraph Company of America, and William E. Vansize, patent attorney of the company, attended events incidental to the reunion.

Court Awards Vacuum Valve Decision to Marconi

Controversy Over Fleming Valve and de Forest Audion Decided by Judge Mayer and de Forest Declared an Infringer

THE contention of the Marconi Wireless Telegraph Company of America that the deForest Radio Telephone and Telegraph Company had infringed its rights to the sole use and ownership of the patent covering the Fleming detector was sustained on September 20 in an opinion written by Judge Julius M. Mayer of the Federal District Court, of New York.

Judge Mayer's opinion made clear at the outset the court's conception of theory versus fact.

"Whatever differences may exist between men of science," it read, "in respect of the theories by which they account for the movement and action of the unseen forces about which so much has been testified and argued in this case, the solution of the points of the controversy with a single exception is not difficult. This, because courts, in an art of this kind, place their decisions upon things demonstrable and cannot speculate as to theories in regard to which there is not a common agreement among recognized authorities."

It then pointed out that in endeavoring to resist the Marconi attack, the deForest interests had proceeded on the theory that beginning with his parent patent No. 979275 antedating Fleming, deForest gradually developed his conception until finally it found practical exemplification in the two so-called three electrode "Audion" devices as to which plaintiff had confessed judgment. "In line with this plan of defense," notes the opinion, "defendants have elaborately built up an unsteady theoretical structure and upon this have superimposed an observatory from which they can see in the mind's eye only that which they call 'Audion' action."

The Judge then considered the vacuum valves as detectors, and the various forms of receiving devices which preceded them. "As the practical radio art developed, there was a constant effort to improve the detector in three directions; first and most important, in sensitiveness to received signals; secondly, in reliability, and thirdly, in ease of manipulation by the receiving operator.

"There were many types of detectors prior to Fleming, the most useful of which were known as the coherer, the microphone, the magnetic, the electrolytic and the crystal.

"Some detectors, such as that of Hertz and the hot wire barreter of Fessenden, were never of any commercial utility and may be disregarded.

"The crystal detector, particularly because of ruggedness of material, is still in extensive use but, as is generally accepted and was fully demonstrated in the court room, it is somewhat unsatisfactory by the reason of the necessity of taking time to feel around, as it were, sometimes for a sensitive point and sometimes for the best point on the crystal and the liability that such a point may be destroyed or its sensitiveness impaired by a strong incoming signal, by static or by the local sending station.

Fleming Used Incandescent Lamp First

"These criticisms or defects of one kind or another in the detectors prior to Fleming—or since, for that matter—will be fully appreciated when it is realized that efficiency in this art consists in attaining accuracy and quickness in reception of signals as well as distance, whether the radio message is across the ocean from one merchant to another, from a vessel in distress calling for help from land or sea, or from a naval officer to the ships under his command.

"With the state of the art as briefly outlined, *supra,* John Ambrose Fleming disclosed the incandescent lamp detector. While the United States patent application was filed April 19, 1905, the effective date is that of the British specification filed November 16, 1904.

"Fleming is a British scientist of the highest standing and, as appears from his patent and his papers read before learned societies, is and long has been recognized as a man of major accomplishments with the ability to make clear what he intends to convey.

"Stripped of technical phraseology, what Fleming did was to take the well known Edison hot and cold electrode incandescent electric lamp and use it for a detector of radio signals. No one had disclosed nor even intimated the possibility of this use of a device then long known in another art. Cohering filings, magnets, electrolytes and sensitive crystals, *at that time,* failed to give any hint of the utility in this art of the Edison lamp."

Clearly a Valuable Invention

The opinion then discusses the theoretical considerations which led to Fleming's conclusions respecting the invention's utility as a detector, summarizing as follows:

"Whether right or wrong in his theory, the result of Fleming's invention was to give the art a new valuable and easily obtainable detector, which has gone into important commercial use. This Fleming detector is highly sensitive, quickly adjusted by an operator of even inferior skill and only momentarily disturbed by static or strong signals. The thoroughness and earnestness of this litigation is its most significant testimonial. Nothing in the prior art urged by defendants in negation of invention calls for extended discussion. The Tesla patent (No. 645,-576) and the Fessenden patents (Nos. 706,742; 706,743 and 706,744) were far removed from the incandescent lamp and were commercially useless; and, nothing could be learned for this purpose from the Valbreuze and Zehnder tubes.

"Rectifiers of low frequency oscillations, such as those of Wehnelt and Cooper-Hewitt, taught nothing. These are rectifiers for commercial power frequencies and it was not common knowledge, as of Fleming's date, that rectifiers of low frequency oscillations would rectify radio waves nor is it a fact that all rectifiers of low frequencies are likewise rectifiers of radio high frequencies.

"In the absence of a well accepted theory of operation which needed merely some physical embodiment and, in the absence also in the art of the physical device itself, at a time when men of great skill were constantly endeavoring to bring forth an advance in this branch of the art, the contribution of Fleming was clearly invention and is entitled to liberal interpretation and consideration—unless impeded by deForest."

In relation to the application for the parent patent of deForest No. 979,275, of November 4, 1904, it was decided by Judge Mayer that "nowhere is there a suggestion of an incandescent electrode. On the contrary, in the specification and the drawings it is entirely apparent that deForest pointed out only what the layman understands as heating gas." A review of the claim made is followed by this conclusion: "Translated into plain English, this meant, "I will try to make the gas conductive between two electrodes by heating it to the dissociating point."

"It was attempted to read incandescence into the specification or rather to infer much that later knowledge has taught, but incandescence had long been a word of art and Fleming had no trouble in using it either in his specification or his Royal Society paper. Why not deForest? Merely because the incandescent lamp detector was the farthest from his thoughts."

Entitled To Use Local Battery

In considering what Judge Mayer termed, "the only substantial question in the case—the infringement claimed against defendants," the opinion cites the claims of the Fleming patent: a broad claim for the incandescent lamp as a radio detector and another covering its application to a radio system; *i. e.,* a local circuit containing means for detecting a continuous (direct) current such as a telephone or galvanometer and means of impressing high frequency oscillations on the detector, such as the secondary of the oscillation transformer.

"Fleming's theory, as has already been stated, was that of rectification," the decision notes, "while defendants account for the action of their 'Audion' on the theory that it is a telephone relay or, in other words, that its products are alternating currents of 'Audio' frequency and of the local energy and not of the 'input' energy.

"As a result of these differences, the effect and relation of the local battery was one of the sharply contested points in controversy.

"It was satisfactorily proved that for some reason not yet understood, incandescent lamps possess idiosyncrasies of operation, as demonstrated by a batch of a dozen lamps of identical dimensions made of identical stock, pumped at the same time for a vacuum and sealed at the same time.

"Of these, some worked best at the negative end; *i. e.*, without a battery, some with a small amount of battery, some with a battery equal to the battery for lighting the filament and some with a battery in addition to that used for lighting the filament.

"While, with care and time, lamps could be selected which would work best without a local battery, such a course would obviously be foolish commercially and unnecessary, when a simple and well known means could be employed to utilize all the lamps, whatever their idiosyncrasies. This means was a local battery, and a potentiometer, whereby a varying local potential may be applied to the lamps. The potentiometer is a resistance connected across the lighting battery of the detector so that any fraction of the lighting battery may be tapped off and applied to the local circuit. The local battery is used to bring the lamp detector to the sensitive point of its characteristic curve and the potentiometer is the simple and effective device which, varying the local battery, accomplishes this task.

"Nearly all prior art detectors were used in this way—the coherer of Marconi and Lodge; the microphone of Hughes and Branley; the electrolytic of Fessenden, Vreeland and others and the crystal of Bose.

"The use of the local battery to locate the sensitive point on the characteristic curve, was well known and accepted as of Fleming's time and, as appears by his 1905 lecture, was fully understood by him.

"Plaintiff is undoubtedly entitled to use the Fleming detector with a well known instrumentality and, therefore, to employ the variable local battery; for practically all the prior art detectors required local batteries to locate the operating points. Plaintiff is likewise entitled to use the Fleming device in the ordinary detector circuits of the prior art. The circuits of the Marconi patent No. 627,650 are the specific circuits which plaintiff has used and the modern operative Fleming device has simply been substituted for the coherer in old and familiar circuits."

De Forest Experiments Followed Fleming Articles

Several pages in the opinion are devoted to comparison of the P. N. Type Audion deForest Detector with the Fleming valve detector and it is noted that both sides agreed the deForest two-element and three-element bulbs operate on the same principle. It is also, in Judge Mayer's opinion, "established with reasonable certainty" that the deForest device, in order to operate, must have a heated electrode connected to the negative terminal of the local battery. Reviewing the theory that the local battery changes the mode of operation of the incandescent lamp from rectifier to relay, Judge Mayer observed that in many experiments and much testimony it had not been satisfactorily demonstrated. The opinion continues:

"In order to reconcile the explanation of the action of the deForest grid detector with the language of deForest's earlier patents so as to work out the idea that deForest's two and three electrode detectors were simply the logical development of an original thought, Pickard advanced the theory that the action of the deForest grid was by ionization by impact and, therefore, that it was necessary to have a local battery to impel electrons at a high speed on their journey of succeeding collisions.

"But this theory is shattered or at least impaired by the tests which showed that when ionization by impact occurred the detector showed a blue glow and stopped operation. If anything was shown in this regard it was rather, as plaintiff contends, that the device operates in spite of and not because of ionization by impact."

In awarding the decision to the Marconi Company the opinion observes:

"Within the limits of an opinion it is, of course, impossible to analyze at length a mass of experiments, tests and theses and an infinity of detail necessarily involved in the testimony of experts in an art of this kind; but * * * * * * the physical facts all support plaintiff's claims.

"Here, as is so often the case in law suits, resort is had to the story of events and the outcroppings of human nature.

"DeForest had long been proceeding on a theory different from that of Fleming. Having read Fleming's article, he began to experiment with the incandescent lamp. He probably doubted its efficacy at first but within a very short space of time—perhaps a week, perhaps a month—he changed his mind and, discovering that Fleming was right, wrote his solicitor, after he had filed his application for No. 824,637 that the 'new receiver is the best yet.' Thereafter, he used the language of the incandescent lamp and in an address on October 20, 1906, before the American Institute of Electrical Engineers, really described fundamentally the Fleming lamp detector although using phraseology which has since become Audion vocabulary. Thus, the physical ocular fact is that in the alleged infringing P. N. device, the Fleming detector and not the Bunsen burner is used and the broad Claim No. 1 of the Fleming patent is infringed, precisely the same as if a patented crystal has been placed in some old or new type of circuit with a local battery—such, for instance, as the Weagant and Armstrong circuits."

Many Sets Ordered from American Marconi Co.

THE rapidly increasing importance of wireless telegraphy in war time is illustrated in the announcement made recently by the Marconi Wireless Telegraph Company of America that an order had been received from the English Marconi Company, asking for urgent delivery of 250 wireless sets of the cargo vessel type. These equipments are of American design and similar to those recently ordered from the American Marconi Company by Belgium and Italy.

It is announced also that the United States Navy has just ordered two direction finders for installation on the U. S. S. Pennsylvania and the U. S. S. Birmingham. This apparatus is used as a wireless compass in determining the direction and latitude and longitude of wireless stations, also as detector of the approach of vessels in fog. A high-power wireless telegraph set has also been ordered by the Navy for a shore station, and four special type receiving sets are under construction, together with twenty-nine transformers for high-power equipments.

Additional wireless telegraph equipment required under the new Navy program includes seventy-five aeroplane sets and ninety small powered equipments. Orders will soon be placed, it is understood, for 126 receiving sets for long and short distance work and forty additional sending and receiving equipments of varying ranges.

The United States Signal Corps has given the Marconi Company orders to assemble at its factory ten 2 k. w. radio tractor equipments. The tractors will include complete sending, receiving, aerial and counterpoise devices.

An order has also been received from the Italian Marconi Company calling for delivery of fifty sets of ¼ k. w. power.

The Raid of the U-53

Quick Response to Wireless Appeals of Six Ships Sunk by German Submarine off the New England Coast

WIRELESS telegraphy, conveying a message that the German submarine raider U-53 had sunk six steamships off the New England coast on October 9, brought the first news that underseas craft warfare had been brought to the shores of the United States. It was wireless also that started a flotilla of United States destroyers and the American-Hawaiian liner Kansan steaming full speed to the rescue of the passengers and seamen of the vessels torpedoed by the submarine. All of the 216 passengers and seamen on the sunken vessels were saved.

The U-53, after a short stay at Newport, left on October 7, having accomplished her ostensible mission of delivering a letter for Ambassador von Bernstorff. The first intimation that her visit to American waters was not entirely a peaceful one was contained in a wireless message from Captain Smith of the Kansan, asking why a German submarine had halted him on October 8 near the Nantucket Shoals lightship. Captain Smith, after stating his nationality, had been permitted to continue his voyage.

Then came other wireless messages telling of the attack on the British freighter West Point, the British freighter Strathdene, the Norwegian freighter Christian Knudsen, the British passenger liner Stephano, the Dutch freighter Bloomersdijk, and the British freighter Kingston. Following these messages, seventeen destroyers set out from Newport to the rescue. The Jarvis was the first boat to get away and the others followed. These were the Drayton, the Ericsson, the O'Brien, the Benham, the Cassin, the McCall, the Balch, the Porter, the Fanning, the Paulding, the Windlow, the Aylwin, the Cushing, the Cummings, the Conyngham and the Melville. Soon after the destroyers had left the bay a wireless came from the Nantucket Shoal Lightship saying that twenty of the crew from the Strathdean had been taken on board the lightship. Admiral Gleaves, who was keeping in touch with the fleet by wireless from the radio room of the flagship, directed the destroyer nearest the lightship to take those rescued on board and transfer them to the Melville. While the work of rescue was proceeding a series of messages from the commanders of the destroyers was received. In them was contained every incident and every bit of information that the commanders could obtain.

The first call sent by Oscar B. Hanson, Marconi operator on the liner Stephano, which was steaming from Newfoundland ports to New York, read as follows:

"S O S. Am being torpedoed. American passengers."

One of the destroyers flashed the following in reply:

"We are coming to your assistance."

Hanson said that he had received a wireless message previous to the torpedoeing of the Stephano, saying that the West Point had been attacked by a submarine. The Stephano's officers paid little attention to the message as the liner was steaming away from the position named as the scene of the disaster. Then another wireless was received, this message having been relayed from the West Point itself. Afterward came word from the Kansan to the effect that she intended to change her course and go to the aid of the West Point. Later, Hanson said, the Kansan was sighted by the Stephano and the latter was again asked if she were going to the aid of the West Point. A short time afterward the Stephano was attacked.

Marconi Operator Arthur Gray of the Christian Knudsen, in describing his experience to a correspondent in Newport, said:

"We heard the sound of firing some time before the submarine hove in sight,

(Continued on page 97)

DEATH OF GENERAL ZABRISKIE

Brigadier General Andrew C. Zabriskie, commanding the Junior American Guard, with which the National Amateur Wireless Association is affiliated in military signal corps work, died on September 15 at his country home, Blithewood, at Barrytown-on-Hudson. At the funeral services held in New York, the escort of honor was composed of members of the Junior American Guard, the 71st Regiment, N. G. N. Y., and the Veteran Corps of Artillery. The escort accompanied the funeral cortege to the grave at Woodlawn Cemetery and closed the services with a salute from the firing squad and the blowing of "Taps" from the bugle.

Among the officers accompanying the escort of honor were Major F. L. V. Hoppin, Adjutant General, First Brigade New York Militia; Major William H. Elliott, Adjutant General, Junior American Guard, and Major J. Andrew White, Chief Signal Officer.

General Zabriskie was born in New York City sixty-four years ago, and was a son of the late Christian A. Zabriskie and Mrs. Sarah J. Titus Zabriskie. He was a member of one of this country's oldest families, being a descendant of Albrecht Zaborowsky, who landed from the ship Fox in 1662. He was educated in private schools and was graduated from the School of Mines, Columbia University. He became a member of the Seventh Regiment, N. Y. N. G., in 1873. Afterward he served as inspector of rifle practice for the Seventy-first in which he was captain of Co. C. He resigned from the regiment in 1897. He took considerable interest in politics in Dutchess County, being a member of the Democratic State Executive Committee and chairman of the Dutchess County Board of Supervisors.

Mr. Zabriskie was well known in charitable work and was vice-president of the Hospital and House of Rest for Consumptives, a trustee of the Sheltering Arms and of the Parochial Fund of the Protestant Episcopal Church and president of the Board of Trustees of the Church of St. John the Evangelist at Barrytown-on-Hudson. He was one of New York City's largest real estate owners, spending much of his time at his offices at No. 52 Beaver street, caring for his estate. He was a director of the Poughkeepsie Trust and the Bonner

Brig.-Gen. Andrew C. Zabriskie

Brick Companies. For ten years he was president of the American Numismatic and Archæological Society. He was a member of the Union, Metropolitan, Army and Navy and other clubs.

CLUB GIVES LAWN FÊTE

The Mahoning Valley Radio League, Niles, Ohio, gave a lawn fête on August 5 for the purpose of raising funds for the purchase of instruments. A complete sending and receiving set was in operation and an undamped receptor of the "beat" circuit was also employed.

The Phantom Call

A Fiction Story

By Magda Leigh

IF you have never come into the fog off the California coast you don't know what fog is! Man, you can reach out and get solid handfuls of it! Well—almost!

And the s. s. Amador had had three steady days of it. Lord, but we were a restless lot! and we hugged the haze-filled warmth of the smoking-room and the cheer of its clinking glasses. If it hadn't been for the Purser, with his never-failing stock of yarns, I don't know what would have become of us.

But now, the Purser was busy. We were nearing the Golden Gate, and he had his manifests and other papers to get into shape. When we had tired of cards and the eternal war arguments, we found ourselves sadly missing our entertaining companion.

It just happened that I looked up in time to catch a peculiar little twinkle in the eyes of the ship's doctor—a dark, silent man, named Brooks, who invariably sat with us, listening to our chatter from his special corner of the settee, but saying little, if anything.

"If it's funny, for the love of heaven, tell it to us, Doctor!" I burst out. The eternal fog-whistle was beginning to wear on my nerves.

The ship's doctor looked over at me, mildly surprised, his brown eyes, however, still twinkling.

"If *what's* funny?" he asked, quietly.

"Whatever you're thinking of, that makes you laugh with your eyes!" I snapped in reply.

"I was thinking of humanity." He paused. Then he added, quizzically: "And as for that, I don't know that there's anything funnier than humanity—certainly there's nothing more interesting!"

We looked at him, speculatively. "In your business, you must have an almighty good chance to study it!" Van Norden exclaimed.

"Ha!" The brown eyes snapped. "Every case I have is a human document. And out here, at sea, I find my cases so much more interesting," he continued, thoughtfully. "There seems to be something, out here, that plays Merry Ned with most people's characters. The sea *humanizes* people. It makes 'em unfold, blossom, branch out. Where I, perhaps, touch only lightly on the personal end of a case, ashore, out here I have the full document from cover to cover, with preface, illustrations and appendices thrown in!"

"Good heavens!" Van Norden stared. "Do you mean to say you are an enthusiast over seafaring life?"

"Why not?" the Doctor smiled amiably. "I care for nothing so much as studying the human in the raw—and that's how I get him, out here!"

"How delightful!" Greene murmured, appreciatively. "We've heard the Skipper calling this a 'dog's life'; we've listened to the Chief's lament about the amount of coal this 'old hooker' consumes; we've condoled with the Mate because he swears he can't keep his paint clean, what with kids with pencils and men with penknives; and we've even sat up nights with Sparks, and helped him cuss static! At last," he grinned at us, "we meet that rare bird—a seafaring man who likes seafaring!"

We all laughed and turned to the doctor. There was, however, no answering smile. He was, for the moment serious.

"Static!" he murmured. "It's a queer, uncanny thing—static!" His voice dropped, as if he were talking to himself. "It's what finished young DeWitte—static that smashed his conscience with its phantom call. That was a human document worth reading!"

And then, to our utter amazement, he squared away and spun us the yarn.

Before I came over to this coast, I was on one of the big fruit steamers out of New York to Santa Marta—the s. s. Seramalac, a white beauty of a ship, known along South street as the "Rose of the Fleet."

I had been on her only two trips when the events of which I shall tell you occurred.

I don't mingle much with the crew, as a rule, and never know much about it unless something special is called to my attention. Sometimes, though, one is unable to keep clear of gossip, and it was on my first trip that I heard various snatches of the ship's talk about Philip DeWitte, our senior wireless man.

DeWitte interested me, as soon as ever I first saw him. I took to spending a goodish bit of time with him, up in his lofty wireless quarters. One could run up, unobserved, and spend many quiet, uninterrupted moments, smoking and listening to the big, singing spark. It was a good spot for man-sized talk.

DeWitte was almost as new to the ship as I was. He had made only one trip previous to my arrival. But most of the officers knew him, as he had been junior operator at the big Santa Marta wireless station, for three years, and used to come over aboard ship, when she was in port, to pilfer the latest magazines and newspapers.

You know, every ship is a little village unto itself. And it has its village gossip. There being so many men in the crew—and only one or two women—why, the lord have mercy upon the souls of all stewardesses!

The Seramalac carried two stewardesses: Mrs. Dunphy, a dear old soul who had been with the company since the year Noah launched his ark; and a little, slender, dark-eyed beauty known as —well, we'll call her "Miss Chase."

Any port steward who ships a woman as pretty as Aileen Chase ought to be sacked for incompetency—or locked up for madness!

Aileen Chase had joined the Seramalac a trip before DeWitte. They tell me there was hysteria among the crew that trip—every man-jack falling over himself to make friends with the Little Stewardess. And she would have none of their friendliness. A curt "Good morning!" was the extent of her cordiality.

But when DeWitte joined the Seramalac it was different. DeWitte had evidently known Miss Chase before, and they were seen talking together, many a time, serious of face and tone. Of course, tongues began to wag. But neither Miss Chase nor DeWitte paid the slightest attention to this. They went about their duties, quietly and unobtrusively.

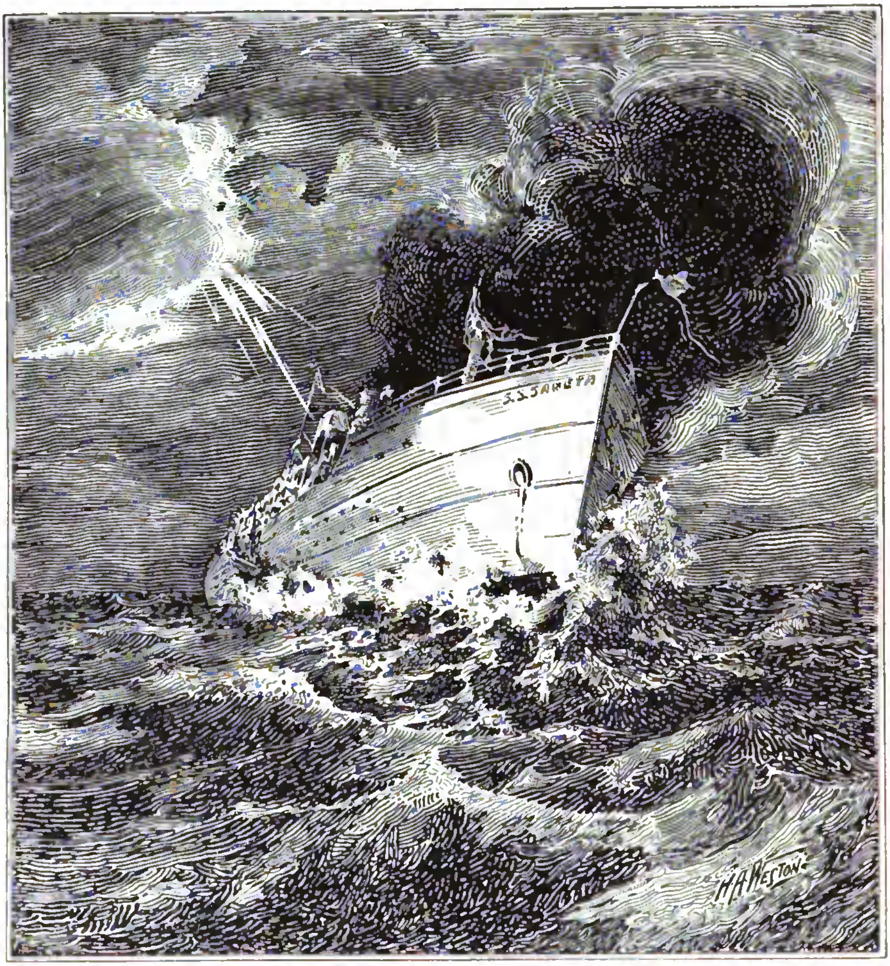
The trip I joined the Seramalac was a bad 'un! It was hurricane season, however, so this was not unexpected.

We hadn't been more than a day out, when gossip began to reach me about DeWitte and his former senior at Santa Marta, Bob Wilkins. Wilkins, it seemed, was now on the s. s. Saneta, one of the 5,000-ton ships belonging to our company, running out of New Orleans. No one knew why the Santa Marta station had changed operators, but gossip had it that DeWitte and—oh, the usual, eternal triangle business! Anyway, there was little friendship left between the two men, and the New York office had been wise enough to put them on different runs.

The Seramalac touched at Jamaica, Panama, Cartagena, Puerto Columbia and Santa Marta—returning over the same route. It was a fine trip of about twenty-two days. The Saneta called at Panama, too, so that once in a while the two ships stood a chance of meeting in port, though that happened but once in a blue moon. They were in wireless communication a good deal, though, and down in the Caribbean, where their courses finally converged, they were even within sight of each other at times.

We had unusually fine weather, I remember, that first trip, until we were well into the Caribbean. And then the big sparks from our stations at Swan Island, Cape San Antonio, Bocas del Toro, Limon and Santa Marta snapped out a circle of warnings. There was a hurricane chasing its tail around 'way down in the direction of Colon, and we were heading for it. Then Saneta, northbound, was heading for it, too.

As our junior wireless man had had a touch of fever, since we left King-



The poor old Sancta had been quite given up. Not a sign of her had been found by any of the many ships sailing over her course. Her name was struck off the list of the company's fleet, and the Hydrographic Bulletin gave notice that her wireless letters, "KDK," had been rescinded ton, DeWitte was standing an extra watch or so. I left the hospital steward (yes, we carried them on the Seramalac) on watch, and made my way up to the Wireless Room from the Dispensary, for a look-see at the Junior, who had refused to go out of his own quarters. His fever was higher than it should have been, so I told DeWitte he'd have the honor of nursing the wireless through the storm.

"We pass the Saneta, soon," he answered, wearily, "and that means extra close attention, in case she has any messages for the Skipper."

I knew I should be needed below, so bade him a good-night, and made my way back to the Dispensary.

Lord! What a night! The Seramalac, with all the strength of her 9,000 tons, fought sea and gale for hours. There isn't any need for me to describe a hurricane to you gentlemen. You've all been through them. They're—well, they're hell let loose!

The women passengers kept a host of us busy, for most of them were hysterical with fear, as well as deathly seasick. Several times during the night I was working with Miss Chase. I noticed a peculiar expression in her eyes—an expression of most dreadful anxiety. I wondered if she were worrying about DeWitte, up in his storm-beaten quarters, or whether she was just plain scared. I'd find her looking over her shoulder toward the port hole of whatever room we were in, with a strangely shrinking manner. I made up my mind she'd have to be talked out of that state, pronto, for those crazy women needed to see faces filled with confidence about them or there would be panic. Hurricanes try the stanchest of souls!

As we were passing along an alley, going from one room to another, I turned to her and said:

"There isn't any cause for fear, Miss Chase. The Seramalac is a staunch ship and has gone through worse gales than this. Think of the Saneta just now—only a little over half as big as the Seramalac!"

And then I stopped, for the woman turned deathly white and clutched my arm, staring into my face with eyes of horror.

"The Saneta—! Is she—is she—in this?"

"Why, yes," I answered, puzzled by her manner. "She's not very far from us, if she's on her course."

Her eyes closed sharply and she swayed. I put my hand out and steadied her. Frankly, I could have shaken her. I suppose we seafaring men become rather brutal toward seafaring women. We think they should have no emotions—they should become mere serving machines.

Miss Chase's next question came with an apparent effort.

"Who is on watch in the wireless room?"

"DeWitte," I answered, shortly. "Craig is ill."

She looked up at me as if she wished to say something, but her lips moved soundlessly. I saw her shake her head slowly, from side to side, and noticed that her shoulders drooped as if I had placed a too-heavy burden upon them.

But we were needed, and I took her firmly by the arm and guided her to the room where one of our patients lay suffering.

When we had made the rounds, once, I turned to the Little Stewardess and spoke sharply.

"This is an all-night job for us. You've got to brace up or you'll cave in. Now, I want you to come to the Dispensary and get something. Your nerves are not in shape for this kind of a night, at all."

She followed me meekly enough, the two of us staggering and stumbling to the rolling and pitching of the big, storm-driven ship.

It was morning before I could get a chance to run up and see Craig again, and I wondered how DeWitte had stood the dreadful siege of an all-night watch, in that weather.

I entered the wireless room and then came to an abrupt pause. I had expected to find DeWitte badly used up, but I had not expected to find him like he was. The man was a ghost. His face was white and drawn hideously, and his hands, fumbling with the key, were trembling like a drunkard's.

"Here, man!" I said quickly. "You're all in! This is a deuce of a mess you're in! Can't you quit now and turn in for a spell?"

He looked at me out of dull eyes. "I'm trying to raise the Saneta," he answered, and his voice was like a drunkard's, too.

"But I'll report to the Skipper that you're not in condition to work any more. His messages can wait."

DeWitte's eyes closed, wearily. "You don't understand," he answered. "I can't raise her. She—she hasn't replied. I've been sending and sending her call letters —KDK—KDK! She doesn't answer!"

Perhaps I was just tired myself, with the night's strain. Or perhaps I am naturally slow. It took me several minutes to grasp what DeWitte meant. Then I shook him by the shoulder.

"You mean——"

He sprang up from his chair with such a wild look in his eyes that he startled me. "I tell you, they don't answer!" he said, hoarsely. Then he sank down again, burying his face against his arms, and I heard him sob: "Oh, God!"

It wasn't altogether shipshape for me to do, but I went and found the Old Man. I reported to him that DeWitte had gone as far as he could, without a rest. He'd either turn in—or break down. But the Skipper was in a great state over the Saneta, and couldn't see how DeWitte could be spared, unless Craig could stand his watch. This was out of the question, and I told the Skipper so, in a few words. His answer was brief. DeWitte must keep on trying to raise the Saneta. She must be heard from. She was within easy radio-communication at the beginning of the hurricane—she should answer—she must answer.

I took DeWitte a good stiff drink with my own hands, and stood over him while he gulped it down. And then I left him, sending his eternal call of "KDK! KDK!"

At noon, that day, I learned from one of our officers that all the shore stations were calling the Saneta, but that there was no answer. We had passed the position where we should have met the other ship, and by wireless orders from the offices in New York, we steamed around in a radius of some ten miles. There was no sign of the Saneta. And then, because we had passengers, perishable cargo, and other reasons for haste, we gave up the search and made for Limon.

Fortunately, at Limon, another of our Company's ships was in port. We borrowed one of her wireless men in exchange for Craig, so the latter could be taken back north as speedily as possible. We needed someone on the Seramalac to relieve DeWitte. The man was a wreck. To tell the truth, I was afraid he was going off his chump. His eyes had a wild look in them, and he wouldn't go below for his meals. Insisted upon staying in the wireless room, where he would watch the new junior, Shaw, in his every move. Once when I was up there talking to him on the way home, Shaw, listening in, shoved one side of his phones up, so he could hear our conversation. This is a little, amazing trick of wireless men: listening to the human voice with one ear, and to a wireless voice with the other. Suddenly, Shaw turned and jammed the receivers close over his ears, and DeWitte sprang to his side, asking in a choked voice:

"Who is it, Shaw? Who is it?" shaking the other, as he did not at once answer.

And it struck me, as I watched him, that we were just in the position where we had been, the night of the hurricane, when he must have been listening in for the Saneta.

Until we passed north of the Greater Antilles and were well on our way toward New York, DeWitte acted like this. That he had been profoundly affected by the loss of the Saneta—and lost she was, for there was never a sign of her, no, not even a bit of wreckage!—was not to be wondered at. After all, he and Wilkins might have had a tiff, but they had been pals, inseparable partners down in the big station at Santa Marta for three long years. And the crew of the Seramalac, to a man, took pains not to mention the lost ship before DeWitte. His feelings were too deep.

But if a change had come over DeWitte, what shall I say of Aileen Chase? The day after the hurricane, I had been sent for in a rush to see the Little Stewardess. She had fainted away at the lunch table and lay unconscious in her bunk, where the Chief Steward had had her carried.

"She went smash on the table!" Mrs. Dunphy told me, in a flurry, as I worked over the ghastly woman. "We were talking about the storm, and the Steward was telling us about the Saneta being lost or whatever's become of her, when Miss Chase just gave a queer little sort of choke and fell forward on the table."

I made no answer. I was too busy, both mentally and physically. As I said before, I may be slow in getting things through my head, but it didn't take me so very long to recall the look on Miss Chase's face, the night before, when she asked if the Saneta were out there in the storm. What was there in this woman's interest in the Saneta?

When I saw that she was regaining consciousness, I found an excuse to send Mrs. Dunphy on an errand to the Dispensary. I wished to be alone with Miss Chase for a moment.

As she opened her eyes, she started weakly upright, with a low cry of fear—or horror—or anguish.

"Lie still," I commanded. "You are not to move, yet."

Recognition came into her eyes, as she looked up at me, and she clutched my arm tightly.

"The Saneta?" she gasped. "Have they heard from her, yet?"

"No," I answered, quietly, watching her face. "DeWitte has been calling all morning. But she doesn't answer."

And then, in the same tone DeWitte had used, she moaned: "Oh, God!"

I determined to solve what was now a riddle to me, and so spoke, as gently as I could, to the white-lipped woman.

"Had you friends on the Saneta?" I asked. "You were anxious about her, last night, I remember. Is there someone on her that you know?"

Miss Chase started up at me, wide-eyed, and I saw that her breast was heaving.

"No!" she answered, and I thought the one word strangely fierce. "No—I had no friends on her!"

And then she lay quiet and white, letting me chafe her cold hands.

Lord, that trip north! It was a horror! Between Miss Chase and DeWitte, I thought I might as well start a private insane asylum as soon as we reached port! A happy pair to doctor! I should have loathed it, had there not been enough psychology beneath it all to stimulate my interest. There was a mystery, somewhere, that I meant to fathom.

When we again sailed from New York, the poor old Saneta had been quite given up. Not a sign of her had been found by any of the many ships sailing over her course. That she had been lost in the hurricane was beyond a doubt. Her name was struck off the list of the company's fleet, and the Hydrographic Bulletin gave notice that her wireless letters, "KDK," had been rescinded.

Among other things connected with Miss Chase and DeWitte, I noticed a decided change in their manner toward each other, upon our next voyage. DeWitte did not seek out the pretty stewardess, as he had formerly, and her bearing toward him was one which simply whetted my curiosity about her. She would stand and stare at him whenever they were near each other, and there was a peculiar questioning in her eyes. Once I ran into them, in a secluded corner of the promenade deck, and was in time to see her little hands clench at her sides and her eyes look into his with an expression of anguish.

Things went more or less smoothly, however, until we left Kingston and started south for Limon. Then DeWitte began to act strangely. Restive? Good Lord! That man was never still! I don't know when he sat down—when he slept—when he stopped moving from one place to another—but never far from the wireless room. Sometimes he'd stand and look out toward the horizon, sweeping the sea through a pair of glasses, as if seeking, seeking, seeking something he could never find. There was something on DeWitte's mind—something heavy—and I realized that if he didn't get rid of it, *wikiwiki,* there'd be a mental smash.

We were nearing that same latitude in which the Saneta had been lost, when Shaw came to me and drew me into conversation. He began rather awkwardly, and I could see with half an eye that he'd something he wished to ask, so I led him on. Finally, he blurted it out.

"Say, Doc, is DeWitte quite right? Isn't there something loose in his upper story?"

I spoke slowly and carefully, weighing each word.

"That's a funny one," I said. "Why should he be anything but quite right?"

The junior operator shot a resentful glance at me.

"If you had to work with him, you wouldn't ask!" he snorted. "He says the darndest things every once in a while."

"What, for instance?"

"Oh, he's always bothering me about listening in. Says if he ever finds me asleep on watch, he'll brain me. As if I didn't know my duty as well as he does! And he keeps saying: 'If you ever hear a ship calling S O S, let me know, old man. Never let a ship call S O S without my knowing.' I guess I am as capable of answering a distress signal as he is!" And then Shaw paused and looked scarchingly at me. "Sometimes," he said, slowly, "I wonder if old DeWitte was asleep, the night of that hurricane, and if the Saneta's S O S didn't pass him by!"

I looked right back into Shaw's eyes, I can tell you, and didn't speak in a very friendly tone.

"I wouldn't wonder any such thing as that to anyone else, if I were you, Sparks," I answered. "In the first place, no man could have slept through that hurricane. It was—a hellion. In the second place, how do you know the Saneta ever sent a distress signal? It was never picked up."

"I don't. I know no one ever heard it," he replied, sullenly. "But what's wireless for, if not for that?"

"The matter of the Saneta has been given a good deal of serious consideration, young man," was my answer. "And the consensus of opinion is that the ship sunk before a call could be sent."

The next time I saw Shaw was when he walked into the Dispensary and came over to me, white of face.

"You better go up and pay a call on your friend, DeWitte," he said, and his voice was actually shaking.

"What's the matter?" I asked.

"He's got 'em," was the laconic reply. "He insists he hears a ship calling S O S, and then swears she signs off KDK. Those were the call letters of the Saneta, if you remember. They've been rescinded. There aren't any such call letters on any ship, right now."

I studied him a moment. Then I asked: "Have you listened in, as you call it? What do you make it out that DeWitte hears?"

"Static!" was the scornful sniff. "Just pure, unadulterated static. It's fierce. I never heard it so bad, before."

So I climbed up two decks to the wireless room, and entered as nonchalantly as could, under the circumstances.

I confess I was shocked. DeWitte's face was gray; his lips blue. His hand, on the key, shook like a palsied thing.

He turned as he saw me and snatched the phones off his ears. Springing from his seat, he clutched my shoulders and peered into my eyes.

"Doc!" His voice was almost a sob. "Doc! For God's sake, sit down there and listen to that thing! Tell me if I'm crazy—or if that isn't the Saneta calling—calling!"

I patted him soothingly on the shoulder. Gad! He was in a bad way!

"My dear man," I answered gently, "how would I know? I can't understand wireless."

He paused and stared closer at me, for a moment. Then his eyes brightened.

"I can teach you, in just a minute, what her calls letters sound like—that and the S O S. Please, Doc!" He was in such a state that I decided to humor him. So I sat down beside him and, with a little buzzer affair, he taught me the sounds of the dots and dashes that made up the letters "K D K," and "S O S." When I knew them so I could slowly spell them on the buzzer, he attached an extra pair of phones to the wireless set and bade me listen in, with him.

Of course, another person's emotions are bound to influence you to a certain degree. As I sat there, bent forward listening, I was conscious of a sort of subdued excitement in my own mind—a sympathetic response to DeWitte's anxiety.

And by Jove! Just because I was trying so hard to hear these letters I had so laboriously learned, out of that queer, crackling sputtering in my ears, it seemed to me I *did* make them out.

Something in my face must have given me away. I must have nodded my head—or my eyes must have shown some sign of acquiescence. For DeWitte, who had been watching me like an eagle, sprang suddenly from his chair, tore the phones from his ears, and gave a terrible cry.

"I knew it! It's Bob!" he screamed. "It's Bob! He's come back. I knew he would! I knew he'd turn on me, some day, and get me! He knew she was here with me, as stewardess! And when I wouldn't answer his S O S—I knew he'd come back and get me for that! God! God! They'll all hear him, now—they'll all hear him! And he'll tell them that I heard him that night, and wouldn't answer him, because I was mad for Aileen and wanted him out of the way. He'll tell them—he'll tell them—" and then he fell, crashing against the settee, as he went down to the deck.

The doctor paused and looked around at us, soberly.

"Of course, it was only static. His conscience was what had come back and was telling on him. But it didn't matter. DeWitte was dead of heart failure when we got him to the Dispensary."

He paused and lit a cigarette.

Van Norden leaned toward him. "The woman, Doc?" he asked. "What became of her?"

"What could you expect?" the Doctor answered. "That fool, Shaw, had told her about DeWitte's imagining he heard a ship calling, and she (probably suspicious of the truth from the beginning) had stolen up to the boat deck. She was just outside the wireless room door when DeWitte broke down. The Mate found her crouched there, half-fainting, and took her along the deck to a quiet spot where he could calm her."

"But what a strange ending——" Van insisted, as the Doctor paused.

"She became the Mate's wife, after about three months. They both joined the hospital corps in Europe, after the war broke out, and they are today giving their all—somewhere in France."

"But what a strange ending——" Van began.

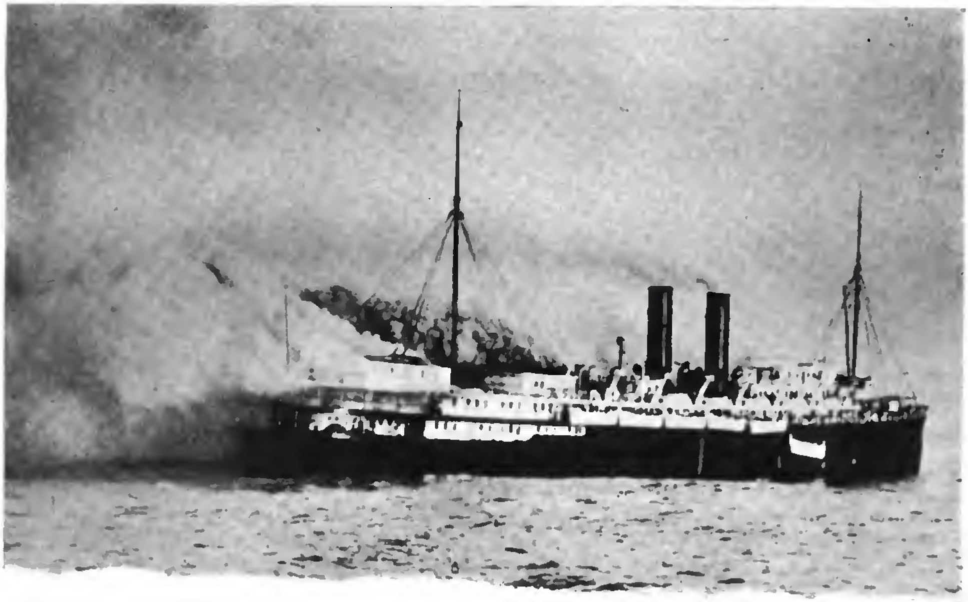
"No!" the Doctor's quiet voice interrupted. "It is quite in order. Aileen Chase felt that she was as guilty as DeWitte, since it was his madness for her that caused him to disregard that call for help. Therefore, when the Mate asked her to be his wife, she agreed only on condition that he should allow her to go to the front and do as much toward saving life, as possible. You see," he added, after a pause, "as I said in the beginning; there's nothing more interesting than—people."

NEW RECORD FOR AEROPLANE TRANSMISSION

A new record for flashing wireless messages from an aeroplane in flight was established by Captain Clarence Culver, of the signal corps aviation school, of the United States army, when he succeeded in keeping in constant communication with San Diego while on a reconnaissance flight to Santa Monica and return, a total one way distance of 114 miles, in an aeroplane.

Captain Culver ascended from the military aerodrome in a Martin Tractor, No. 50, piloted by Sergeant William Ocker. He flew at an even height of a mile and a half, sending messages every three minutes to Lieutenant W. A. Robertson, who handled the receiving instruments of a private station.

Captain Culver's feat was accomplished with a radio set designed by himself. The power for the transmission set is derived from a generator placed on the lower wing section of the aeroplane and driven by a two blade propeller. Aerial wires hung from the fuselage, with an insulated counterpoise hung from the wings to the tail of the aeroplane, complete the set, which weighs less than forty pounds.



The steamship Congress burning off Coos Bay, Ore.

How the Congress' People Escaped the Flames

A Disaster of the Pacific Marked by a Race Against Time and a Severe Test of the Wireless

ANOTHER disaster of the Pacific Coast in which wireless was employed to save human lives has been recorded. This instance of the value of the art occurred when fire was discovered in the hold of the Congress, largest of the Pacific Steamship Company's fleet, off Coos Bay, Ore., on September 14. The situation was full of peril. Land was a considerable distance away, the flames were making headway rapidly and there was no ship in sight to aid the 233 passengers and crew of 175. There was a chance that the vessel might reach shore safely, however. Therefore, Captain Cousins, the commander of the Congress, ordered the prow of the vessel headed for the coast, toward which she sped, while her wireless, in charge of R. H. Brower, first Marconi operator, and C. A. Lindh, his assistant, flashed the S O S broadcast. These appeals were not without result and when the decks of the Congress was scorching, her people choking in the smoke, and she was about to be completely enveloped in flames, rescue ships arrived and saved every one on the doomed craft.

The Congress, bound from San Francisco to Seattle, had reached a point approximately 200 miles north of Eureka, Cal., when the ship's barber saw smoke coming up through the floor of his shop. This was about three o'clock. An investigation was made of the hold under the shop, but the smoke was so dense that it was impossible to locate exactly the source of the fire. In this extremity Captain Cousins turned to the wireless and directed Operator Brower to send out the S O S.

Tests showed, however, that the fire had cut off the power of the main set and Brower employed the auxiliary equipment to flash the appeal. The call was answered by the Marconi station at Eureka. Five minutes afterward the Naval Station at Cape Blanco "came in" and the burning ship's position was given as eight miles off Coos Bay. The message to Cape Blanco produced quick results for at ten minutes to four o'clock that station informed the Congress that tugs and a life saving crew were on their way to the distressed ship. The Marconi station at Marshfield, Ore., then called and reported that the steamers Tilamook and A. M. Simpson were on their way to the assistance of the Congress.

Meanwhile the Congress had been racing toward shore and when two miles off Coos Bay bar her people took to the lifeboats. The dredge Michie—one of the rescue craft—was already on the scene and the vessels dispatched from Marshfield were standing by also. Hardly had the rescued folk left the Congress than she flared up like a torch and the flames spread from stem to stern, marking in spectacular fashion her final end.

THE STRANDING OF THE BAY STATE AND THE SUMMONING OF RESCUE VESSELS

The steamship Bay State, groping her way through a dense fog early in the morning of September 23rd, piled up on the ledges off McKenny's Point, Cape Elizabeth, Me. There was fear for a time regarding the safety of her 250 passengers, for a great hole had been torn in her bottom and the water rushed into the hold in torrents. The force of the collision worked damage to the wireless set, throwing the condenser top off the condenser case, and breaking the tabs off the condenser plates. Marconi Operator A. R. Gardner quickly repaired the equipment, however, and within three minutes after the Bay State had struck he was in communication with the Cape Elizabeth Naval Station. As a result the revenue cutter Ossippe and the tugs Portland, Cumberland and Scandinavia were rushed to the wreck and, aided by the life saving crew of the Two Light Station, rescued those on the stranded ship.

When the revenue cutter and the tugs arrived lines were run from the Portland to the Bay State with the object of hauling the steamship off into the deep water. The hawser parted, however, and the Bay State apparently settled farther on the ledges. Plans were then made to transfer the stranded ship's people to other craft. In order to effect the transfer rope ladders were lowered over the side at the gangways and one by one those aboard the Bay State made their way into small boats and thence to the rescue vessels.

WIRELESS IN SUBMARINE RAIDS OFF THE NEW ENGLAND COAST

(*Continued from page* 86)

but we had no idea what it all meant. By the time we had discovered that a submarine was operating in our vicinity it was too late to escape. When we came on the scene of action the underseas boat was engaged with the Stephano. While the passengers and crew of the Stephano were disembarking, the U-boat ran alongside the Knudsen and ordered us to steam over nearer the Stephano.

"While the submarine was alongside the Knudsen waiting for the Captain to take his papers aboard one of the United States destroyers came in view. Almost immediately the submarine disappeared beneath the water and remained there until the destroyer came near enough to be recognized as a neutral vessel, when she immediately came to the surface and continued her work.

"We were told to pack up our belongings and leave the ship, which we at once began to do. We had plenty of time to get off while the submarine was disposing of the other vessel. We had rowed some distance away before the submarine fired on the Knudsen."

Odds and Ends for the Amateur Station

By Elmer E. Bucher

THE design of the principal parts of a wireless equipment for a complete amateur station is a matter of common knowledge among radio experimenters, but some mechanical and electrical details frequently undergo neglect or are not well understood. A piece of equipment often misunderstood is the protective condenser.

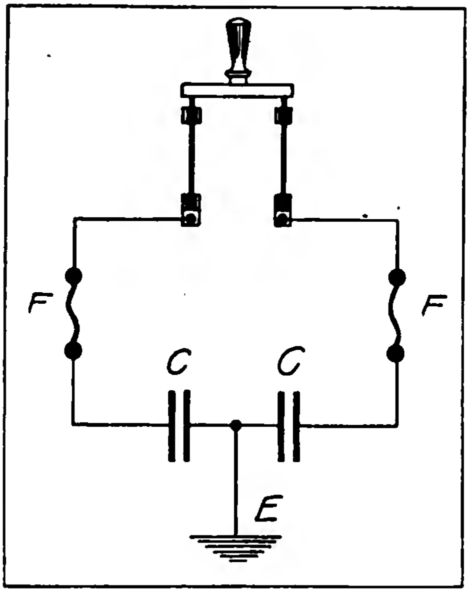


Fig. 1

Protective Devices. — Primarily the protective condenser was intended to protect power circuits, house lighting circuits, the windings of motor-generators, etc., from the induced potentials of a local wireless transmitter, because it is a well known fact that a conductor lying parallel to a transmitting aerial will absorb a certain amount of energy. Hence it is desirable in so far as possible to run low potential power mains at a right angle to the aerial wires, thus reducing the effects to a minimum.

The most effective protective device is that indicated in Figure 1, where two condensers of two microfarads capacity each are connected in series, the terminals being connected to the power mains and the center point connected to earth. Should the condensers by chance be punctured, due to an extra high potential discharge, the power lines would be short-circuited with corresponding effects. Therefore, to prevent disaster to the circuits, the fuses F, F, of 1 ampere capacity are connected in series.

A second method for protection of circuits is the use of a carbon or graphite rod having a value of 1,000 to 10,000 ohms. These rods are shunted across the power circuits and connected to earth at the center point. Static charges accumulating on the power circuits are thus neutralized and led to earth.

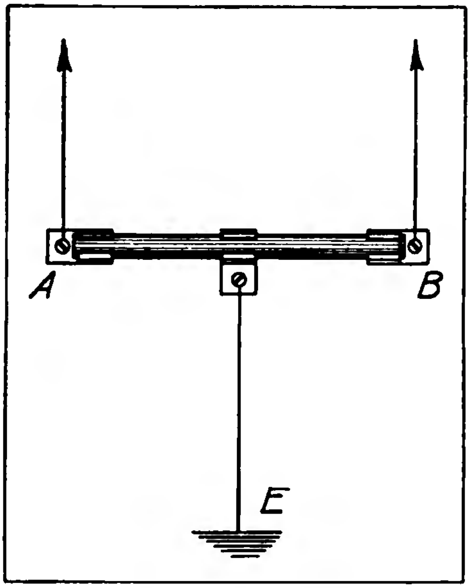


Fig. 2

In some radio stations, a condenser or a protective rod is connected from the frame of the motor-generator to the windings, thus preventing a large difference of potential being set up between them. In amateur stations where the power leads enter the house through the basement and the radio apparatus is located on a.. upper floor, a set of these protective devices should be connected across the primary terminals of the transformer and a second set near to the basement meter.

High-Frequency Choking Coils.—It is often desirable to protect the secondary windings of a high potential transformer from the high frequency oscillations released by the condenser during discharge. This is particularly important for a home-made transformer where the constructor lacks the facilities for properly insulating the windings. Should the spark gap be opened to abnormal length, the current of radio frequency may break down the insulation of the secondary pancakes and thus render the transformer inoperative.

Protective choke coils are represented at N, N, and they may be constructed in a simple manner. A spiral winding of annunciator wire with outside diameter of 6 inches may be made on any convenient insulating base, or if preferred a single tube 4 inches in length, 4 inches in diameter, may be wound with a single layer in the usual manner. These coils may be constructed with or without an iron core, but they will be effective in either manner.

The function of the reactance coil or regulator is frequently not thoroughly understood. It is often employed in the primary winding of poorly designed transformers to prevent an abnormal consumption of current. It is of value, however, in any transformer winding where the power input is to be reduced by steps.

A reactance regulator may take the designs indicated in Figure 4A or 4B. In the former a straight iron core has two or three layers of wire of suitable current carrying capacity, the turns of which are equally divided between the taps of a ten-point switch, or we may use the design in Figure 4B where two coils of fixed inductance are connected in series and a "U" shaped iron core inserted. Then, by drawing the core in and out of the windings, the self-inductance can be varied over considerable range and the power input accordingly increased or decreased.

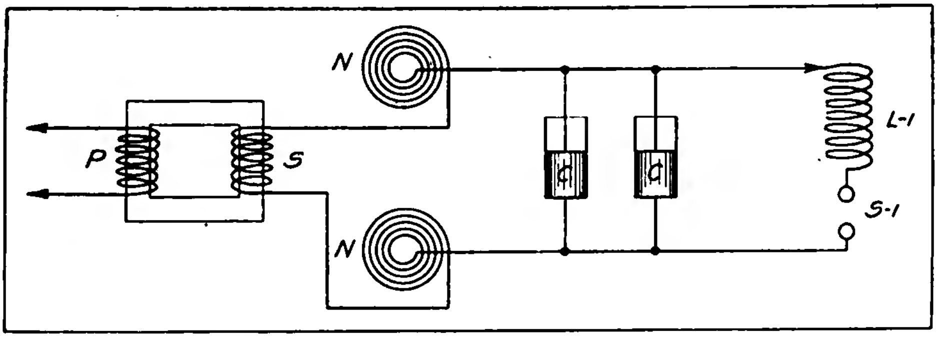


Fig. 3

For the average amateur transformers having an input of ½ k. w., the core for the design (Figure 4A) may be 14 inches in length, 2 inches in diameter, wound with three complete layers of No. 14 D. C. C. wire, with tappings brought out at certain intervals.

The core for the design (Figure 4B) should be laminated, *i. e.*, constructed of thin sheets of iron stocked up and assembled as the core of the usual type of transformer. The core for both windings A and B may be 1½ inches square, 8 inches in length, with a cross bar or yoke 7 inches in length. Two layers of No. 12 wire are now wound on each leg. The precaution should be taken to place the turns on each leg in the opposite direction.

It is of course understood in either type that the windings are insulated from the core by means of two or three layers of Empire cloth. The actual dimensions of these coils and the number of turns will probably not apply to all types of amateur transformers, but a few trial experiments with each will reveal a winding of the correct proportion for a

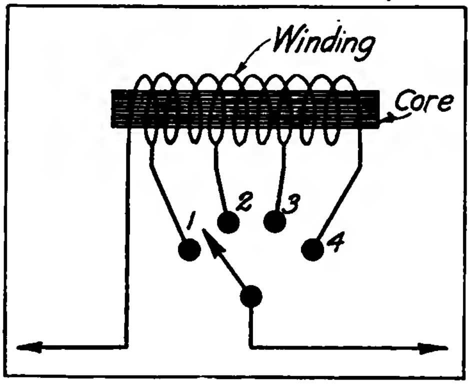


Fig. 4-a

given radio set. Should the reactance regulator show signs of overheating it may be immersed in a small tank of insulating oil.

Radiation Indicator.—An indicator for determining conditions of resonance between the condenser and aerial circuits of a radio station is an absolute necessity. The amateur market is not well supplied with a cheap and efficient aerial ammeter and consequently many experi-

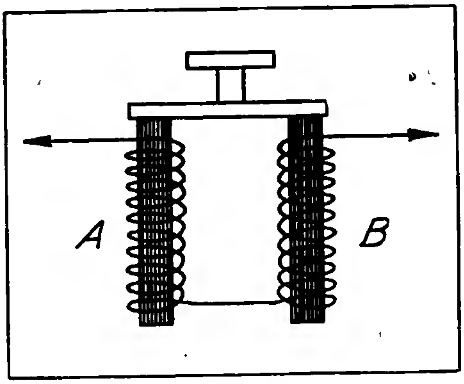


Fig. 4-b

menters prefer to construct this device themselves.

The simplest device for this purpose is that indicated in Figure 5, wherein a two or four-volt battery lamp, L, is connected in series with the aerial system through the binding posts, A and B. The lamp is shunted by the loop of wire, W, bent in a semi-circle over which slides the variable contact, C. The dimensions of the loop vary according to the current flowing in the aerial system; its diameter may have to be increased or decreased accordingly, but a few trial experiments will quickly reveal the correct position so that the lamp will not burn out when complete resonance is established.

The better method for obtaining resonance is to set the inductance of the

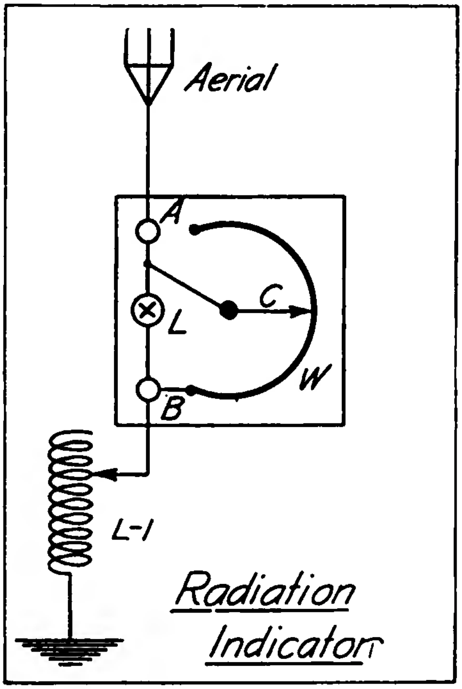


Fig. 5

closed circuit at some fixed point and follow it by altering the inductance in the aerial circuit until a brilliant glow is secured.

An Aerial Ammeter.—The experimenter preferring a hot wire aerial ammeter that can be calibrated by comparison with a meter of standard construction should note carefully the diagram in Figure 6. The instrument shown therein will measure at the full scale position, 0.1 ampere, and by placing several additional wires in parallel to it, the range may be increased to any desired value. Between the copper bars, B-1 and B-2,

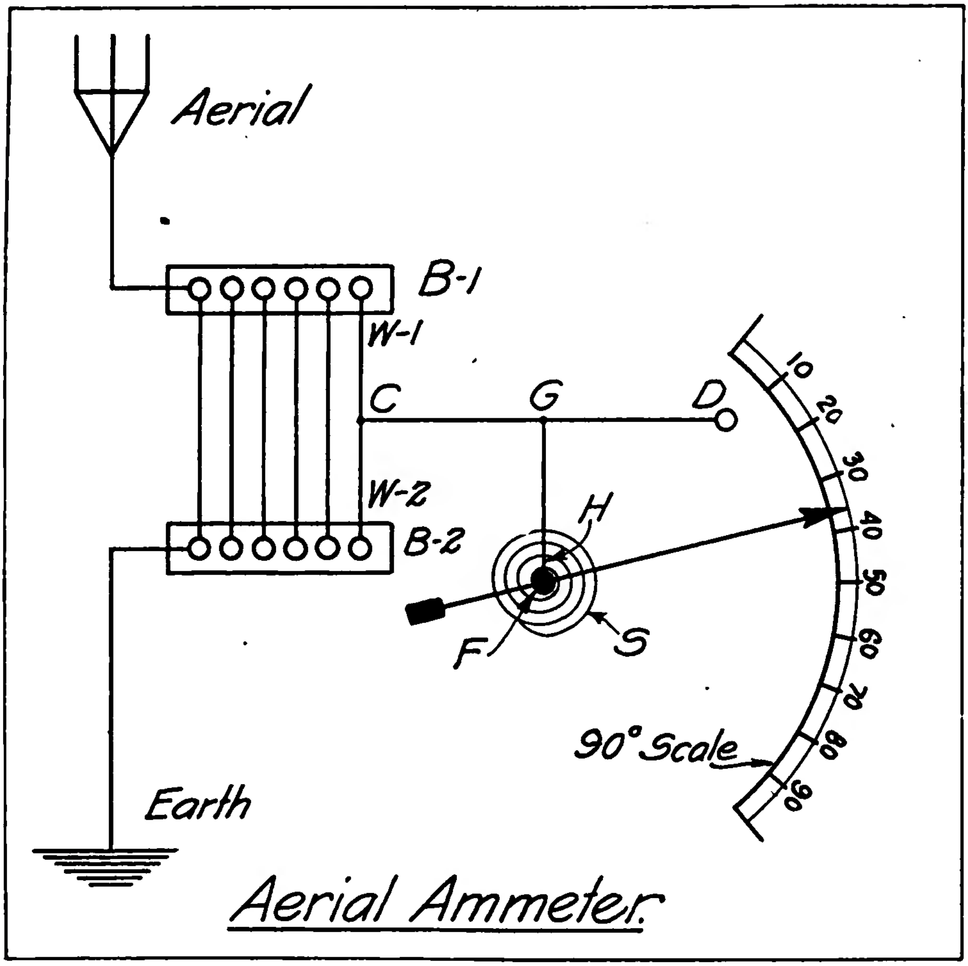


Fig. 6

is stretched a piece of Therlo resistance wire, 4 inches in length and .003 inch in diameter having approximately a resistance of 9.5 ohms. C, D, is a piece of silk fibre about 3 inches in length, while G, H, is another piece 2 inches in length. The latter thread is attached to C, D, and wound around the shaft, F, which is preferably supported by jewelled bearings. Without the tension of the small hair spring, S, the pointer would fly to the full scale position, but the force exerted by G, H, holds it to the zero position. Then when current is caused to flow through the W-1, W-2, the wire expands, releasing the back tension of the spring, and the pointer accordingly moves across the scale.

To take care of larger values of aerial current, four to six Therlo wires should be placed in parallel, from bar to bar, until the correct current carrying capacity is secured. The pointer may be made of a light piece of straw attached to the shaft by a bit of *beeswax*.

A small counterweight, A, should be attached to the opposite end of the pointer to give the correct balance.

Aerial Outgoing Insulator.—An aerial insulator for bringing the aerial leads through the roof of a building or the side of the house must be carefully constructed to prevent leakage of water. An insulator of elaborate construction is beyond the means of many amateurs and therefore the type shown in the drawing may be substituted. A hard rubber tube at least 16 inches in length with a hole

⅜ of an inch to ½ inch in diameter is clamped to the roof by means of the wooden blocks, B, B, drawn together by

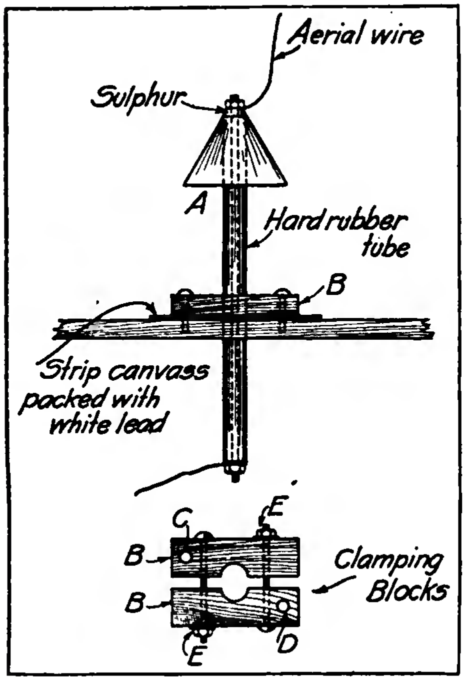


Fig. 7

the bolts, E, F. The fit of the tube should be snug when the bolts are tightly drawn. A second set of bolts are inserted at C, D and the blocks thereby drawn to the base board.

To make the joint water tight a strip of canvas slightly larger than the blocks has a hole the size of the tube cut in the center, after which it is thoroughly smeared with white lead. The bolts are

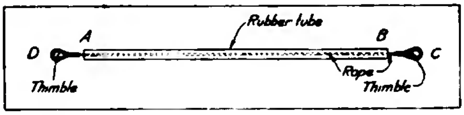


Fig. 8

then placed at C, D, and the blocks drawn to the roof. If allowed to dry, a water tight joint will result, provided the strain of the leadings is removed by appropriate guys.

The wire extending through the insulator should be at least No. 6 D. B. R. C. stranded conductor, which may be made water tight by surrounding it with melted sulphur. A certain quantity of sulphur should be heated in a pan until it runs freely; the bottom of the insulator is then stuffed up with waste and the sulphur poured from the top until the insulator is completely filled. When dry the sulphur hardens and possesses the requisite insulating qualities.

A cone shaped metal can may be attached to the top to prevent leakage of the high voltage current during a rain storm, but it is not absolutely essential.

Antenna Insulators.—In a somewhat similar manner we may construct insula-

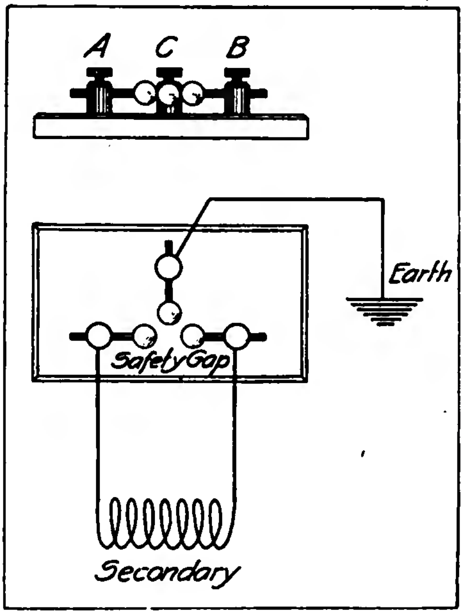


Fig. 9.

tors for aerial wires. A thin hard rubber tube about 12 inches in length may have extended through it a piece of ⅜-inch diameter marlin rope which in turn is served about heart shaped thimbles, as at C and D. The tube should be large enough to permit a small air space between the rope and the walls, around which is poured a quantity of melted sulphur. When dry the sulphur usually soaks into the rope sufficiently to make a water tight joint, after which the insulators may be attached to the spreaders for support of the wires.

(*Continued on page* 118)

Bridging Distance in 3,000,000 Square Miles of Jungle

How the Great Network of Wireless Stations in Brazil Serves That Country

By J. L. Barttro

TRUE though trite is the statement that wireless is playing a most important part in the extension of civilization. And perhaps the widespread influence of the radio is nowhere more in evidence then in Brazil where the art draws closer together the various points in the country's three million square miles. Up to a few years ago many parts of this jungle-covered section were almost unknown to the rest of the world. Now a great network of wireless stations transmitting business, thoughts and laws to the farthermost sections, makes this vast territory thoroughly alive.

If you will take an atlas in hand you will be able to follow to better advantage the progress of the wireless as I learned it while employed in radio in Brazil. Beginning at Para, at the mouth of the Amazon, radio stations have been erected as far as the Pacific coast, with installations at Manaos, Santarem, Iquitos, Quito, Lima, Porto Velho, Senna Madureira, Rio Branco, Cruzeiro de Sul and Xapury. For your information it may be well to state that Porto Velho, or, wirelessly speaking, PV, is at San Antonio Falls, 700 miles up the Madeira River, and the balance of the southern stations are in the Acre rubber district, located between the Purus River and the Madeira.

Messages from the government officials in Rio de Janeiro are transmitted to their subordinates along the western border in large volume. This is especially true of the wireless and of the relay from Para on, 2,500 to 3,000 words being the average traffic business transacted in four hours from that place to Senna each morning. After making the river trip from Para to Porto Velho, which takes two long, hot, tiresome weeks, or the month's journey from Para to Senna up the smaller rivers, one is particularly impressed with the speed and ease of communication effected by wireless. As for Rio Branco and Cruzeiro, it is fatiguing even to think of the time and unpleasant features involved in a trip to them. Mail does not arrive with the morning sun in these places. But the morning messenger does bring the telegrams to the subprefect in his little thatched office in the rubber wilds.

And in many novel ways does the radio serve the government officials stationed at isolated posts. If someone in officialdom has a birthday fifty long Portuguese words of esteem and best wishes wing their swift, silent way from and into the depths of the wilds. A marriage may take place in Manaos. Immediately the jungle stations are notified of the event and from them come congratulations and expressions of good will. If a law is passed at the capital affecting a tiny spot in near oblivion, the wireless is resorted to and two days later the act, word for word, is in the hands of the proper officials.

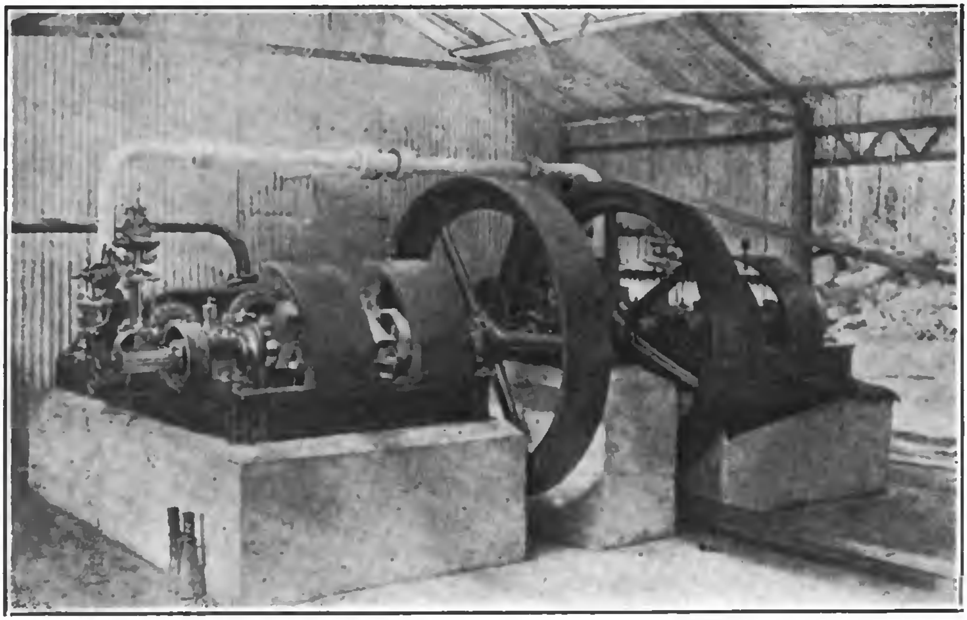
When the soldiers and police begin a quarrel in which shooting, rioting and arson are mixed indiscriminately, "Sparks" chuckles, pounds the report of the unpleasantness out on the "mill" and speculates regarding the next government staff. Chuckles? Certainly! For these are noisy, but usually bloodless revolutions.

So the game—for game it is—goes on. Little jungle railroads, steamboat lines of which folk outside of Brazil never hear and new business offices in the rubber districts, spring up like settlements in the early days of the West in the United States. Adventures thrilling and gruesome in the jungle; tales of death by the dread disease beriberi; little incidents of the wilds, crudely told, but containing all the elements of life in the raw. These are the tales that come into the head phones of the wireless man in Brazil.

Static prevails from twelve to eighteen hours a day. The period free from this condition is from six o'clock in the morning until noon, during which time the heavy traffic is dealt with, from sixty to seventy thousand words in a month of twenty-six working days being handled.

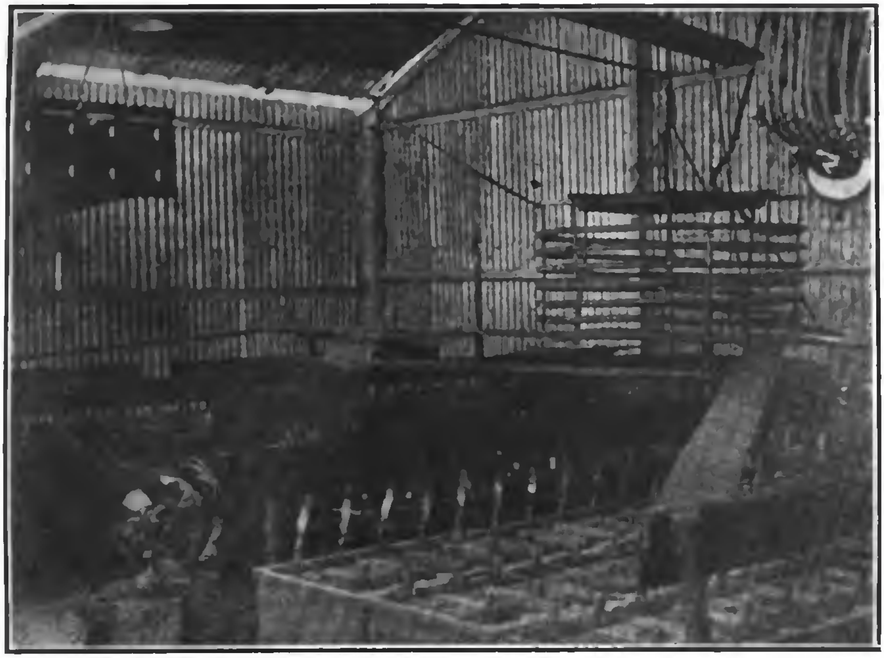
The stations at Manaos and Porto Velho are of 150 k. w. maximum capacity, but only require about one-fifth of this in clear weather. The sets are worked with Morse wire keys which control a double make and break relay system at a speed of twenty-five to thirty words a minute. Most of the messages are copied on typewriters, the signals coming in with a loud ringing note like those of the old Cape Cod station. Before the introduction of the typewriting machines it was difficult to average more than 600 words an hour. The typewriter record is between five and six thousand words of Portuguese and code in a six-hour trick. Portuguese words, it should be understood, generally have nine letters each. The record referred to was made with two operators, working three-hour tricks, at each of the two stations employed.

The stations are equipped with 200-foot aerial masts and special type tuners with a balanced carborundum set, the latter being the handiwork of a Marconi engineer. As a result excellent receiving records have been made by these stations. Clifden was heard one night and signals were regularly received from Arlington.



The engine room at Porto Vehlo, a Marconi station located at San Antonio Falls, Brazil, 700 miles up the Madeira River, a two weeks' journey from Para

Working in the Manaos and Porto Velho stations has considerable interest and the experiments carried on at one time were even more interesting than the work. There was for example, the task of assisting the Brazil-Bolivia Survey Commission in determining local longitude. The operators' part in the work consisted in sending time signals so that accurate observation as to chronometer variations could be obtained. The longitude of Porto Velho was determined within a few hundred feet and with this as a base, members of the survey party start-



The condenser room of the 150 k.w. station at Manaos, from whence the survey party of the Brazil-Bolivia Commission received its longitude signals on a portable set erected each night in the depths of the jungle

ed for the depths of the jungle, carrying a portable wireless set. Every night the aerial of the latter was swung from high trees and the operators listened in for PV time signals, noted their variations and then shot the stars.

The obstacles to be overcome were not inconsiderable and the work could only be carried on during the dry season. During the rainy period of the year large clouds are almost constantly in the sky and drops of water the size of marbles descend to the ground. The storms are often accompanied by destructive high winds, lightning and thunder, all work being brought to a halt while they last. The Madeira rises steadily as the rain falls, reaching at times a height of from fifty to sixty feet above low water, and inundating many thousands of miles of the surrounding lowlands. Nature plays strange pranks following these deluges. One of the most striking was remarked by a member of the surveying party who told of a river flowing in the opposite direction from its original course, 200 miles from its position on the map.

I have attempted in this article to convey a rough idea of the work of a wireless man in a country where comparatively little is known regarding the details of his duties. If the word picture I have set down is alluring to some let me remind them that reading about this tropical land is more fascinating than the reality of living in its jungles, fighting sand flies and mosquitoes and waiting for the seemingly never-ending rainfall to cease.

Do Not Miss the First Two Pages of this Issue

Important Announcement to Wireless Age Subscribers

Long Distance Transmission on Low Power and Short Wave-Lengths

By A. S. Blatterman, B.Sc.

PART III (Conclusion)

TABLE 1 has been worked out to give the total inductance and capacity, including the lead-in, of four-wire inverted L aerials of different heights and lengths.

Table 2 gives the same data for T aerials.

Figure 11 gives the natural wave-lengths of inverted L antennas with no inductance at the base, consisting of four wires spaced 2 feet apart, for heights varying from 30 feet to 100 feet and lengths from 30 feet to 130 feet.

Figure 12 is similar to Figure 11 except that it refers to T aerials. It will be noticed that doubling the length of the flat-top of an L aerial in forming a T aerial does change the wave-length somewhat.

These curves take into proper account the distributed character of the inductance and capacity of the aerials, and are considerably more accurate* than the values given in the author's 1913 paper.

Figures 13 and 14 give the natural wave-lengths of L and T aerials respectively when a coil with an inductance of 10,000 cms. is placed in the antenna near its base. This coil is supposed to be the secondary of the oscillation transformer. These curves were calculated by means of formula 10 and the curve of Figure 9. (See the October issue.)

Inductance of Coil at Base.—The inductance of the secondary of the oscillation transformer can be calculated by means of the following formulae and table:

$$L = 4\pi r n^2 \left\{ 2.3 \left(1 + \frac{3b^2 + c^2}{96 r^2} \right) \log_{10} \frac{8r}{\sqrt{b^2 + C^2}} - y_1 + \frac{b^2}{16 r^2} y_2 \right\} \quad \text{..........(11)}$$

where the dimensions b, c and r are as shown in Figure 15-a, and y_1 and y_2 are read from the table.

b/c or c/b	y_1	y_2
0.00	0.50000	0.1250
.05	.54899	.1269
.10	.59243	.1325
.15	.63102	.1418
.20	.66520	.1548
.25	.69532	.1714
.30	.72172	.1916
.35	.74469	.2152
.40	.76454	.2423
.45	.78154	.2728
.50	.79600	.3066

This formula must be corrected in the present instance to take account of the actual distribution of the current over only a part of the cross-section bc. For a first approximation, when the conductor is of taped shape section and the distance between the turns is the same as the width of tape, this correction will be

$$\Delta L = 4\pi \left(0.6949 \sum_1^{n} r' - 0.1285 \sum_1^{n-1} r' \right)$$

where r′ is the mean radius of a turn. $\sum_1^{n} r'$ means the sum of the radii of all the turns. $\sum_1^{n-1} r'$ means the sum of the radii of all except the outside turn

* These curves have been at least partly checked by actual measurements on antennas.

The actual inductance is that calculated by formula (11) plus the correction Δ L. These formulae are equally applicable to either the pancake spiral type of coil or to the cylindrical helix.

TABLE 1

TOTAL CAPACITY AND INDUCTANCE OF 4-WIRE AERIALS, INVERTED L

HORIZONTAL LENGTHS

	40 ft.		60 ft.		80 ft.		100 ft.		120 ft.	
H ft.	C mf.	L cm	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.
30	.000186	22430	.000252	28280	.000334	34010	.000395	39770	.000456	45610
40	.000190	28900	.000258	85000	.000324	41100	.000392	47200	.000459	53310
60	.000213	42180	.000276	48800	.000837	55460	.000400	62090	.000463	68700
80	.000241	55410	.000800	62400	.000860	69320	.000418	76300	.000478	83300
100	.000268	69000	.000325	76260	.000382	83500	.000439	90750	.000496	98020

TABLE 2

TOTAL CAPACITY AND INDUCTANCE OF 4-WIRE T AERIALS WITH LEAD IN TAKEN FROM CENTER

HORIZONTAL LENGTHS

	60 ft.		80 ft		100 ft.		120 ft.		140 ft.	
H ft.	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.
30	.000252	15050	.000834	16530	.000395	18000	.000456	19480	.000555	20950
40	.000258	21000	.000324	22580	.000892	24150	.000459	25740	.000528	27820
60	.000276	33790	.000337	35460	.000400	87150	.000468	38820	.000522	40500
80	.000800	46530	.000360	48330	.000418	49850	.000478	51870	.000538	53630
100	.000325	59870	.000382	61690	.000439	68430	.000496	65340	.000553	67180

	160 ft.		180 ft.		200 ft.		240 ft.	
H ft.	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.	C mf.	L cm.
30	.000629	22480	.000702	28900	.000775	25880	.000928	28380
40	.000599	28900	.000664	30500	.000781	32050	.000867	84720
60	.000584	42180	.000645	43860	.000706	45550	.000830	48890
80	.000597	55880	.000654	57190	.000713	58950	.000881	62490
100	.000610	69000	.000667	70840	.000724	72680	.000838	76810

Corona Loss from the Antenna.—There is another very important, though seldom considered, factor relating to the overall effectiveness of the transmitter. This is the loss through "corona," or brush discharge from the antenna.

When a wire is charged to a high potential of the order of 100,000 volts, there is a leak of energy into the surrounding air, and if the potential exceeds a certain value, "the visual critical value," this leak is accompanied by a visible halo-like glow on the surface of the conductors. The loss due to this leakage of energy into the air is practically negligible below what is called the "disruptive critical voltage." The "disruptive critical voltage," or the voltage at which loss begins, is lower than the "visual critical voltage," or the voltage at which blue glow first appears. It is wrong, therefore, to assume, as is often done, that because an antenna does not appear luminous after dark, there is no corona loss. This loss may be a considerable fraction of the total aerial energy and still not produce the blue glow.

In another paper* the writer has developed formulas for calculating approximately the probable corona loss from antennas. These formulas are here summarized for convenience. They are:

$$P = \frac{265N}{10^{18}\delta}\sqrt{\frac{d}{h}}\left(\frac{V}{2} - V_0\right)^2 \quad \ldots .(12)$$

Where:

P = power in watts lost from one wire per ft. length of the portion whose potential is above the disruptive critical value (=x).

N = spark frequency.

δ = log. decrement of antenna per half period.

h = height of antenna in inches.

d = diameter of wire in inches.

V = max. voltage on aerial at free end.

V_0 = disruptive critical voltage.

$$= 74{,}000\ d \log_{10}\frac{4h}{d} \quad \ldots\ldots\ldots (13)$$

The maximum antenna voltage V can be calculated by the formula:

$$V = \frac{26\ I}{C}\sqrt{\frac{\lambda\delta}{N}} \quad \ldots\ldots\ldots\ (14)$$

Where:

I = current in aerial at base (measured by a hot-wire ammeter).

C = capacity of aerial in microfarads.

λ = wave-length.

In Figure 15, the disruptive critical voltage is represented by the dashed line

* A. S. Blatterman, The Wireless Age, July, 1916.

V_o. The actual antenna voltage is represented by the dotted line with maximum voltage V at the end. The corona loss only occurs over the length X, which is the length wherein the antenna voltage exceeds the value V_o. To calculate this length, X, from which power is lost, for an inverted L antenna, we have the following formula:

$$X = L \left(1 - \frac{2}{\pi} \times \text{angle whose sine is } \frac{2V_o}{V}\right.$$

$$V^1 = (1 + 0.267/\sqrt{0.064}) \log_{10} 240 \times 12/0.064 = 45{,}000 \text{ volts.}$$

whereas loss of power through corona begins at 21,900 volts.

The curves of Figure 17 have been calculated from these formulae. They show the loss in watts due to brush discharge as a function of antenna current for various sizes of antennas. In all these curves the wave-length is assumed to be 200 meters, the antenna decrement 0.1 per half period, which is the legal limit, and the spark frequency 600 per second. Also the antennae all have a

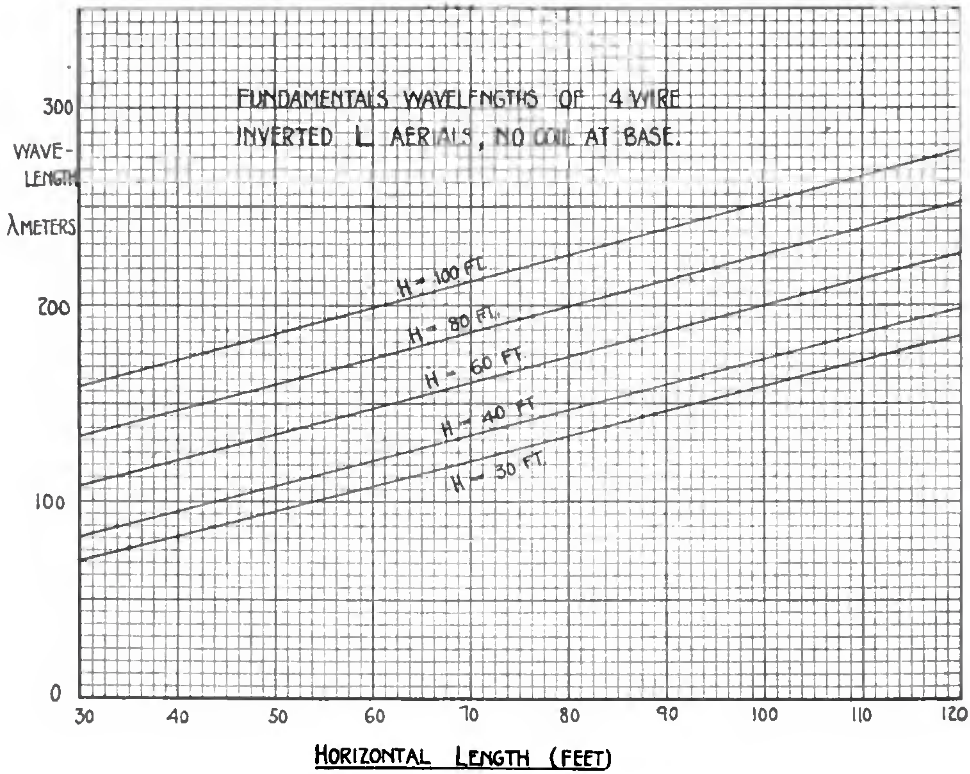


Fig. 11

For a T aerial power is lost from twice this length. (See Fig. 16).

The voltage at which brush discharge first begins to show as a blue glow is approximately:

$$V^1 = (1 + 0.267/\sqrt{d}) \; V_o \quad \ldots\ldots (16)$$

which shows that for small wires the visual voltage is very much greater than the voltage at which loss begins. Thus, a No. 14 wire 60 ft. from earth will begin to glow at a potential of

coil of 10,000 cms. inductance at the base for coupling, and are of the four, No. 14 wire inverted L type discussed above.

The formulae and curves show that in order to reduce the corona loss from the antenna it is necessary to use high spark frequencies, short wave-lengths, low decrements, large wires and large capacity, that is, low antennae.

Extraordinary Distances and Freak Transmission.—We have considered so

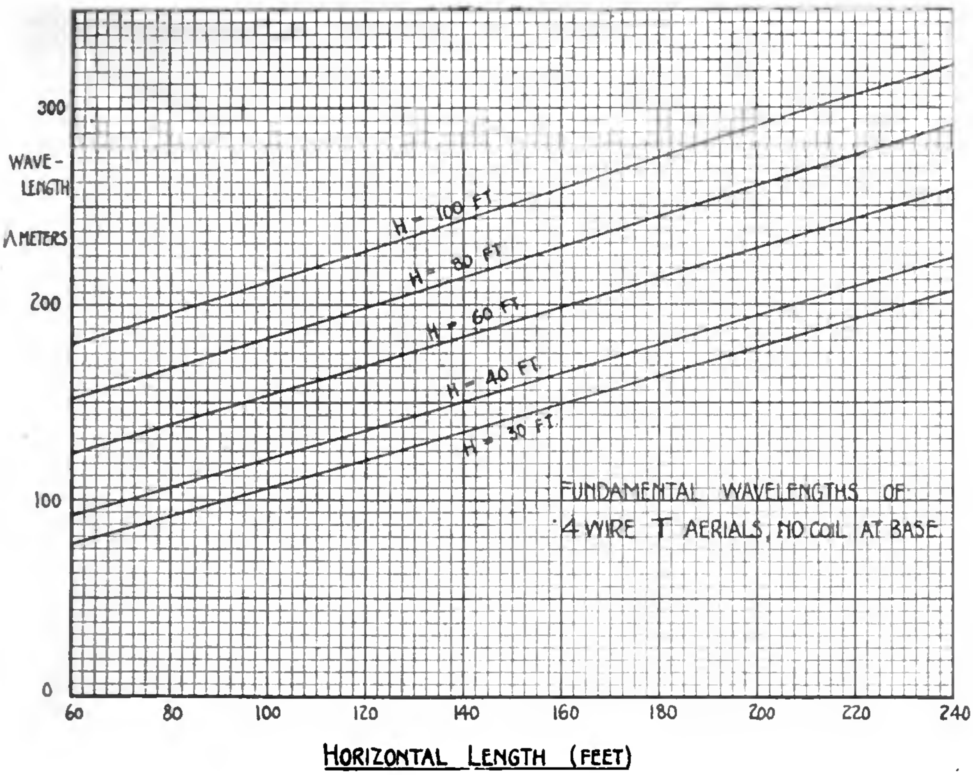


Fig. 12

far only the possibilities of continuous transmission on a regular schedule according to well defined combinations of such important factors as the wave-length, the antenna proportions and the aerial current. The distances involved herein may be considered as the normal ranges of land stations in the twilight hours near sunset and sunrise.

It is well known that after sundown the range of a station, particularly with short wave-lengths, may be considerably greater than it is at any other time. Also it is a very common observation among operators that signals vary in a most erratic way after dark, at times permitting communication over very long distances, and then suddenly reducing the strength of signals to a value almost as low as the regular day strength. The writer has lately been engaged in experiments* carried on between Washington University in St. Louis and the University of North Dakota, which were designed to study the variations in nocturnal transmission, and based largely on these tests, the following facts and theory are presented as tentative explanations of some of the phenomena commonly encountered.

There seem to be two kinds of fluctuations in nocturnal overland transmission. The first is a rapid fading, and the second is a slow swinging in signal strength. The first may be due to changes in the nature of interference effects. These could be local at the sender or at the receiver, or they might be caused by rather sharp surfaces of discontinuity almost anywhere between the stations.

The second or slower effect may be due to refracting masses of moving ionized air in the path of transmission, producing at times a lens-like concentration and at other times a dispersive effect.

The interference theory is generally regarded as the more tenable.

Let A, in Figure 18, represent a transmitting station sending to a receiving station at B. We can represent, conventionally, the waves traveling out from A along the surface of the earth, by the

* A. H. Taylor and A. S. Blatterman, "Proc. Inst. Rad. Eng." Apr. 1916.

solid wavy curve X-X. This is the direct wave. Suppose that there exists somewhere between the stations a rather sharply defined surface of electrical discontinuity, such as a floating ionized cloud-bank. Such a surface will reflect waves striking it. If this reflecting cloud-bank moves into a certain position, such as C, then waves radiated from the sending station will be reflected from it and return to earth as shown by the dashed line, Y-Y. It is seen that for this particular position of the reflecting surface, C, the reflected wave returns to earth in exact phase opposition to the direct wave, X-X, and thus causes a weakening of the signals at the receiver, B.

If, now, the reflecting surface moves to the position, D, then at the point where the reflected wave returns to earth it is in phase with the direct wave and hence re-enforces it. In this case, therefore, the signals at B are improved.

Thus, shifting reflecting surfaces, probably moved by air currents, cause alternate strengthening and weakening of signals; and, of course, it is entirely possible that favorable reflection of this kind might take place from several of these surfaces at the same time, thus permitting transmission for a short time over comparatively great distances.

This also explains the frequently observed fact that signals from one station gradually grow stronger while those of another fade out.

Superposed upon these transient fading effects there is another quite general and slowly changing set of conditions which is manifestedly the generally improving transmission toward midnight. Curves obtained during the tests cited showing the variation of signal strength during the night have the general appearance of that shown in Figure 19.

Soon after sunset the strength of signals increases very noticeably, and though it varies a great deal during the night, in accordance with the fading effects just discussed, the transmission, as a whole, improves up to a little after the solar

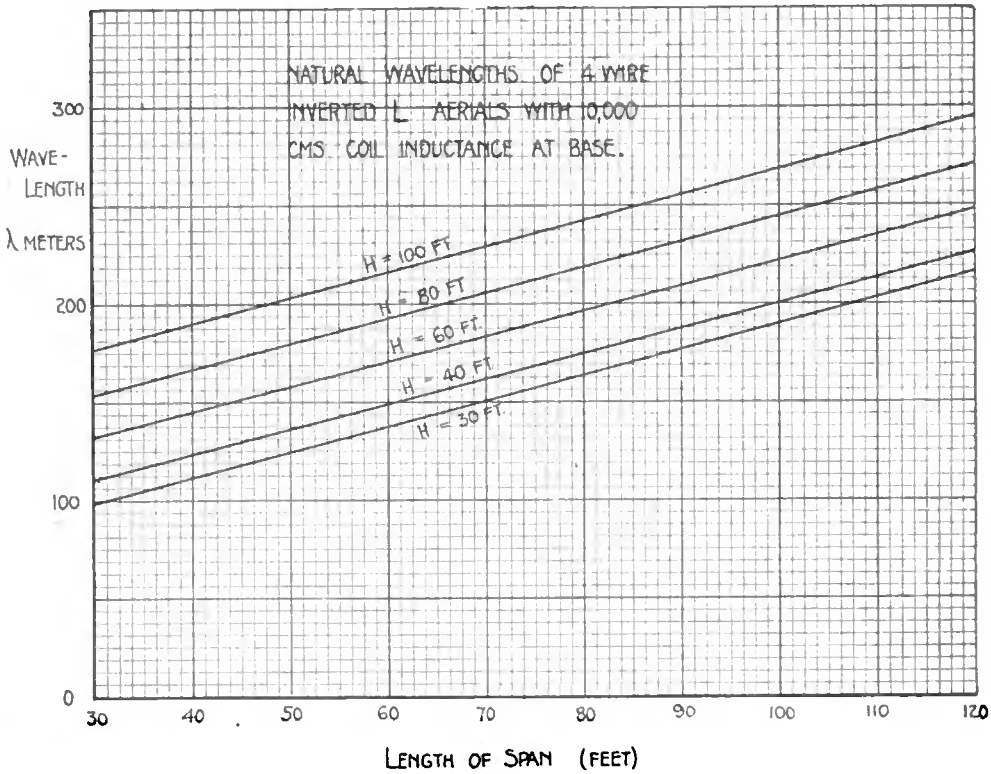


Fig. 13

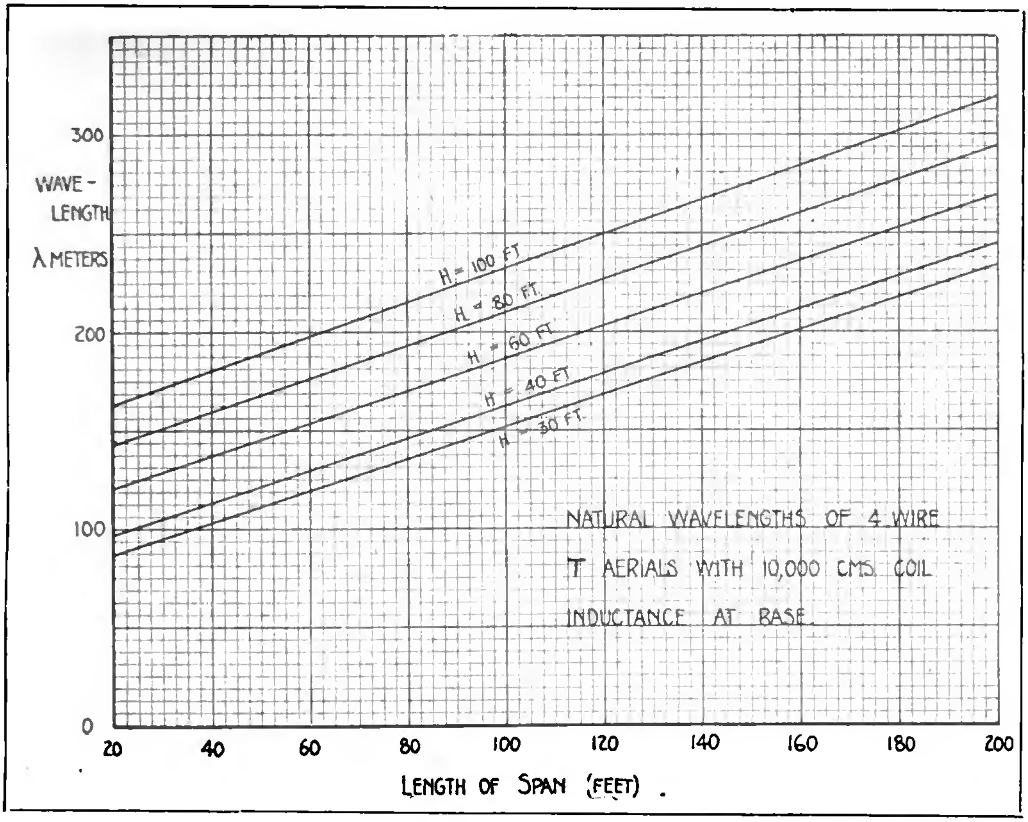


Fig. 14

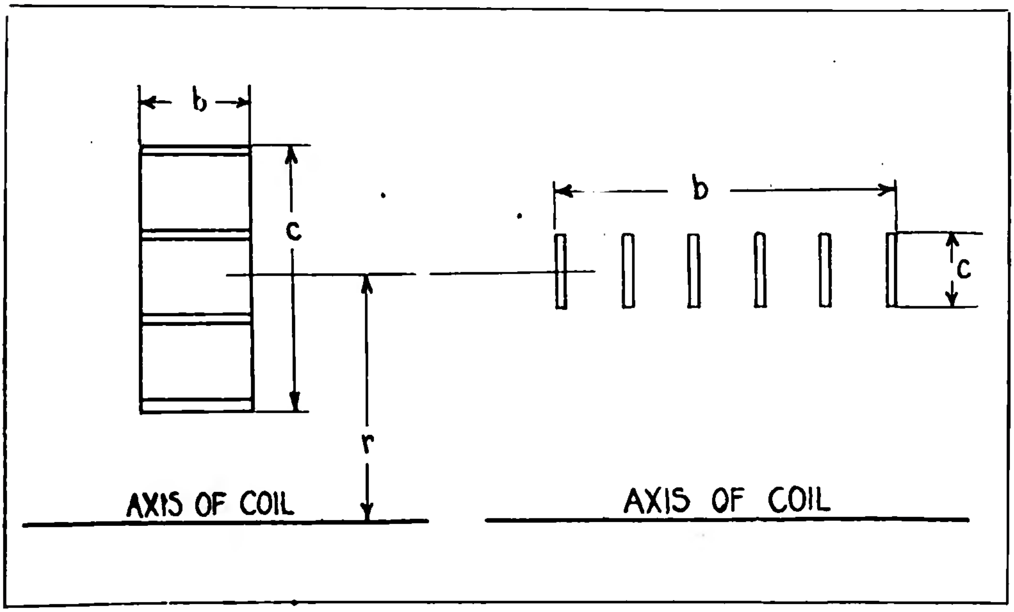


Fig. 15-a

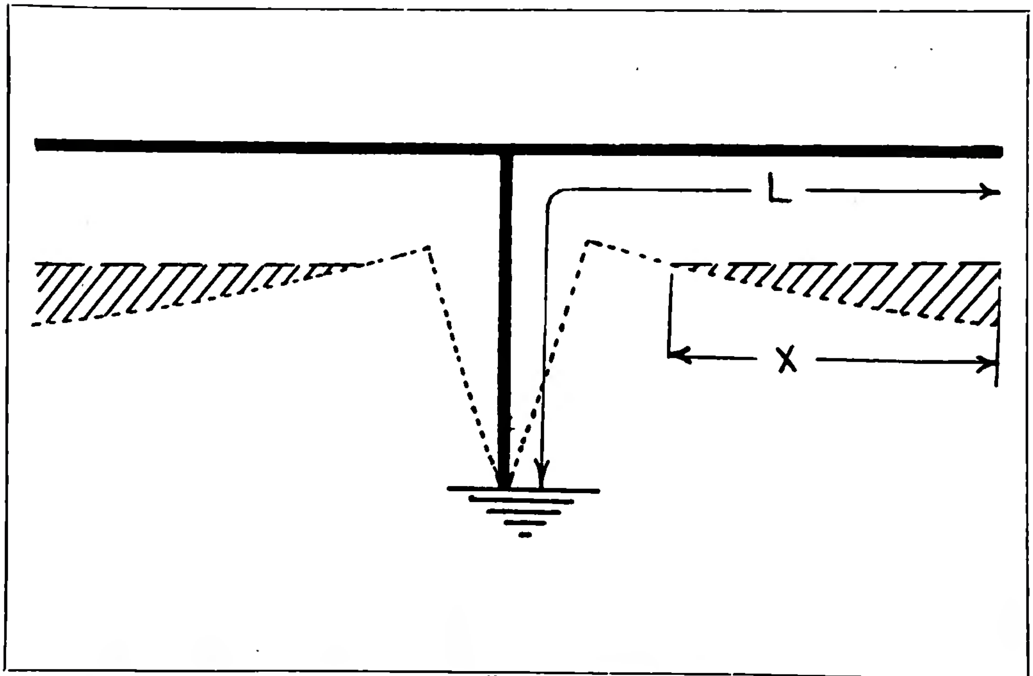

L
X

Fig. 16

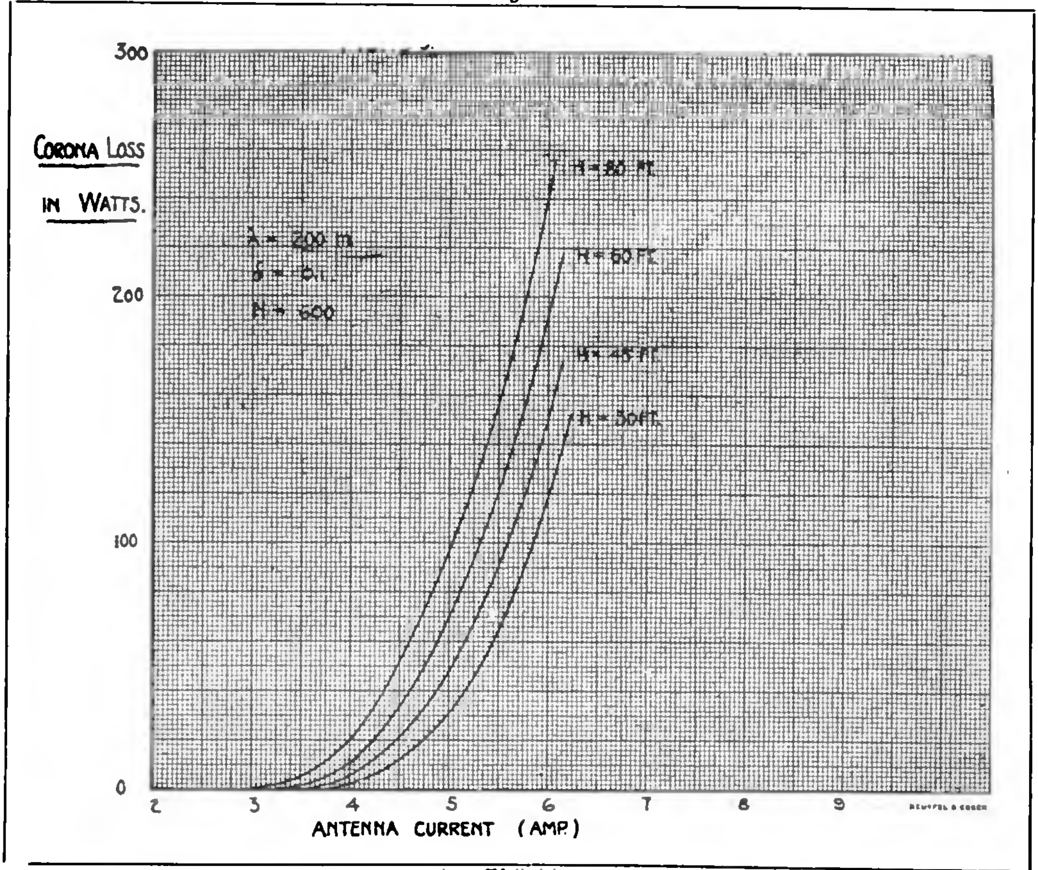

CORONA LOSS
IN WATTS.
300
200
100
0
λ = 200 m
H = 60 FT.
H = 50 FT.
2
3
4
5
6
7
8
9
ANTENNA CURRENT (AMP.)

Fig. 17

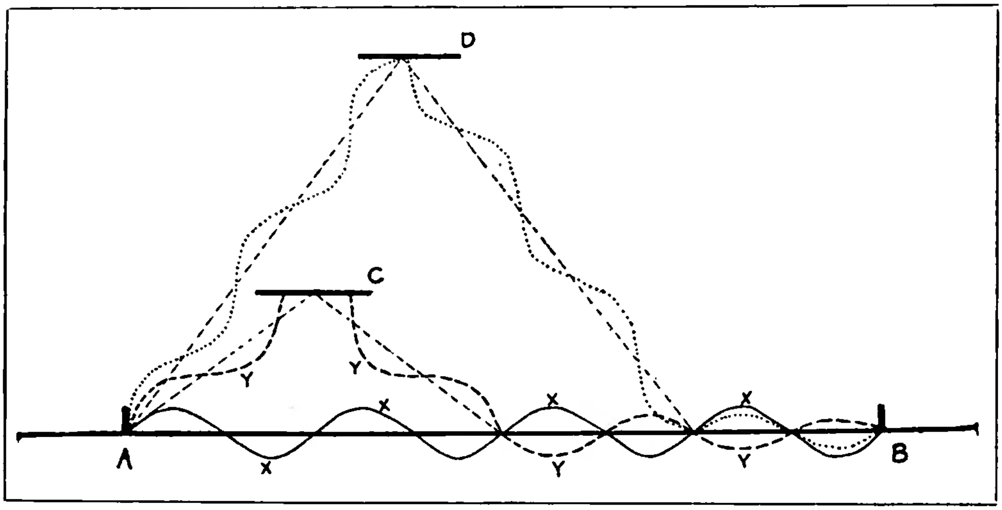


Fig. 18

midnight when it again falls off with the approach of sunrise. The dotted lines of Figure 18 show the fading effects. The solid line shows the general trend of transmission; this is an average curve drawn through the observed points. It is to be especially noticed that the best time of night is not midway between sundown and sunup, but is usually about an hour later than this—about one or two o'clock in the winter at the latitude of St. Louis.

One very likely explanation of the better transmission at night rests upon the fact that during the day the ultra-violet rays of sunlight render the upper layers of the earth's atmosphere conducting by splitting up the air molecules into positive and negative ions. This causes energy to be abstracted from the waves and dispersed upward into the higher strata of space, thus weakening received signals. At night, however, there are no ultra-violet rays to produce ionization. The homogeneous atmosphere then takes on the property of a perfect insulator and the waves travel with very little absorption and dispersion.

The ions, which render the air conducting (especially at high levels) during the daytime, do not, however, disappear at once with the setting of the sun, but it takes an appreciable time—several hours—for them to completely dissolve or disperse. This results in gradually improving transmission conditions after nightfall, as shown in Figure 18. The improvement is not an abrupt one. It is only toward the middle of the long winter nights that all of the ions have had time to disappear; and at this time one wave is as good as another as far as the absorption is concerned because all waves are then unabsorbed. Our tests support this unabsorbed transmission hypothesis near midnight.* It is likely that in summer, when the nights are compartively short, there is not sufficient time for the ionization of the preceding day to entirely disappear before that of the next day's sun is felt, and therefore, even at midnight there is considerable ionization and absorption of the waves. It is well known that transmission is much better on winter nights than it is in summer.

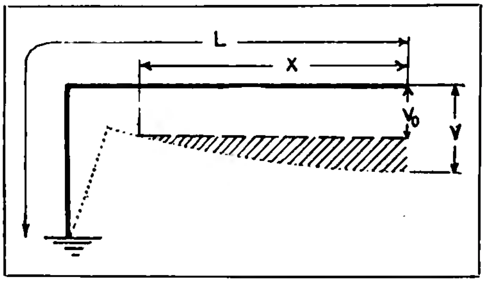


Fig. 15

If the above theory is correct it is therefore not at all the surprising fact many have thought for amateur transmitters to send 1,000 miles at one or two o'clock on a winter night. If we go back for a moment to the Austin transmission

* Proceedings Institute Radio Engineers, l. c.

formula discussed in Part I of this paper, and put into it the condition that the waves travel without absorption, then instead of the absorption factor 0.0762 we have to use 0. The formula then becomes:

$$I_r = \frac{635\ I_s\ h_1\ h_2}{\lambda\ d} \qquad \text{.............} \quad (17)$$

Solving this for distance:

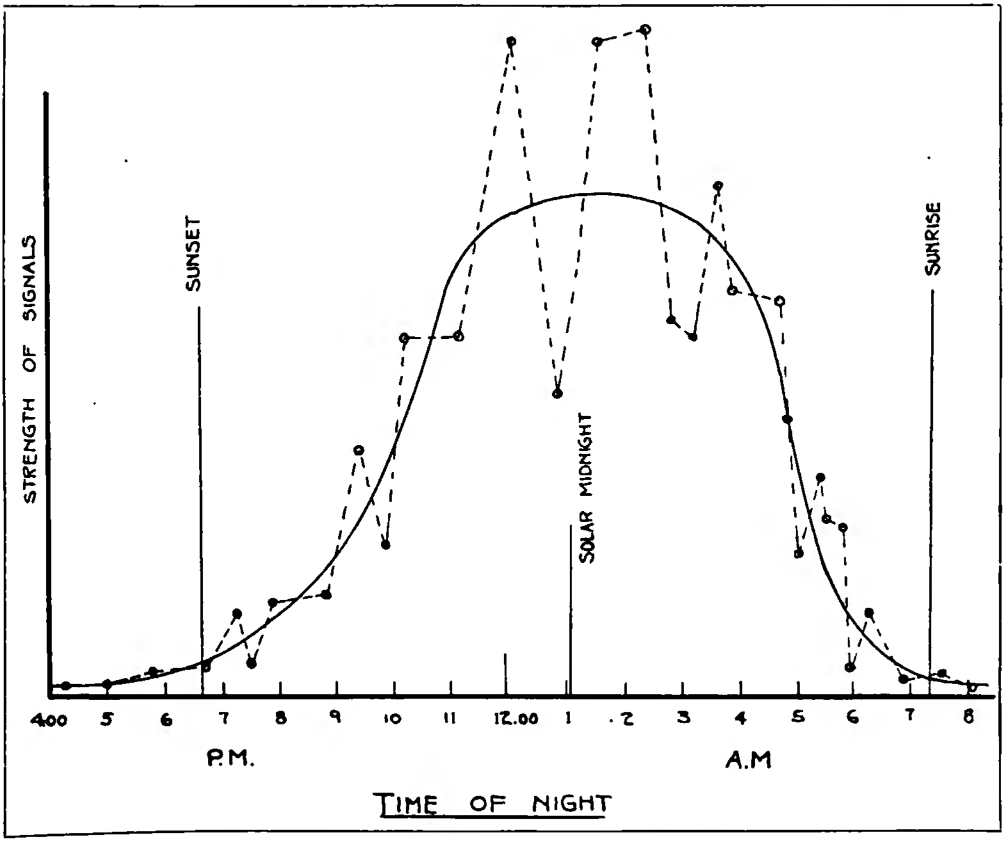


Fig. 19

$$d = \frac{635\ I_s\ h_1\ h_2}{\lambda\ I_r} \qquad \text{..............} \quad (18)$$

This is a midnight, winter transmission formula.

As an example, let $h_1 = h_2 = 50$ ft., $\lambda = 200$ m., $I_s = 4$ amps., and $I_r = 40$ microamps., which corresponds to good readable signals. Then,

$$d = \frac{635 \times 4 \times 2500}{200 \times 40} = 800 \text{ miles.}$$

We thus have a range of 800 miles, barring the effects of reflection and consequent fading, etc., discussed in the foregoing; and there is no wonder attached to regular communication between two such stations during the middle of a winter night.

It has been shown that when absorption exists, that is, particularly during the late afternoon and early winter evenings, the usual transmission formula given by Austin applies to amateur stations, and at those times it is very important to properly proportion the antenna to the wave-length, the distance and the aerial current. When the proper combination and proportion of these quantities are obtained, considerable distances, of the order of 200 to 300 miles, are quite feasable and can be consistently covered with 200 meter wave-lengths. A number of amateurs have apparently hit upon the proper adjustments through chance, and to less fortunate co-workers the results obtained seem startling.

VESSELS RECENTLY EQUIPPED WITH MARCONI APPARATUS

Names	Owners	Call Letters
Cauto	New York & Cuba Mail S. S. Co.	K W F
Panuco	New York & Cuba Mail S. S. Co.	K W M
Kuskokwin River	Westward Navigation Co.	W L K
Jos. R. Parrott	Florida East Coast Ry. Co.	K J P
Maryland	Crew Levick Co.	K I N
San Rossore	Furness Withy & Co.	I O A (temporary)
Oregon	Wilson Bros. & Co.	(Unassigned)
Idaho	Wilson Bros. & Co.	(Unassigned)
Wm. Rockefeller	Standard Oil Co. of New Jersey	K W O

THE SHARE MARKET

New York, October 6.

There has been little change in the market as regards American Marconi shares. Traders have remarked on the fact that the stock is not higher in view of the activities of the American Marconi Company, calling attention to the fact that it has recently received large orders from abroad for wireless sets as well as from the United States Navy. They are optimistic, however, and look for better prices in the future.

Bid and asked quotations today:

American, 3⅜—3⅝; Canadian, 1¾—2¼; English, common, 14—17½; English, preferred, 13—16½.

SAN DIEGO STATION COMPLETED

The third of five wireless links in the United States Navy's chain extending from Washington, D. C., to Cavite, P. I., via the Panama Canal, has recently been completed at San Diego, Cal. San Diego's link consists of three towers, each 600 feet high. They will connect with the two stations already in working order at Arlington, Va., near Washington, and in the Canal Zone, halfway between the canal's Atlantic and Pacific terminals, and with the proposed station at Pearl Harbor, Honolulu. The Honolulu station will connect the Philippines with the United States.

It has been announced that the formal opening of the station at San Diego will take place later, possibly not before December 1. A force of twenty operators will be on duty at the station. The equipment provides for the reception and dispatch of messages at the same time. Lieutenant J. M. Ashley of the Navy will be in command at San Diego.

REDUCTION IN ALASKAN RATES

The Marconi Wireless Telegraph Company of America made a substantial reduction in its telegraph rates in the Northwest beginning October 1st. The rate previously charged for messages from Seattle, Wash., and Astoria, Ore., to Juneau and Ketchikan, Alaska, was $1.25 for ten words and twelve cents for each additional word. The new rate is $1 for ten words and ten cents for each additional word. The company opened its Alaskan chain of stations a little more than a year ago.

SHOPPING BY WIRELESS

The wife of the Colombian minister of the United States, traveling on one of the fruit liners on her way to New York, lost her hat overboard, relates a newspaper. She immediately went shopping by wireless and ordered a hat in New York, acquainting her husband with the transaction. He was in New York and when the steamer reached port he met his wife at the dock and handed her the hat she had purchased in such an uncommon way.

Experiments With an Indoor Aerial

By W. G. Cady

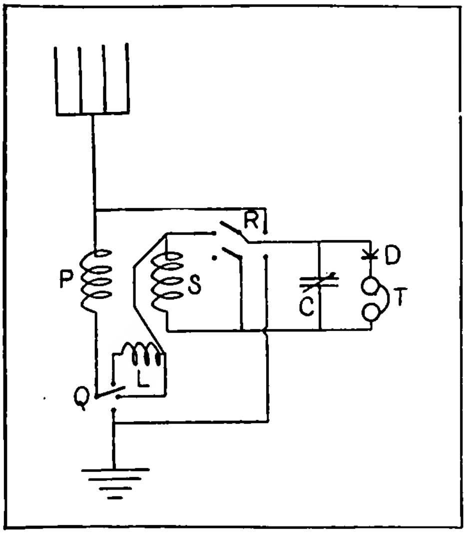
THE opinion seems to be commonly held that an indoor aerial is practically useless for receiving, except over short distances. It may be encouraging to some readers who have no outdoor aerial to know what can be accomplished indoors under fairly favorable conditions. The indoor aerial has the advantages of being cheap and safe, free from danger of lightning, and outside the pale of insurance regulations.

The house in Middletown, Conn., where these tests were carried out, is a wooden frame dwelling with a shingle roof, standing near the top of a slope. Many trees and electric wires are in the neighborhood, and close to the house are several trees that tower high above the roof. The antenna is of the umbrella type, and is tacked to the rafters of a loft over the attic. The floor of the loft measures about 21 by 26 feet. From the central point overhead, about 35 feet from the ground, half-a-dozen wires, from 8 to 15 feet in length, run off at a slant in various directions. One of the wires is continued down through the floor to the second story of the house, where the receiving apparatus is located.

Electric light conduits and telephone wires in the attic pass a few feet from the aerial wires. A switch at the receiving apparatus disconnects the latter from the aerial, when the station is idle. This is partly to protect the detector from static, partly because during a thunder storm the roof is perhaps less likely to be struck by lightning if the wires immediately under the shingles are not grounded.

From the station, the ground wire runs to the kitchen immediately below, where it is connected to the water pipes. All aerial wires are well soldered together. They consist of old electric light wire about size 14, held down with double-pointed tacks. This sort of insulation would not do, of course, for transmitting, unless it were planned simply to send for a short distance by means of a buzzer.

The apparatus consists normally of a home-made receiving transformer of 1,000 meters maximum wave-length, Blitzen condenser, Western Electric 1,500-ohm receivers, and Crystaloi detector. Galena and ferron detectors have also been successfully used, while a



Baldwin 'phone responded audibly to N A A when held a foot from the ear.

For receiving at a wave-length above 1,000 meters, primary and secondary coils of the transformer are connected in series and the detector circuit is connected across the two. This is a simple and effective way of greatly extending the wave-length of any receiving transformer. The connections are as shown in the accompanying drawing, in which P is the primary and S the secondary of the transformer, D and T the detector and 'phone, respectively. When the D.P.D.T. switch, R, is to the left, primary and secondary are separate, and each plays its usual part. When R is closed to the right, primary and secondary are in series, and the connections are similar to those of a single-slide tuner. Whenever R is to the left, the 3-way key, Q, must be in its lowest position, *i. e.*, with antenna grounded through coil P. When R is to right, Q is set at its middle point, except for very long waves, when it is set at the highest point, thus throwing the loading coil, L, into the circuit. L may, of course, be omitted.

When P and S are in series, the wave-length can be altered by varying the number of turns of either coil or by varying the coupling. It is important to make sure that the current circulates through both cells in the same direction, making practically a two-layer coil out of the combination. The distributed capacity added to the circuit by this arrangement is too small to cause trouble.

By slight further complication it would be possible to make the system equivalent to a two-or three-slide tuner, but I have not found this necessary. This form of connection is useful for picking up stations of all wave-lengths, as it is only necessary for one adjustment to be made at a time.

When the coils are close-coupled, with all turns in series (coil L not being used), resonance with the 2,500-meter signals from N A A is attained when a small fraction of the capacity of the condenser is in parallel.

By using with any receiving transformer the connections shown in the drawing, the range of received wave-lengths can be increased four-fold. Of course signals are not as loud, nor is the range as long, as if an inductively coupled tuner of large size were used, still the results are surprisingly satisfactory. The principal limitation is, that it is not easy to tune out interference.

In addition to hearing N A A day and night at all seasons, it is generally easy at the station here described to read stations on the Atlantic Coast and many amateurs within a radius of fifty miles.

If the roof is wet with rain, signals are dimmer. It might be expected that when the roof was wet and hence more conductive, the capacity of the aerial and therefore the wave-length would be increased, but I have not found this to be the case.

By means of a wave-meter the natural wave-length of the aerial was found to be about 140 meters, and its capacity 0.0003 microfarad. These values are remarkably large, considering the dimensions of the aerial. This is doubtless due to the grounded conducting material in the house.

Few amateurs realize how simple a tuner is needed for receiving such long waves as those from W C C or N A A, if one possesses a good detector and receiver. For example, the writer has sometimes removed the receiving transformer entirely, and in place of it connected between antenna and ground three coils in series, each coil being nothing more than a closely wound "hank" of magnet wire about six inches in diameter. Such coils can be wound in a few minutes around a tin can or even around the spread fingers of one hand. No attempt at winding regular layers is necessary—in fact, the capacity of the coil is less if the winding is done at random. After winding, the coils are slipped off, the turns bunched together, and wrapped with a little string or tape to keep from spreading.

The coils mentioned had about forty, fifty, and seventy turns, respectively, of Size 18 wire. For most stations, two coils of 150 turns each are recommended. In parallel with these coils, between antenna and ground, the detector and phone are connected in series. The phone may, of course, have a fixed condenser in parallel with it. As is well known, the self-inductance of a closely wound coil varies with the square of the number of turns. Hence when two similar coils are laid on the table, one on top of the other, so that the current traverses each in the same direction, the self-inductance is nearly four times that of either alone; if now one coil is simply turned over, the self-inductance becomes a small fraction of that of either one. Thus by leaving one coil on the table, and moving the other about or turning it over, the system can be tuned continuously over a very wide range of wave-lengths.

With the three coils used by the writer, results were similar. Unfortunately the lowest wave-length that can be depended on is about 1,000 meters, owing to the comparatively large distributed capacity of the coils, but from 2,000 meters up, this crude arrangement gives results which in loudness are not so very inferior to those from an expensive tuner. Trouble from interference is also not as great as might be expected, especially if large wire is used and all connections are perfect. Flexible leads of lamp-cord should be used to connect the coils in series.

Middletown is about 300 miles from Arlington, yet time signals, news, and weather reports are very easy to copy, using the indoor aerial, with the simple apparatus described. No variable condenser is necessary if the coils have enough turns. Of course, the coils must be kept at a distance of some inches from masses of metal.

I have occasionally found the system to be in resonance with 600-meter stations, when the antenna system was tuned to five or seven times this wave-length. This is because an odd harmonic of the fundamental oscillation of this complex system of self-inductances and distributed capacities may happen to be especially prominent.

ODDS AND ENDS

(Continued from page 102.)

Safety Gap for High Potential Transformer.—During the adjustment of the rotary spark gap, the secondary winding of the high potential transformer should be protected by a safety gap.

The design in Figure 9 is applicable. Two brass rods ¼ inch in diameter have balls ½ inch in diameter mounted on the end. A third ball is placed in the center and thoroughly connected to earth. The actual distance between A and B (Figure 9) depends upon the potential of the transformer, but ordinarily the spacing is no more than ½ inch between the three electrodes. Then, if the spark gap proper of the closed circuit is widened to abnormal length, a discharge takes place from A to C, B to C, thereby protecting the windings.

Crystalline Detectors.—Sensitive crystals may be protected from dust or dampness by placing a few drops of oil on the used surface. This will not interfere with the action of the detector, but will prevent it becoming inoperative under the conditions.

Several inquiries have been made regarding the leak resistance for the vacuum valves.

The static leak between the grid and filament of the vacuum valve has a resistance value lying between 500,000 and 2,000,000 ohms. A strip of paper placed underneath two binding posts and a lead pencil line drawn between them will give about the required value. The paper and the pencil line should be about 2 inches in length.

A PRIEST WHO MADE A NAME IN WIRELESS

The death of the Rev. Father Archibald John Shaw, scientist and artist, in Melbourne on August 28th, marked the passing of an interesting figure in wireless in Australia. Just previous to his death he had completed the contract for the sale of the plant of the Shaw Wireless, Ltd., to the Australian Navy Department for $275,000, of which he was to receive half for his share.

Father Shaw was born near Wagga about forty-four years ago, and did not enter the priesthood till he had gone through a training which laid the foundation of his recent success. As a young man he was employed for some time at Sydney, as a telegraph operator.

Eight or nine years ago the telegraph operator found the priest again. At the time of his death he had a number of wireless patents and a powerful plant. The first company was the Maritime Wireless Shaw System, Ltd., and with new capital and new business it became the Shaw Wireless, Ltd.

After the explosion

The Seventy-Seventh Voyage of the Tennyson

As recorded by Reginald Merry, wireless operator

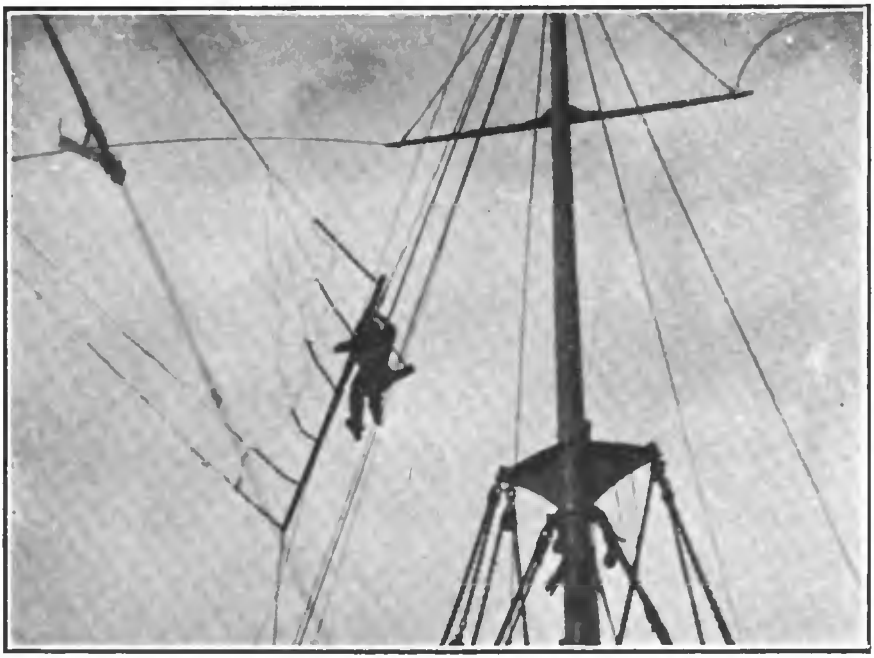
IT was a gloomy outlook for the ship's company of the s.s. Tennyson when they were informed that the vessel was scheduled to steam from New York for the tropics on December 24—the day before Christmas. In port only a few days after a tedious voyage of four months, we had been looking forward with considerable pleasure to spending the holiday season ashore. So it was with somewhat heavy hearts that we watched the receding sky line of the city as the Tennyson steamed through the Narrows and left Sandy Hook astern, well under way for Santos, our port of destination—5,000 miles distant.

Christmas day dawned cheerless and cloudy, with a strong wind whipping the waters into formidable looking waves. The wind increased in force as the day wore on and late in the afternoon the ship was rolling and pitching as if she might at any moment turn over and hurl us into the sea. Old sailors said that they had never before seen the gale equalled in fury. One wave reached such a height that it knocked the bottom out of the crow's nest, carried away one of the sky lights on the boat deck and moved a life-boat out of its chocks. Weird beyond conception were the tricks played by the gale. Terrific gusts, shrieking like thousands of demons, would seize the ship in their grasp, apparently seeking to rival the force of the gale. Then, above the roaring of the blow, could be heard the plaintive wail of the steamship's whistle as the wind seized the wire cord that controlled it.

These weather conditions prevailed for four days and of course we of the wireless cabin momentarily expected to hear of ships in distress. Therefore, we were not surprised when the Thessaloniki on December 27 sent out calls for aid, saying that she was sinking. We were not near enough to be of aid, but we heard other vessels answering her appeals.

The storm at an end, our voyage proceeded, for a time, with nothing but pleasant incidents to mark its course, and we arrived at Santos on January 15. Here the Tennyson was loaded with bananas, leaving in the evening for Montevideo, where she docked four days later. At Buenos Aires, our next port of call, we loaded a cargo of quebracho, a gum-like substance used for dyeing, extracted from a tree in the Argentine.

Eight days later saw us safely anchored in Bahia Bay. Here we loaded hides and sixteen cases described as



Repairing the aerial

"photographic samples." The latter looked harmless enough but—however, I'll go on with my story.

The unexpected occurred five days after we had left Bahia for Trinidad, our next port of call. I was asleep in my bunk at fifteen minutes after four o'clock in the morning when an explosion so terrific that it can only be likened to the simultaneous discharge of a hundred cannon, shook the vessel and made her seem about to leap out of the water Slipping hurriedly into my clothes, I rushed to the deck. Here an indescribeable scene of havoc met my eyes. The entire after end of the ship had been blown away and the decks twisted about as though they were playthings in the

which probably weighed a quarter of a ton, had been blown over the mainmast and crashed through the boat deck. But most alarming of all was the sight of the flames started by the explosion which, it was afterwards determined, was due to a bomb in the hatch where the "photographic samples" had been placed.

Of the eight men sleeping aft only five escaped death. One of the survivors—the ship's carpenter—obtained an axe as soon as he had made his escape and groped his way back through the flames and smoke to rescue another member of the crew who was hemmed in his room. The carpenter succeeded in smashing two deck planks over the room of the imprisoned man and then, exhausted by his efforts and partly overcome by the flames and smoke, he abandoned his attempt.

The wireless had not escaped damage, the antenna having been torn from the mast and hurled to the deck, a tangled, twisted heap. It was a situation that called for quick action, so we obtained two wires and ran them up to the signal arm on the foremast and down to the cabin. The dynamo continued to operate and, having obtained the ship's position, The crew had been playing the water from the fire hose on the flames and this was not without its effect. Another encouraging sign was also discovered in the fact that the ship was not leaking, and hope began to be entertained that the vessel could be saved. By noon time the flames were so well under control that it was possible for members of the crew to make their way aft. The engines were still in good order, although the steering gear had been considerably damaged, and, a jury rudder having been rigged up, it was decided to navigate the vessel at half speed, toward Maranhao, 180 miles away.

We were without an adequate chart of the coast toward which we were headed, but the weather conditions were favorable and the vessel made steady progress. However, as we neared the coast a storm blew up and the Tennyson, too badly crippled to combat it, ran her nose into a sand bank. She was released without great difficulty from this predicament, however, and steered to a safe anchorage.

The next morning a pilot boarded the vessel and we arrived in due time at Maranhao. There were no facilities here to make repairs to the Tennyson, however, and consequently she steamed for Para, still using the jury rudder. Calm weather prevailed during the trip and for this I was thankful as we had rigged up a two-wire aerial which I was fearful would be displaced in the event of a storm.

At Para the cargo and wreckage was removed from the ship and then it was towed to a small place called Val-de-Caes, where the work of patching up the Tennyson began.

Here we remained for seven weeks. At length the Tennyson steamed back to Para to load what remained of her cargo. At Para we rigged another two-wire aerial from the foremast, and, as the mainmast was missing, we ran it to a spreader on a flag staff on the poop.

April 26 was a red letter day for us, for on that date we steamed for New York, via Barbados. The Tennyson had been only two days out of Para, however, when the carpenter was stricken with illness and it was feared that he had yellow fever. At Barbados a physician came aboard, but he was unable to determine the exact nature of the carpenter's illness. Three other physicians were no more successful and they ordered that he be taken to the quarantine hospital on Pelican Island where he died. Following his death, the captain of the Tennyson was directed to bury the carpenter's body five miles out at sea.

These incidents of course resulted in delay in getting again started on our voyage for New York. In fact many of us believed that the carpenter's death was due to some contagious disease and we were prepared to become reconciled to a quarantine. Great was our surprise

Havoc was on all sides

therefore in the afternoon following the burial to be informed that the carpenter had died from acute meningitis and that the Tennyson was free to leave port. The crew needed no urging to make haste in their preparations for departure and at midnight the vessel was showing her heels to Barbados.

As if to make up for previous neglect, good fortune smiled radiantly on the Tennyson during the last leg of her voyage. Excellent weather prevailed and the vessel made a speedy trip to Sandy Hook. A short time afterward saw us at Quarantine and with the high tide we went to dock. In this manner was the seventy-seventh voyage of the Tennyson ended.

Photo Electric Phenomena*

By Dr. J. A. Fleming, F. R. S.

THE Phenomena of Light and Electricity are so closely connected that we may truthfully say the study of both is embraced within the confines of a single branch of science.

The term photoelectricity is, however, restricted to the description of a particular effect—viz., the power of light of certain kinds to cause an electric discharge or leakage of electricity from many substances, or under some conditions to produce an electric charge, or electromotive force or ionization.

The starting point for this subject is found in an observation Hertz made in the course of his celebrated researches on the production of electric waves, in which he noticed that the discharge in the form of an electric spark between two balls is facilitated when light from another spark falls upon them.

This effect can be shown by a special form of apparatus devised by the writer. It consists of two upright strips of wood carrying copper strips which are connected at two places by a pair of spark balls, adjustable as to distance. The lower pair of balls are inclosed in a glass box, whilst the upper pair are exposed in the air. The copper strips are connected to the inner and outer coatings of a pair of Leyden jars, and these again to an induction coil. When the coil is in action, electric sparks jump across between the balls. We can then adjust the two spark lengths so that the sparks always take place between the two bottom balls in the glass box, because these balls are a little closer than the upper pair. If we now illuminate the upper balls by the light from an electric arc, or a piece of burning magnesium wire, or the light from another electric spark between zinc balls, or else points of Invar, which is a nickel-iron alloy, we see that the sparks discharge at once takes place between the upper balls. This effect is not due to the visible or eye-affecting light, because the interposition of a sheet of glass or mica stops the effect. On the other hand, a sheet of transparent quartz does not. Hence we infer that the action is due to the ultra-violet rays in the light, or those of very short wave-length. The material of which the spark balls acted upon are made does not seem to have much influence. Experiment also shows that the chief part of the effect is due to the action of the ultra-violet light on the negative spark ball.

These observations were made by Hertz in 1887, and immediately suggested lines of research to others. Hallwachs soon afterwards discovered that the same kind of light could discharge electricity from a negatively electrified zinc plate.

If a plate of zinc, or better, magnesium which has been recently well polished with emery paper, is placed on an insulating stand connected with a gold leaf electroscope, and a charge of negative electricity given to it, it is found that the charge rapidly disappears if the plate is exposed to the light of an arc lamp. The experiment succeeds better if an uninsulated brass grid or plate of coarse gauze is placed between the plate and the light. If the plate is oxidized or tarnished, or has been long exposed to the air since polishing, then the discharge of negative electricity from it proceeds much more slowly. If the plate is positively electrified, the discharge does not take place, or but very slightly.

We may show the experiments in another way. If we insulate a piece of brass gauze and connect it to an electroscope and charge it with positive electricity, then, if the insulation is good, there should be no leakage. If then we

* From "The Year Book of Wireless Telegraphy and Telephony, 1916."

hold near to the gauze a polished plate of zinc, magnesium or aluminum which is uninsulated, we find that no discharging effect takes place until light from an arc lamp or other source of ultra-violet light illuminates the polished plate, and then the positive electricity of the electroscope is discharged.

These experiments may be modified by employing a very sensitive galvanometer in place of an electroscope. If we connect to the negative terminals of a high potential battery a polished zinc plate, and to the positive terminal a piece of metal gauze, and insert in the circuit a galvanometer, and then bring the gauze near to the zinc plate, we find no current as long as the zinc plate is not illuminated. If, however, a strong light, rich in ultra-violet rays, is thrown through the gauze on to the zinc plate, the galvanometer at once gives indications of an electric current which is called a photoelectric current.

Light Effects Escape of Electrons

The consideration of all these effects shows that there is a leakage of negative electricity from negatively electrified bodies when they are exposed to light, chiefly ultra-violet light. In modern terminology we say that light falling on certain substances causes an escape of electrons from them.

Many things affect this photoelectric discharge.

First, the nature of the body itself. Some are highly photoelectric, such as zinc, magnesium, potassium, sodium, rubidium. Broadly speaking, the most oxidizable metals are most photoelectric, and the photoelectric order is very roughly that of the electro-chemical series, the most electropositive being the most photoelectric.

Secondly, the physical nature of the surface, whether polished or tarnished, smooth or rough, has a great deal of influence, and,

Thirdly, the nature of the atmosphere or surrounding gas.

A convenient method of exhibiting these facts and testing various substances is by an apparatus as follows:—It consists of a box within which is contained a series of spark gaps between Invar points. The ultra-violet light radiated passes out of an aperture covered with a thin transparent quartz disc and passes down a tube and falls upon a disc of the substance under test. Around the outside of the tube, but so protected as not to be affected directly by the light, is an insulated metal ring which is connected to an electroscope. This ring is given a charge of positive electricity. When the spark light shines on the disc under test, it liberates from it negative electrons. This discharge passes through the air and discharges the positively charged metal ring. By observing the time taken for the electroscope to be discharged we can compare various substances, solid, liquid or in powder, with each other with regard to their photoelectric activity in air. The results, however, of such observations in air must be interpreted with caution. It must be noted in the first place that the radiation most effective in the case of one metal or subtsance is not so in another, and, moreover, the nature of the surrounding atmosphere affects the result. Also, we have to take into account a very noticeable effect which is commonly called *photoelectric fatigue.* It is found that the sensitiveness of a freshly cleaned surface of metal rapidly decreases if the metal is left exposed to the air. It has been found that this depends much on the size of the vessel in which the substance is kept. In the open air photoelectric fatigue progresses most rapidly, but less so if the body is kept in a closed chamber. The term "fatigue" is not very appropriate, because the photoelectric sensitiveness is not recovered on resting.

Photoelectric Deterioration

Elster and Geitel found that a freshly polished zinc surface lost half its photoelectric sensitiveness in five minutes. Hoor noticed that for freshly cleaned metals, zinc, copper and brass, the activity was reduced one-tenth of its initial value by exposure for forty-eight hours to the air. The effect, however, is not due or wholly due to oxidation of the surface, because it takes place in hydrogen as well as in air. Again, it takes place in the case of such insulating materials as sulphur, shellac and paraffin, which are not oxidizable. It would be more apropriate to call this falling-off the *photoelectric deterioration.*

The reasons for this photoelectric deterioration have not yet been fully ascertained, but as far as the evidence goes, it seems to be due to a peculiar condition of the gaseous layer adhering to the surface of bodies. It is suspected that in some cases it is due to the formation of a film of hydrogen peroxide, which is extremely absorbent of ultra-violet light, and this again may be due to the action of the ultra-violet light on aqueous vapor in the air, or moisture condensed upon the surface, according to the chemical equation $2H_2O = H_2O_2 + H_2$.

Experiments seem to prove that pure clean metal surfaces in a very high vacuum show no photoelectric fatigue.

How to Obtain Consistent Results

Accordingly, experimentalists sooner or later realized that consistent results can only be obtained when we experiment with freshly prepared surfaces in a very high vacuum. This, however, introduces great experimental difficulties, and it is necessary to devise methods for distilling or preparing the metal or other substance in the vacuous tube. Some years ago the writer described methods for doing this in the case of the liquid potassium sodium alloy, which is very highly photoelectric, and, moreover, sensitive to ordinary visible light. Small lumps of potassium and sodium are placed in a glass tube, the weights being in atomic ratio—viz., about 2 to 1. When this is melted in vacuo it produces a liquid alloy resembling mercury, which can be tilted off from the solid dross or oxide. If such liquid alloy is placed in a clean part of the exhausted tube provided with an electric connection, consisting of a platinum wire sealed through the glass, and if there is a clean platinum plate, also with an external electrode placed over and near to the alloy surface, we can observe the following facts:

First, the alloy surface rapidly discharges negative electricity when light from an arc lamp falls upon it. Also when illuminated the alloy discharges positive electricity from the platinum plate, provided the alloy is kept connected to the earth. Most remarkable of all is the fact that the alloy when illuminated actually generates an electric current. If we connect a sensitive galvanometer to the alloy and to the platinum plate, then in darkness there is no electric current; but when a bright light falls on the alloy surface the galvanometer indicates a current, and this current is in the opposite direction to that which would flow under the volta contact potential difference. That is to say, the negative electricity comes out from the terminal connected to the platinum plate and flows through the galvanometer back to the terminal connected to the alloy. This proves that light causes an emission of negative electrons from the alloy surface, which has an electromotive force greater than the contact E. M. F. due to platinum and potassium.

The strength of the photoelectric current varies with the color of the light thrown upon it—that is, with the wavelength. Elster and Geitel found that this negative leak is greater for potassium than for sodium, provided we employ white or blue light, but for yellow light sodium is more photoelectric than potassium, and rubidium is vastly greater than either of them, both for white and for yellow light.

Photoelectric Metals

The writer showed that several such photoelectric cells could be joined in series to make a photoelectric battery. If it were possible to obtain the rare metal rubidium in large quantities, it would be possible to construct a rubidium photoelectric battery of a large number of cells, which would create a considerable electric current merely by illuminating the rubidium surface. It is needless to say that the energy represented by this current would be drawn from the light energy.

We may next pass on to notice some curious and interesting facts with regard to the photoelectric properties of various classes of substances, solid and liquid.

It has been mentioned that the most photoelectric metals are the electropositive ones, rubidium, potassium, sodium, magnesium, zinc, aluminum, etc. The least sensitive are the electronegative and non-oxidizable metals, platinum, gold, silver, palladium. Metals such as copper, iron, and nickel occupy an intermediate position.

There are, however, many compounds of metals and non-metals which are highly photoelectric, such as the sulphides and iodides, especially the sulphides. These sulphides may be roughly arranged in the following order, the most photoelectric standing first:—Sulphide of lead, copper, manganese, silver, tin, iron, chromium, bismuth, nickel, antimony, zinc, cadmium, cobalt, and molybdenum. The native sulphide of lead called galena and the native double sulphide of copper and iron, called chalcopyrites or copper pyrites, are markedly photoelectric; whilst the native sulphide of molybdenum, called molybdenite, is very insensitive.

Photoelectric Effects

Again, the phosphorescent sulphides of barium, calcium and the alkaline earths are very photoelectric. Flourspar, which is a fluoride of calcium, is also photoelectric; and silver iodide is said to be remarkably photoelectric under ultra-violet light.

Another important class of substances which exhibit photoelectric qualities are the aniline dyes. Not only is anthracene photoelectric, but also eosin, fluorescine, fushin; and aniline green and violet are very sensitive in the solid as well as in solutions.

There is a certain conection, in fact, between fluorescence, phosphorescence, and photoelectric leak or discharge, and, broadly speaking, the fact that a substance is fluorescent is generally an indication that it is photoelectric and will lose negative electricity when illuminated by ultra-violet light.

With regard to liquids, many experimentalists agree that pure water shows no photoelectric effect when illuminated by the electric arc. Soapy water is intensely non-photoelectric, and even very sensitive materials, such as clean zinc, lose sensitiveness if smeared with soapy water.

Generally speaking, flourescent liquids are photoelectric, and I have noticed a marked leak of negative electricity from the surface of paraffin oil, which is well known to be flourescent.

The flourescence of a body is a property of it in virtue of which it has the power to create a change in refrangibility of light. It absorbs, say, ultra-violet or non-luminous light and radiates or emits violet or visible light. A typical instance of this is a solution of sulphate of quinine.

At this point we may with advantage consider in outline the explanations which have been offered to account for photoelectric effects.

According to modern views, we regard electricity as having an atomic structure, and the atoms of negative electricity, called electrons, are constituents of chemical atoms. All electric conduction and electric currents are considered to be due to a movement or drift of electrons in or between chemical atoms or molecules. All radiation is effected by oscillations of electrons, which create ether or electric waves when the velocity of the electron is being changed. Hence an electron radiates only when it is being accelerated. Again, the forces binding together atoms into molecules are electric forces due to electric charges. Hence we may classify the electrons in a certain manner depending on function. We have to consider the conduction electrons, the radiation electrons, and the valency electrons. This does not imply that the same electron may not function in all three ways. It is merely a classification for the sake of distinction.

Conduction Electrons

The conduction electrons may be regarded as the molecules of a kind of gas. They are assumed to be in rapid irregular movement, and, in good conductors, to be about as numerous as the chemical atoms. Their velocities are distributed according to the same law as those of gas molecules. These free electrons cannot, however, escape from the conductor, because if they did they would leave it positively electrified. In the next place we have those electrons the vibrations of which create the radiation or spectrum of the body when incandescent or luminiscent. Lastly, there are electrons more or less loosely attached to the atom, up to the number of eight, which by entrance to or exit from the atom give rise to the atomic electric charges proportional to the chemical valency, and so effect chemical combination.

The question then arises, to which of these classes do the electrons belong, the escape of which constitutes the photoelectric discharge? If light discharges negative electricity, this implies that light causes an escape of negative electrons. We then ask, what electrons are these, and how is this escape brought about?

Dealing first with the conduction electrons, it may be noticed that there is no good evidence that these are liberated in the photoelectric effect. If they were, one would think the body should become a worse conductor when illuminated. Since, however, in good conductors the conduction electrons are extremely numerous, probably about as numerous as the atoms, there might be a considerable loss of conduction electrons without sensible or measurable loss of conductivity. On the other hand, one well-known case in which light affects conductivity is that of selenium. The effect of light falling on it is to increase conductivity. Again, light is said to increase the conductivity of sodium vapor, and Arrhenius found that the haloid salts of silver increase in conductivity under the action of light.

Conductivity and Ultra-Violet Light

There is no well marked case of decrease in conductivity under the action of ultra-violet light. The author has found one interesting connection between photoelectric sensitiveness and conductivity. It is well known that the contact between certain pairs of substances has a unilateral conductivity. Thus the contact between zincite (native oxide of zinc) and chalcopyrite (copper pyrites) conducts negative electricity better when flowing from zincite to chalcopyrite across the junction than in the opposite direction. The same is true for a junction between molybdenite (native sulphide of molybdenum), and copper, also between plumbago (carbon) and galena (sulphide of lead). Again, a junction of tellurium and aluminum, silicon and steel, carbon and steel, and several other pairs of metals and non-metals, such as gold and iron pyrites (native persulphide of iron), have similar unilateral conductivity.

It has been found that almost without exception, of these pairs of substances which so act, one of them has great photoelectric sensitiveness and the other one small. The two materials which compose a rectifying contact always differ greatly in photoelectric sensitivity or power. The one which loses negative electricity most easily under the action of ultra-violet light is always the sulphide, or else the good metallic conductor. The largest negative current flows across the junction from the material of small photoelectric activity to the one of large activity. For example, chalcopyrite is vastly more photoelectrically sensitive than zincite, and the largest current flows across the junction when the zincite is the negative terminal or electrode, or is attached to the negative pole of the battery.

Sensitiveness Dependent on Molecular Grouping

Whatever may be the proper interpretation of these facts it appears clear that photoelectric sensitiveness is not an atomic property, but is a molecular one, and depends also on molecular grouping. Also we cannot trace any definite relation between this property and electric conductivity. Accordingly, we are obliged to assume that there are in connection with certain molecules or groupings of atoms certain electrons which can be set free by light of short wave-length.

The question then arises: How does the light act? Is it a simple resonance action in virtue of which the luminous vibrations work up these loosely attached electrons to such an amplitude that they break loose from their moorings and are shot off, just, for instance, as water waves might cause a boat to break loose and drive it away? If this were the case, it would seem most probable that the more intense the light—that is, the greater the amplitude and energy of the light waves—the more effective it would be, and the greater the velocity of the electron which is detached and flung out. Also it would appear likely that high temperature in a body, by increasing the electronic motion, should promote or increase photoelectric effects. But two very remarkable facts have been discovered which are quite inconsistent with this resonance theory. The first is that the maximum velocity with which the electron are shot off when the sensitive substance is exposed to light is independent of the temperature, as long as the body is not oxidized or otherwise altered by heating or cooling. Thus, for the noble metals it is invariable between a red heat and the temperature of liquid air.

The second fact is that this maximum electronic velocity is independent of the intensity of the incident light, and depends only on the frequency; but no electrons at all are liberated if the frequency falls below a certain value. There is a special velocity for each substance. For a given metal or substance the maximum velocity with which the electron is shot out increases with the frequency of the light, and the electronic energy is proportional to the excess of this frequency above a certain minimum, which must be exceeded in order that any photoelectric effect may take place at all.

Discussion of a Theory

It appears, therefore, that there is a certain energy required to get the electron away from its atom or to detach it from home; and that over and above this the energy absorbed is proportional to the frequency of the light and to a constant called Planck's constant. The difficulty which we are called upon to face in endeavoring to explain these facts by the ordinary undulatory theory is as follows: A molecule cannot absorb more radiant energy than falls on its surface or projected area. Now the cross section of a molecule is something of the order of 10^{-16} of a square centimetre. It is certain that light of suitable wave-length which falls on a photosensitive surface, giving to it per second energy equal to 1 erg per sq. centim., will produce a photoelectric effect. The liberation of 1 electron requires at least 10^{-12} erg. Hence the above illumination would have to fall for 1,000 seconds on each molecule to impart to it the necessary energy to expel an electron. It is, however, found that the photoelectric effect, if it takes place at all, happens instantly the illumination begins. The conclusion is inevitable that the ordinary undulatory theory, in which the light energy is assumed to be spread uniformly over the wave front cannot, taken by itself, adequately explain photoelectric effects.

It has been, therefore, necessary to introduce modifications. Sir Joseph Thomson has suggested that in the light wave the luminous energy is not distributed uniformly over the wave front, but is concentrated at certain points in it. This supposition is somewhat analogous to a view taken by Faraday in his "Thoughts on Ray Vibrations." On the other hand, we have more recently the hypothesis developed by Planck, Einstein and others, that radiation is not emitted continuously, but in gushes or bundles, which are, in effect, indivisible units of energy and all absorbed as a whole. These gushes of radiant energy are called *quanta*, and the size of these quanta is proportional to the light frequency and to a constant called Planck's constant. Our ordinary measure of radiation is therefore an average, and the maximum value at any moment may greatly exceed the average value. We may compare this view of radiation with the ordinary one by the illustration of carrying water in buckets, say, to put out a fire, as contrasted with pumping a steady stream of water through a hose. In the bucket-carrying process the water arrives in gushes or lots, but the average water delivered per hour is very much smaller than the maximum delivered at the moment when one bucketful is just being poured on the fire.

This view of the case gives to the radiant energy an atomic character, and we can speak of these quanta as atoms of energy.

Phenomena Not Fully Explained

In spite of the fact that this quantum theory helps us to explain very easily photoelectric effects, and also many other matters, such as the distribution of energy in the spectrum and some facts connected with the ionization of gases by ultra-violet light, yet this theory seems hopelessly irreconcilable with the fundamental facts of interference which must be primarily explained. The well-known fact that two rays of light can, under certain conditions, extinguish each other at a point in space is one of the chief truths of physical optics, and is at once explicable on theory of a wave motion. But it is not interpretable on any corpuscular theory of light or radiation. Hence, although this quantum theory of radiation has attracted much attention and exercised much ingenuity, it is probably correct to say that the leading physicists have felt it does not give us a final theory and that photoelectric phenomena are still not yet fully explained.

Case of Gases

We pass on then to consider photoelectric effects in the cases of gases, particularly the circumstances under which light of short wave-length can ionize gases or produce in them positively and negatively electrified particles.

If an electron or negative corpuscle is extracted from a chemical atom it leaves the atom positively electrified. If, on the other hand, a neutral atom takes up an electron it becomes negatively electrified. The extraction of an electron requires the expenditure of a certain energy, and the electron itself is a charge of negative electricity equal to 4.772×10^{-10} electrostatic unit or 16×10^{-20} Coulomb.

Hence we may represent the work required to extract an electron from an atom as proportional to a certain voltage called the ionizing voltage. This ionizing voltage multiplied by the electron charge gives the ionizing work, which last may be measured in ergs. The ionizing energy is of the order of one-billionth of an erg.

The ionizing voltage varies from about 2 to 12 volts for various atoms, being greater for electronegative atoms than electropositive ones. For gaseous oxygen the ionizing voltage is 9 volts, and the ionizing energy about 15 billionths of an erg.

Now experiment shows that ultra-violet light of very short wave-length can ionize gases, and it has also been proved that there is a connection between the length of the longest wave of light which can effect this ionization and the ionizing voltage. The product of this longest wave-length and the voltage is always a number near to 11,000 or 12,000, if the wave-length is measured in Angstrom units (A. U.).) Thus for sodium the ionizing voltage is 2.1 volts, and hence the maximum wave-length is 5,500 A. U.

Hence wave-lengths longer than this will not liberate negative electricity from sodium.

For oxygen, the ionizing voltage is 9, and hence wave-lengths longer than about 1,350 A. U. will not ionize oxygen. This wave-length is about 2 octaves higher up in the spectrum than ordinary blue-green light. It therefore requires ultra-violet light of very short wave-length to ionize gaseous oxygen. It is a difficult matter to prove experimentally the ionization of gases by ultra-violet light. The gas must be contained in some vessel, and have a window of some material transparent to light of very short wave-length. Glass is very opaque to this light, and even quartz does not transmit light of wave-length less than about 1,850 A. U. Almost the only substance available is fluorite (fluoride of calcium). We have to avoid spurious effects due to photo-electric action of the light on the walls of the vessel or upon dust particles in the gas. Nevertheless, by suitable precautions it can be shown that light of wave-length less than about 1,400 A. U. can ionize—that is, produce, positive and negative ions in a gas.

Sun Light and Atmospheric Gases

The question then arises whether the light of the sun thus ionizes the atmospheric gases. It has been shown by Huggins and by Cornu that the light which reaches the surface of the earth from sun and stars contains no wave-lengths shorter than about 2,950 A. U. The spectrum is terminated pretty sharply at that point.

Now the sun is a body at a very high temperature, and must certainly radiate light of very short wave-length. The absence of the very short wave-lengths from the light received at the surface of the earth seems therefore to prove that there is an absorption of ultra-violet light of very short wave-length in the upper levels of the atmosphere.

This light possibly ionizes these higher levels. Ionization in gases is proved by the gas acquiring electric conductivity. An un-ionized gas is a perfect non-conductor. It is found that air even near the sea level has always some small degree of electric conductivity. This, however, cannot be due to true ionization by solar light. It may be due to photoelectric action on dust particles or to radio-active matter in the sea or soil.

Strong Ionization In Upper Atmosphere Levels

There are well-known phenomena in connection with wireless telegraphy which seem to indicate the existence of somewhat strong ionization in the upper levels of our atmosphere which, in part at least, are due to ionization by solar light because they vary with day and night. Such, for instance, as the now well-known day and night effect on radio-telegraphy discovered by Senator Marconi in 1902, in virtue of which signals are in general received at greater distances by night than by day.

In addition to this there seems to be a more permanent ionization of the very high levels of the atmosphere which is not due to true light ionization, but possibly due to the projection of negatively electrified corpuscles from the sun propelled by light pressure and ionizing the upper layers of our atmosphere by impact.

The sun is an incandescent body, and the light-giving portion of the sun called the photosphere is probably in the main composed of carbon. Hence, like other incandescent bodies, such as the filament of an electric lamp, it projects from it electrons or atoms of negative electricity. These, as they pass outwards through the superimposed solar atmosphere, collect molecules round them and form small masses called negative ions.

It was shown by Clerk Maxwell that light or ethereal waves exercise a pressure upon bodies upon which they fall.

At the earth's surface the solar light pressure only amounts to 2.8 lbs. per square mile taken perpendicularly to the light rays. At the sun's surface, owing to the vastly greater intensity of the light, it amounts to no less than 58 tons per square mile. One cubic mile of sunlight near the sun's surface contains energy equal to 302,300 foot-tons, enough to throw twenty of H. M. S. Elizabeth's 15-inch shells over the top of Mont Blanc. Consider, then, a small particle of matter poised in space near the sun's surface. Gravity at that place is twenty-seven times greater than at the earth's surface. Hence the particle is pulled towards the sun with a force twenty-seven times greater than its weight on the earth. But the light-pressure is pushing it outwards. The gravitation pull varies as the mass or as the cube of the diameter, whereas the light-pressure varies as the surface or as the square of the diameter. Hence if the particle is made smaller the light-pressure decreases much less fast than the gravitation attraction, and for a certain diameter—viz., about 0.00013 cm. or 13,000, A. U., if the density of the material is equal to that of water—the push would just balance the pull. Suppose the particle made still smaller, then it can be shown that the light-pressure would not increase indefinitely relatively to the gravitation pull, but would come to a maximum for particles of unit density and of a diameter equal to 1,600 A. U. This is about twice the thickness of very thin gold leaf. For such a small particle the solar light-pressure near the sun's surface would be ten times greater than the solar gravitation, and the particle would be flung away from the sun with an acceleration to start with of about 2 kilometres per second. Hence it would cover the distance between the sun and the earth in a very few score hours, and would enter the earth's atmosphere, if it happened to hit it with an enormous velocity.

Transit Time From Sun to Earth

The writer has calculated for particles of three sizes what this time and velocity would be. Taking three sizes, viz., 1,600 A. U., 5,000 A. U., and 10,000 A. U., the first is about the wave-length of the shortest ultra-violet light easily made, the second that of the wave-length of blue-green light, and the third that of ultra-red or heat rays. The times of transit from sun to earth and final velocities are as follows:

Diameter of particle in Angstrom units.	Time of journey in hours from sun to earth.	Velocity on reaching earth in kilometres per second.
1,600	25	1,700
5,000	55	800
10,000	112	350

Hence the energy contained in quite a small quantity of this dust is enormous. If we suppose 1 kilogram = 2.2 lbs. of the dust of the above sizes to arrive at the earth's atmosphere, the energy it would bring with it would be as follows:

Diameter of particle.	Energy in horse-power hours per kilogram.
1,600 A. U.	540,000
5,000 " "	120,000
10,000 " "	45,000

Therefore as much of this dust as one could carry in one's pocket would convey to the earth enough energy to run one of our large battle cruisers at full speed for 18 hours!

This energy must expend itself in ionizing the upper layers of the earth's atmosphere, which consist principally of hydrogen and helium. Hence the outer layers of the atmosphere are probably in a state of strong permanent ionization.

We have then to recognize, roughly speaking, three layers in the earth's atmosphere, not, however, sharply delimited from each other, in which ionization occurs. In the upper or highest layers of the atmosphere there is strong permanent ionization with a predominance of negative ions. In the middle layer there is ionization, both positive and negative, due to solar ultra-violet light of short wave-length which is strong by day but weaker by night. In the lower layers near the earth there is weak ionization, chiefly due to radio-active matter in the soil or sea, or to photo-electric action on dust particles or ice particles in the air.

This permanent and varying ionization reveals itself by its action on the long electric waves used in wireless telegraphy and upon the stray waves produced by atmospheric electric discharges. This action seems based upon the variation in velocity produced on such electric waves when they pass from a strongly ionized to a weakly ionized region or *vice versa.*

Although it has not been proved experimentally that strongly ionized air has a less refractive index for long electric waves, yet it has been shown mathematically by Dr. W. H. Eccles that if the ions are a certain class of heavy ion the effect is equivalent to a reduction in refractive index of the medium. If this conclusion is valid, then it can be shown that if the bounding surface of the heavily ionized air is fairly well marked a ray of long wave-length radiation would suffer a rapid refraction when incident on the surface equivalent to reflection. Hence it may be concluded that there is on the underneath side of the heavily ionized atmospheric layer at great altitudes an effect equivalent to an *inverted mirage* by which electric rays sent upwards are bent down again.

If, however, the bounding surface of this heavily ionized layer is underlaid by other layers of gradually decreasing ionization, the reflective effect of the upper layer may be greatly diminished. In this manner it is possible to explain some of the curious variations in strength of radio-telegraphic signals at or about sunrise or sunset and the extension of range of freak signals at other times by the refraction or bending downwards of the electric rays.

We have thus good grounds for believing that atmospheric photoelectric effects play a very important part in long distance wireless telegraphy, but it will require many years of careful observation before all these phenomena are disentangled and explained.

INSTITUTE HEARS PAPER BY E. H. ARMSTRONG

At a meeting of the Institute of Radio Engineers, held on October 4th in the building of the American Institute of Electrical Engineers, New York City, Edwin H. Armstrong presented a paper on "The Heterodyne Theory of Amplification and Its Relation to the Oscillating Audion."

NAVY DEPARTMENT CALLS FOR EQUIPMENT

As a result of the Naval Appropriations Bill, recently approved by Congress, schedules have been issued by the United States Navy Department calling for considerable radio equipment of various sizes. It has been estimated that between $400,000 and $500,000 worth of business is involved.

With the Amateurs

The membership of the San Francisco Radio club has increased so rapidly that is has become necessary to vacate the former club room at 737 Shrader street and occupy a new meeting hall at 350 Frederick street.

The new club room is large enough to accommodate 100 persons, and it is expected that the membership will reach the hundred mark by the end of the year. Due to the enormous amount of correspondence to be carried out by Secretary H. R. Lee, an assistant secretary has been elected, E. W. Radford being the successful candidate.

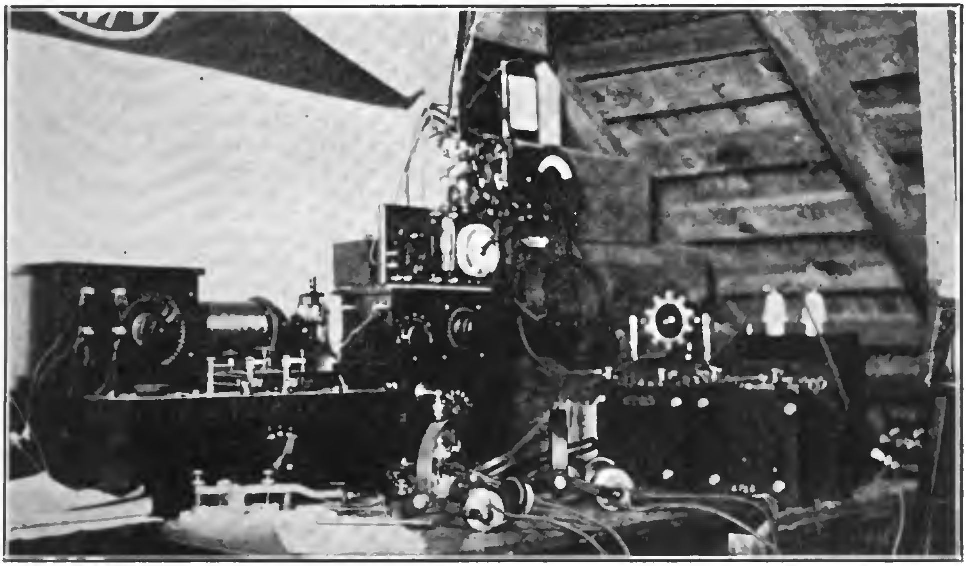
Plans for the installation of a modern radio station are under way and within due course of time the club room will be equipped with one of the best radio stations in the city.

The club is steadily growing in popularity, and approximately ten new members are admitted to the club monthly.

The first edition of the Year Book of the San Francisco Radio Club has been sent to hundreds of addresses. Available copies still on hand may be procured from the Secretary by sending a two cent stamp in order to lighten the mailing charges.

Among radio operators recently admitted to the club are H. R. Spraddo of the National Wireless Telephone Co.; F. L. Busch, radio operator at the Fort Winfield Scott station, and several former marine operators of the Marconi Wireless Telegraph Company of America.

Meetings are still held as usual, Friday evenings at 8 P. M. Notices and announcements, as well as application blanks, may be secured from the secretary, H. R. Lee, 1580 Grove street, San Francisco, Cal.



An amateur equipment located near where the troops are mobilized along the border, the station of D. H. Graham, of House, Texas

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The Roxborough, Philadelphia, Wireless Association was recently organized for the purpose of developing wireless telegraphy and telephony in the Twenty-first ward. The following officers have been elected for the coming year: President and treasurer, Ernest McGee, vice-president and secretary, Earl Henson;

The Association would like to hear from all amateurs in Philadelphia regarding the range of their stations so that it may communicate with them by wireless. Address all communications to the secretary at 6200 Ridge avenue.

The third annual convention of the Hawkeye Radio Association was held in Des Moines recently. Plans were made to enlarge the membership, to assist in the establishing of relay lines and to take up other matters.

The monthly Bulletin will be continued throughout the year as before. The Association was one of the first in the country to print such a Bulletin, and it has proved very valuable.

The following officers were elected:

President, D. R. Lewis, Eldora, Iowa; vice-president, H. K. Sels, Ames, Iowa; secretary-treasurer, J. W. Silcott, Brooklyn, Iowa; purchasing manager, A. B. Church, Ames, Iowa; relay manager, Ralph Batcher, Ames, Iowa.

The Association would be glad to get in touch with any amateurs in Iowa. The relay manager would like to hear from other state organizations in the Middle-West.

The Association held a wireless exhibit at the Iowa State Fair, the station attracting considerable attention. Messages were sent free of charge to many towns.

The most popular feature of the station was a high grade undamped wave receiving set. Arc stations could be heard at nearly all times and news reports were sent daily. Nearly $1,000 worth of apparatus was on display.

The Crescent Bay Radio Association has been formed in Santa Monica, Cal., with the following officers:

President and chief engineer, Thomas J. P. Shannon; first vice-president, George G. Cole; second vice-president, Herbert Bohme; third vice-president, and secretary-treasurer, Elmer Forsythe; general manager, Phillip Leigh; chief operator, Harold Bull.

The officers will act as a Board of Directors, the main office being at the home of the president, Thomas J. P. Shannon, 1148 Fifth street, Santa Monica. He has a ninety-six foot aerial pole and an excellent wireless telegraph outfit. All amateurs are requested to make application to the president. The call of the Association is 6QJ. Meetings of the Board of Directors will be held every two weeks.

The office is situated five blocks from the ocean and overlooks the great race course of the west, where the Vanderbilt cup and grand prize races are held. It is proposed to send out the position of each car to all amateurs and those who wish to copy, thereby giving them the first news of the races.

Following the plan which was adopted two years ago, the radio station operated by the Department of Physics of the Nebraska Wesleyan University will send out coded weather forecasts and a synopsis of current news on each week day at 8:55 A. M.

Coded forecasts will be repeated three times to give opportunity to copy correctly. Through the courtesy of Professor Loveland of the Weather Bureau at Lincoln, these forecasts are up to the minute as they are telephoned from his office immediately on receipt of the data from Chicago, and sent from the university station five minutes later.

Important war news follows the forecast, the latter being in plain English. Reports of athletic contests, debates and news of a similar nature will be sent out from time to time as announced in the morning. In general, base-ball and foot-ball are reported at 6 P. M., and basket-ball at 10 P. M.

Address all correspondence to J. C. Jensen, University place, Nebraska. Station call 9YD.

The weather forecast code for the University station is as follows:

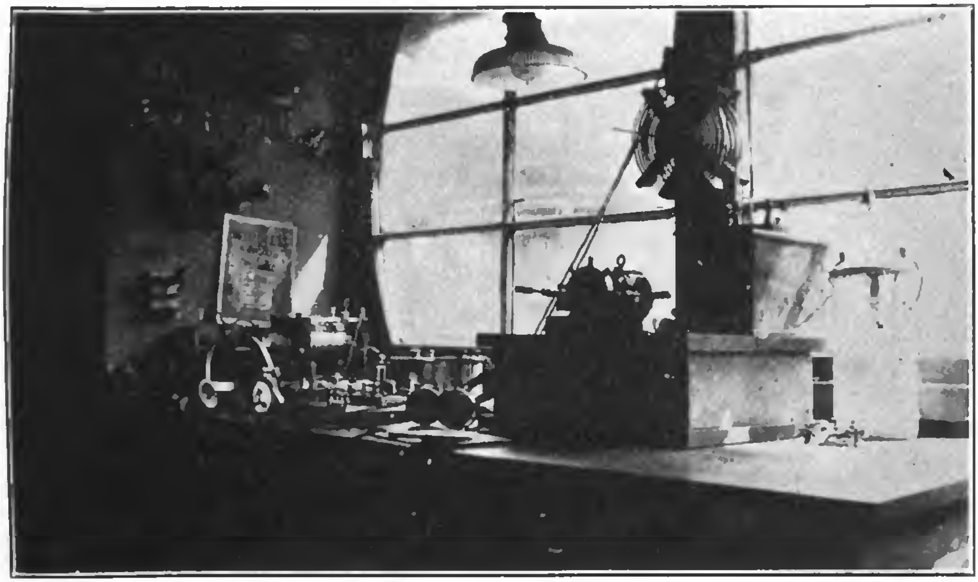
R = rain; Z = thunderstorms; H = hail; S = snow; W = wind; B = blizzard; C = cloudy; X = warmer; Y = colder; P = pressure; T = temperature; U = unsettled; F = fair; L = to-night; M = yesterday; N = to-day; O = to-morrow; Q = changing to; ? = probably; 1 = north; 2 = east; 3 = south; 4 = west, when following W. Thus P728T54W34.R2M.-

RQSN.FXO? would be interpreted as follows: Barometric pressure 728 mm.; temperature 54 degrees F.; wind southwest. Rain in eastern portion yesterday. Rain, changing to snow to-day. Probably fair and warmer to-morrow.

A movement is on foot to form a radio club in Port Richmond, Staten Island, N. Y. A meeting of amateurs interested in the project will be held on or about November 1 at the home of H. E. Ballentine, 17 Sharp avenue, Port Richmond.

The Suburban Radio Club of Washington, D. C., is carrying on a membership campaign as a result of which it hopes to secure almost every amateur wireless operator of the District of Columbia as a member. At the last meeting of the Club, the secretary was directed to notify every member by mail of meetings.

The Club is a chartered organization of the N. A. W. A. Amateurs wishing to join the Club should get in touch with Charles Longfellow, Jr., 5515 Potomac Avenue, N. W., Washington, D. C.



The sending and receiving equipment of Russell A. Neuman, of Springfield, Ill.

During the Kentucky State Fair held at Louisville from September 11 to 16 inclusive, the Louisville Radio Club gave a demonstration of wireless telegraphy. Space was given the club by a local newspaper and a 1 k. w. rotary gap set was installed. N. A. A. was heard and many amateur stations as well.

The exhibit brought six new members into the Club. The Club, which was formed last March, now has a membership of about forty-five, who own and operate eight licensed stations. The Club meets every first and third Thursday of each month, when its members read papers on the art.

An accompanying photograph shows the set of Russell A. Neuman of Springfield, Ill. The aerial is made up of three wires, 40 feet in length by 50 feet in height. The wires are placed one over the other. The receiving set consists of a Chambers loose-coupler, two variable condensers, one fixed and one loading coil. There are three detectors, one crystalori silicon, and two sets of Brandes 2,000-ohm phones. The sending set consists of a rotary and stationary spark gap, an interrupter, a glass plate condenser, key occulation transformer and a transformer coil. The call letter of this station is 9K1.

From and For those who help themselves

Experimenters' Experiences.

The editor of this department will give preferential attention to contributions containing full constructional details, in addition to drawings.

FIRST PRIZE, TEN DOLLARS
Advice Regarding the Construction of Antennae

The average amateur antenna is an unattractive piece of engineering. This is not surprising when we consider the amount of time that the experimenter spends in constructing it. It is usually put up in a great hurry, with little thought as to appearance, efficiency or insulation. Why not put a little more thought into designing an antenna? Sad to relate, the usual method of designing is to go on the roof and place the antenna where it will go up easiest; in most cases there is a new aerial on the roof every month, running in a different direction.

Some amateurs construct transmitting antenna with a flat top length of fifty feet, consisting of four wires with a spread of about six feet between the

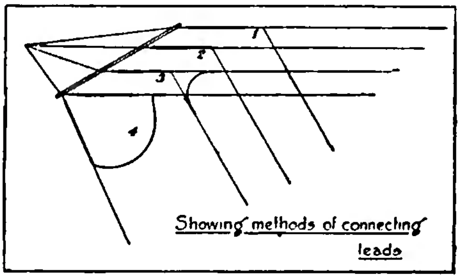


Fig. 1, First Prize Article

wires. Such an aerial is badly proportioned and usually the big spreader is bent into all sorts of queer shapes. Remember that it is not necessary to space wires more than 1/50 of the effective length of the wires. Such things as superfluous insulators in the flat top and in the guys and stays also make an antenna system less attractive.

Referring to Figure 1. The method of insulating shown is used by many amateurs, and is also employed to a consider-

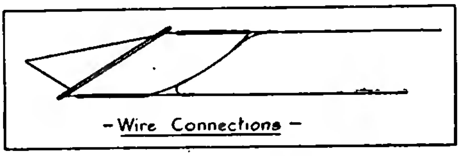


Fig. 2, First Prize Article

able extent by commercial companies. There is an insulator placed in each wire, but there are two objections to this system of insulating. First, it is costly. Secondly, it adds weight to the antenna.

There are several methods of connecting leads to the antenna wires. The method shown at 1 in Figure 1 is usually employed by amateurs. The lead proper is connected directly to the aerial wire. It strains the antenna wire, makes a sharp turn, and is liable to break from twisting. It should not be used. Method No. 2 is better. Here the lead is connected to the wire at the eye in the insulator. Still the turn is too sharp. Connecting the lead and antenna wire by a loop, as in 3, remedies this and is good practice. No. 4 is an excellent method of connecting leads. It adds to the weight of the antenna as a whole, however. There is absolutely no strain on the antenna wire. The strain is on the spreader. It is neat in appearance and effective, if you have plenty of insulators.

In connecting the wires of the system be generous with the connecting lead, as in Figure 2. Allow it to sag slightly and always round off the turns as shown.

An amateur having a vertical antenna

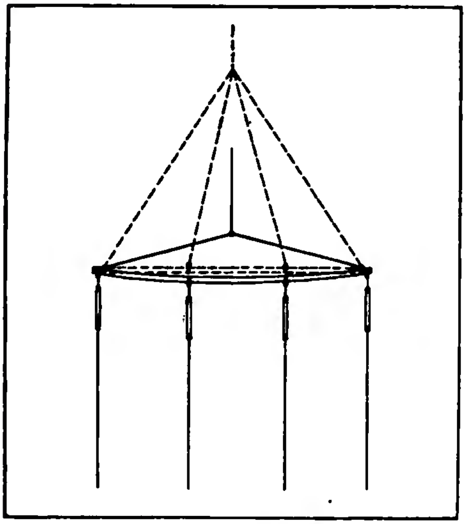


Fig. 3, First Prize Article

for transmitting produced the effect shown in Figure 3 when he used a 12-foot spreader. The spreader was always bent when the aerial was strained. A glance at his antenna showed that his halyards were too short. These supported the spreader only at the ends. Where a long spreader is used there should be a support from where each wire is fastened. Halyards should always be about as long as the spreader itself, both for looks and effectiveness in support. The dotted lines in Figure 3 show this. If this amateur needed every foot of length possible for effective length in his aerial he should have removed the individual wire insulators and used the system shown in Figure 4.

As every one knows, the vertical antenna is a very efficient type for transmitting. For the average amateur it is impracticable, however, as it requires a very high mast in order to make it of a desirable length. If you can construct a vertical aerial of from sixty to one hundred feet in length, do it, as increased efficiency will warrant the high mast. Use the construction shown in Figure 4 for the aerial. This is of navy type and adds considerable to the effective length. The greatest advantage of this system is that it can be better insulated and at less expense than where individual wire insulators are used. One good glazed insulator behind the halyard is more effective than a string of cheap ones in each wire. Again, the whole aerial is lighter and the strain of the leads is on the insulators and not on the individual wires. Remember that the leads should not be of higher resistance than all of the wires in the flat top combined. This is a very neat appearing aerial as well as less expensive than those of most experimenters.

In conclusion: Design your antenna, as well as your other apparatus. Know what you want before you start to construct it, and the labor you spend on it will be justified in a wireless outfit more attractive as well as more efficient.

Irving Farwell, *California.*

SECOND PRIZE, FIVE DOLLARS

A Design for a Non-Synchronous Rotary Quenched Gap

This article contains a description of a design for a non-synchronous rotary quenched gap.

My design is in brief as follows: An air tight, cast iron housing encloses two sparking electrodes, preferably of copper, one stationary, the other rotating. Each electrode has thirty-six radially cut teeth on the inside face. The stationary electrode is split equally in halves,

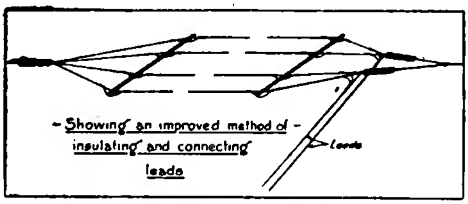


Fig. 4, First Prize Article

this being done to receive the charge from the condenser.

The rotating member is contained in two sets of S. K. F. self-aligning ball bearings which in turn are held in position by cast iron housing. This gap is designed for low potential transformers, and accordingly the electrodes should be about eight or ten thousandths of an inch apart, or according to the voltage of the

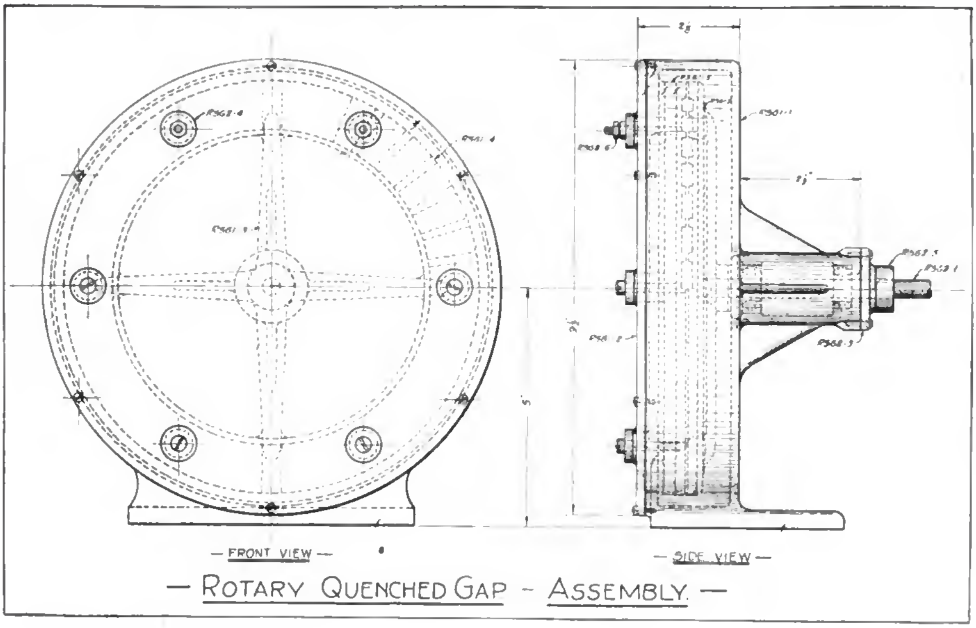


Fig. 1, Second Prize Article

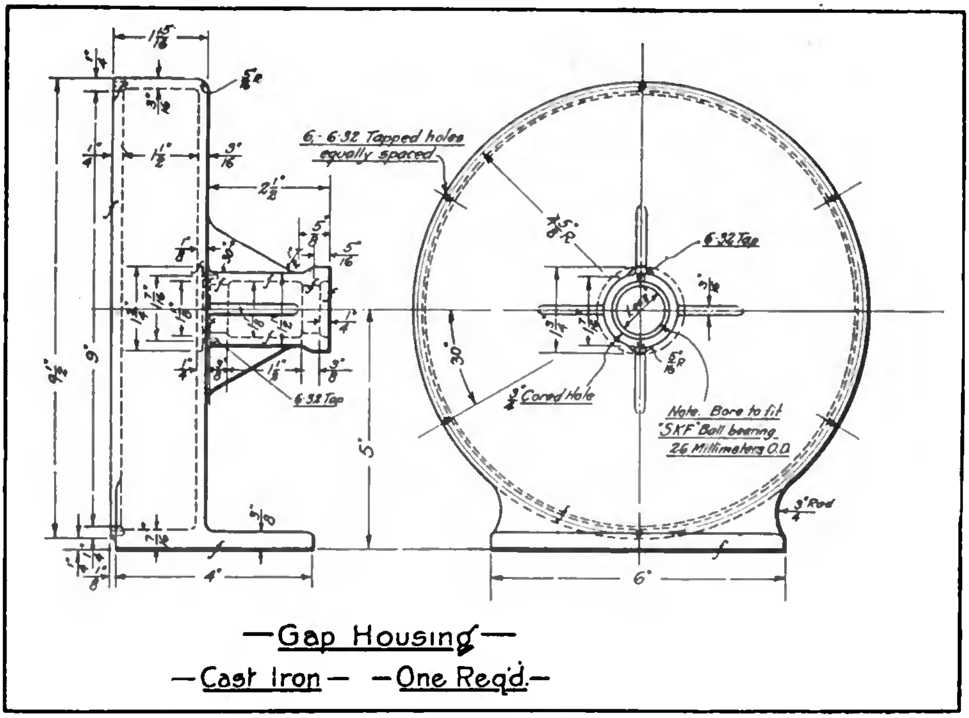


Fig. 2, Second Prize Article

transformer employed. The rotating electrode may be radially adjusted by means of the collar on the shaft. The gap should be revolved at 1,800 r.p,m, to give a spark frequency equivalent to a 500-cycle note.

Referring to the drawings:

Figure 2 shows a cast iron housing. No information is needed, as the drawing shows clearly what the necessary operations are. Care must be exercised in machining the spots which receive the ball bearings and should be finished to give a light force fit.

Figure 3 is the cap or the member which the stationary sparking electrode is mounted upon. In order to obtain an air-tight fit, care must be taken while machining the surface which fits into the housing. Note the hub which is used for convenience in turning. After the part is completely machined, the hub is cut off and the hole plugged with a piece of fiber.

Figure 4 is the wheel for the rotating electrode and is constructed of aluminum. Care must be taken while in the process of machining this part, the operator observing that he does not cut off the metal with a heavy chip, or otherwise the wheel will chatter and slip on the arbor.

Figure 5 shows the details of both the stationary electrode and the rotating electrode. The stationary electrode is split in halves after being mounted on the cap. These are made of copper preferably. After each one of these members is mounted on its respective part, it should be trued up very accurately.

Figure 6 shows the details of the insulation used to insulate stationary electrode from the cast iron cap.

Figure 7 shows the details of the rotating shaft and is made of machine steel. The short end of the shaft should be a driving fit into the aluminum wheel. In grinding the long end of the shaft the required fit should be so one could force the ball bearing on the shaft by the hand.

Figure 8 shows details of grease retainers, the ball bearings being immersed in the grease. Figure 10 shows the detail of the bushings used to insulate the bolts from the cast iron cap. Figure 11 is the adjustment collar on the rotating shaft. Figure 12 shows the details of the bolt used to make a connection with

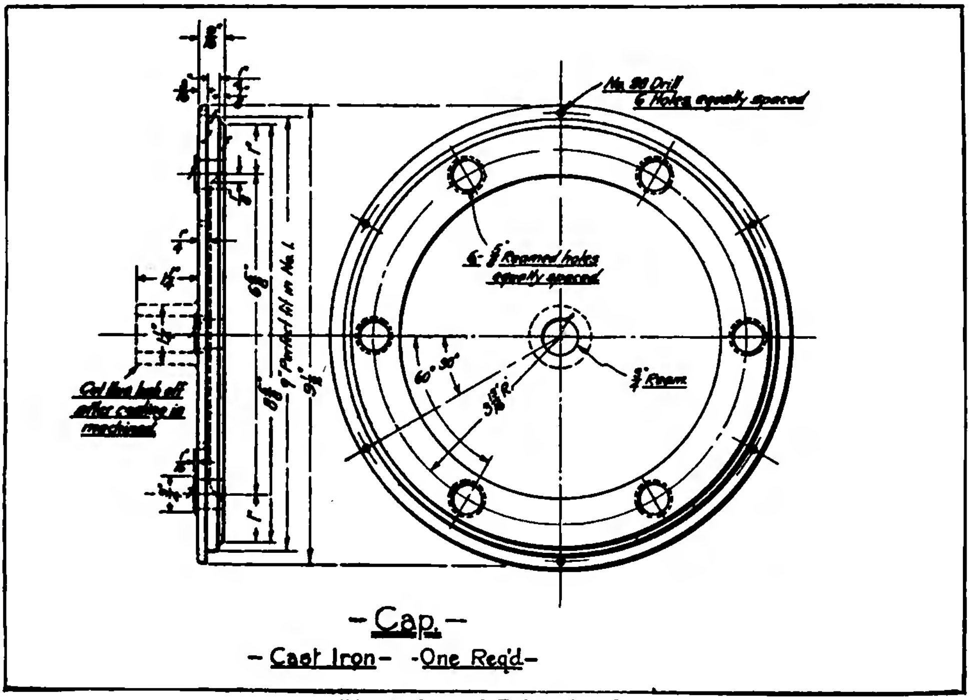


Fig. 3, Second Prize Article

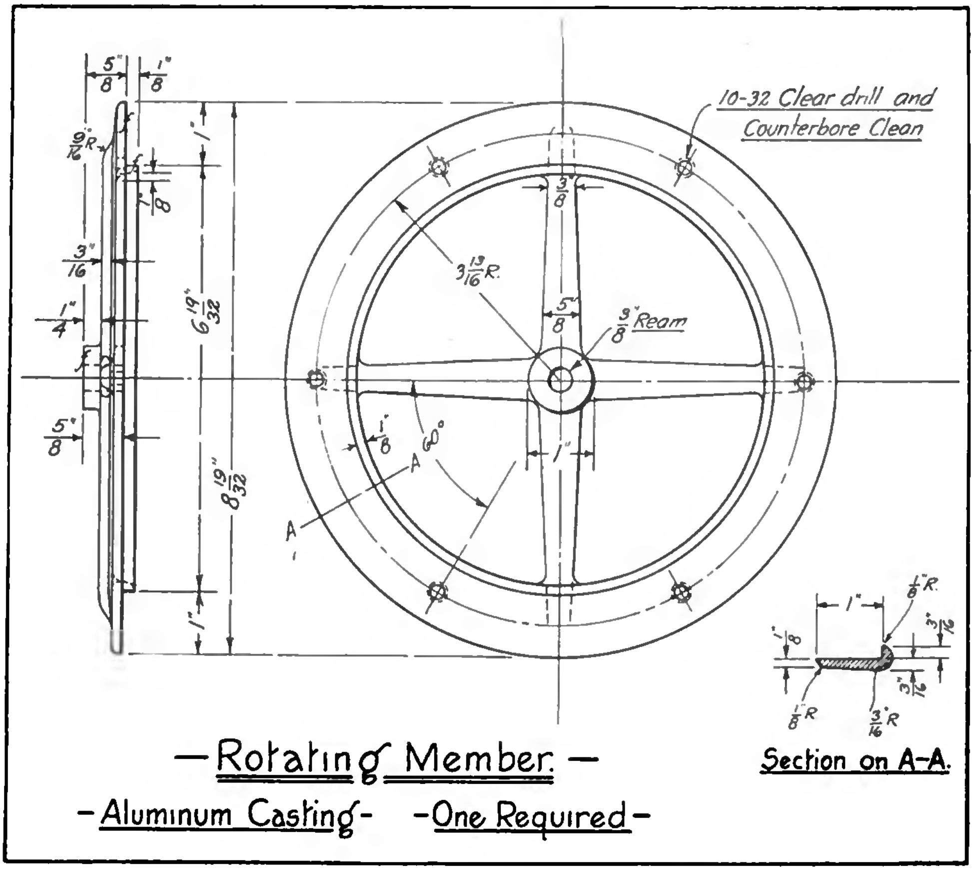


Fig. 4, Second Prize Article

each half of the stationary electrode. Regular 10-32 fillister head brass screws are used to fasten the copper electrodes to the cast iron cap.

If the amateur does not wish to equip his gap with ball bearings, he may use a bronze bearing in its place, but, of course, more motive power will be required than would be necessary if the ball bearings were used. In general, if he adheres strictly to the minute details, he will have when completed a well constructed gap capable of giving very efficient results.

This gap is intended to be used with transformers having secondary voltages of between 2,000 and 3,000 volts. It is suitable for transformers up to ½ k.w. capacity and is therefore highly recommended to the amateur field unlimited in respect to the wave-length employed.

A difficulty in the use of this gap for amateur work lies in the fact that a rather large condenser is required for the highest efficiency and usually the value of capacity is such that the wave-length of the condenser circuit is in excess of 200 meters. Good results, however, can be obtained with a condenser of .01 microfarad by very careful adjustment of all circuits. An oscillation transformer of the usual type will do for this equipment, but the pancake type is preferred or any type where the inductance is continuously variable.

RALPH HOAGLUND, *Massachusetts.*

THIRD PRIZE, THREE DOLLARS
How to Make a Synchronous Rotary Gap and Circuit Interrupter

Knowing that many amateurs desire an efficient rotary gap for use in connection with a spark coil and furthermore that the main draw-back is the loss of so many sparks per second, I designed this little gap to meet their need. The instrument is built around any make of upright toy motor, preferably the Rex or the Voltamp.

Start by removing the shaft and threading it for a distance of ⅜ of an inch from each end with a 6-32 die. Figure 1 shows the circuit interrupter which is roughed from a piece of ¾-inch stock, the hole for the motor shaft being drilled in a lathe and tapped with a 6-32 tap before the machined section is removed. Having drilled and tapped the roughed-out interrupter, cut it off to length and insert the motor shaft. Next, place the shaft in the chuck and finish the interrupter to size. The contact breakers must be finished in this manner to insure the segments running true. Next, cut the segments with a fine hacksaw and after cutting small strips of mica about 1/16th by ⅛th of an inch, pack several in each slot, coating each with shellac before doing so. When dry, finish by filing the edge of the mica with a fine file, the shaft being placed in the chuck of the lathe. Next, plane the fibre rotor to size and drill and tap the holes indicated in Figure 4.

After replacing the shaft in the motor, attach the rotor and thread the brass rod comutator which goes opposite the motor shaft. Insert this rod and the two studs with their connecting wire and proceed with the stator. The strip in Figure 2 is cut to size and filed to a thickness of 1/32d of an inch for a distance of 3/16th of an inch from each end. The filing is done from one side on one end and from the other side on the opposite end to prevent a thick joint in the ring. After drilling at all the dotted lines bend at 45 degrees all solid lines and solder the joints. Next, construct the upright supports for the ring (Figure 3). The length of these pieces, as can be seen, depends upon the height of

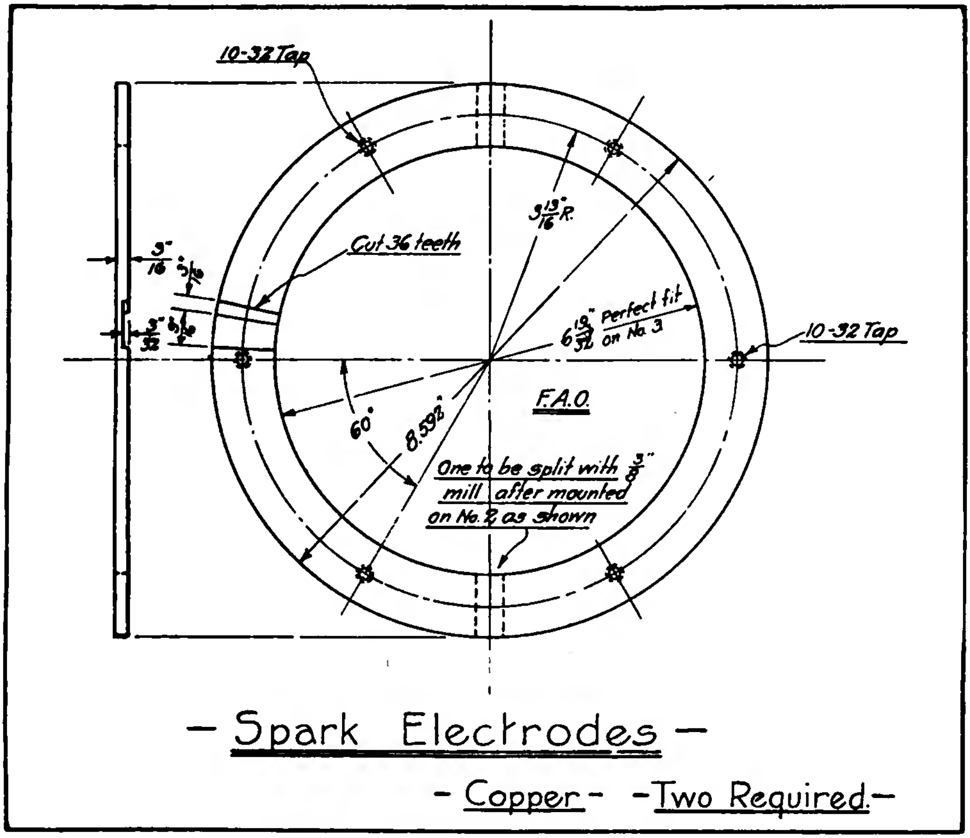


Fig. 5, Second Prize Article

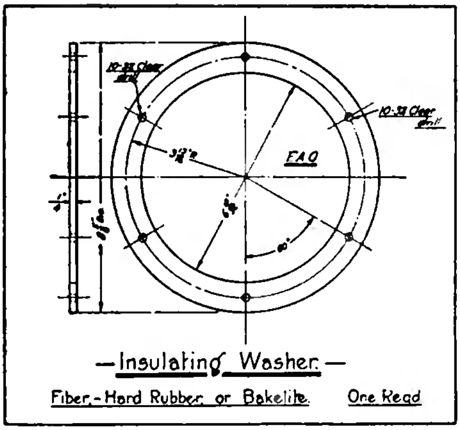


Fig. 6, Second Prize Article

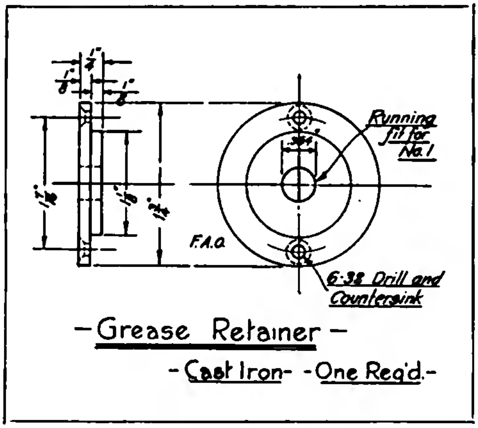


Fig. 8, Second Prize Article

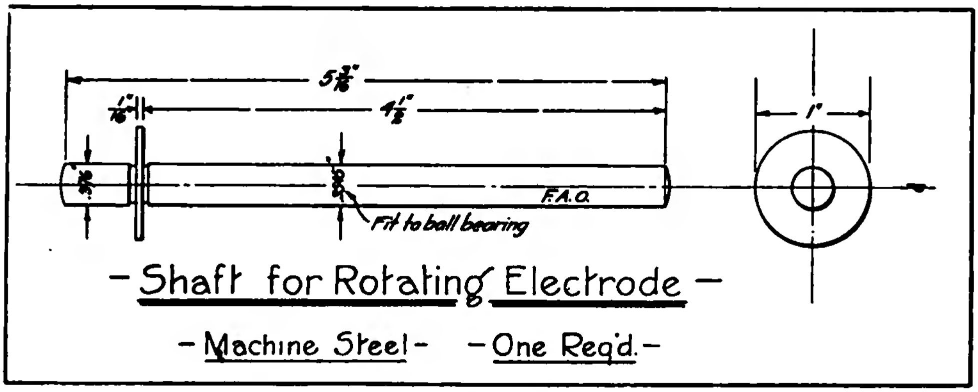


Fig. 7, Second Prize Article

the shaft above the base. Set up the stator and adjust the studs to a 1/16th-inch gap, then attach the two copper brushes shown in Figures 1 and 4. Connect as in Figure 5, using the motor frame for connection to the segmented circuit interrupter. Now, synchronize the gap by setting the circuit breaker so that the circuit is broken just when the studs of the rotor are opposite those of the stator.

With the same amount of care given in the construction of all good instruments, this gap will produce a clear note of high pitch having good carrying properties.

E. D. HIBBS, *Pennsylvania.*

FOURTH PRIZE, SUBSCRIPTION TO THE WIRELESS AGE

A Satisfactory Switch That Is Simple in Construction

This is a description of a switch for use on radio instruments that very nearly approaches perfection, and leaves nothing to be desired.

The several features worthy of mention are as follows: Its construction is simple in the extreme; it has few parts and these are easily and quickly made; the tension of the switch blade upon the contacts is adjustable; the entire moving element can at any time be removed from the instrument upon which it is mounted without disturbing any connections whatever. Its action is smooth as velvet, never binds and is absolutely free from the great fault of most other switches, that is, there are no nuts or parts to work loose in operation, causing loose connections and necessitating the dismantling of the apparatus to tighten and adjust. This single feature alone offsets the disadvantage that it cannot be used when the contacts are a continuous circle and the switch blade must revolve continuously in one direction; however, this is

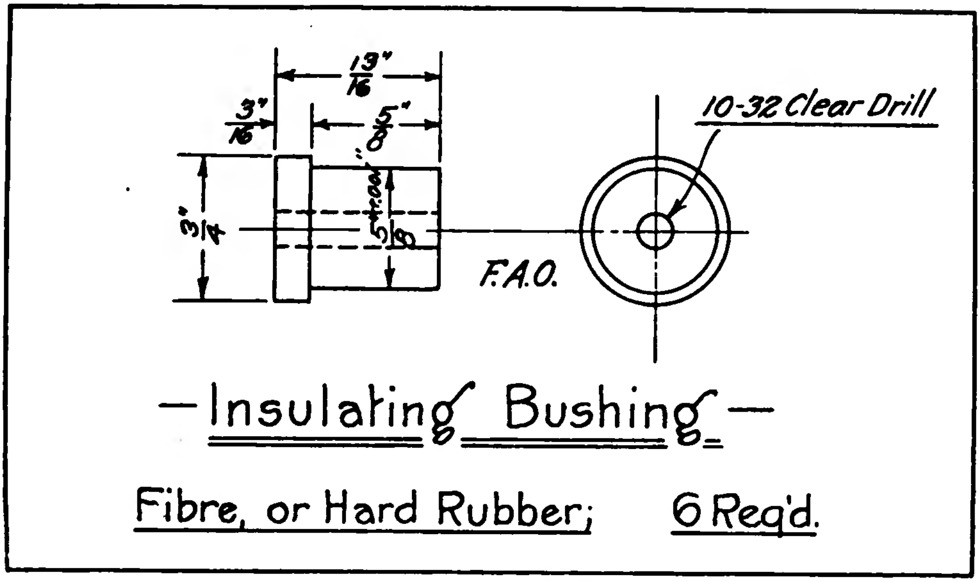


Fig. 10, Second Prize Article

seldom required, as the only advantage gained is (in this case), that the blade may be removed directly from the last contact on the first without revolving the switch back over the other contacts.

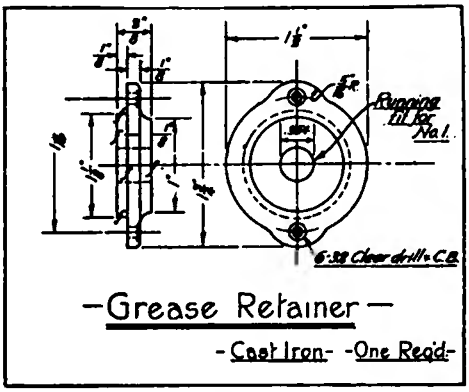


Fig. 9, Second Prize Article

The drawing shows a cross-section through the switch and makes its construction perfectly clear. A is the base of insulating material. B is a brass bushing threaded on the outside to take the lock-nut, C, by which it is fastened to the base, and also the thumbnut, D, which forms a binding post for attaching the connections. This bushing, B, is also drilled and tapped with a fine thread to accommodate the fine thread machine screw, E. Upon the machine screw, E, is placed the insulating knob, F, and the switch-blade, G, both of which are locked in place by the nut, H. The coil spring, I, is slipped over the machine screw, E, its purpose being to take up any play that may exist between the threads of stud E and the threads in the hole of bushing B.

The contact point, J, has its shank threaded and is held in place by locknut K, having thumbnut L to form a binding post for connections.

When the threads on stud E run about forty to the inch and the switch-blade, G, is reasonably flexible the vertical movement of the blade is hardly noticeable, and as far as operation of the switch is concerned, is practically nil.

A careful consideration of the construction will make its various features obvious.

J. A. Wever, *Maryland.*

HONORARY MENTION

A High Potential Condenser Suitable for Use of Amateurs

The condenser which I am about to describe is made by coating test tubes in-

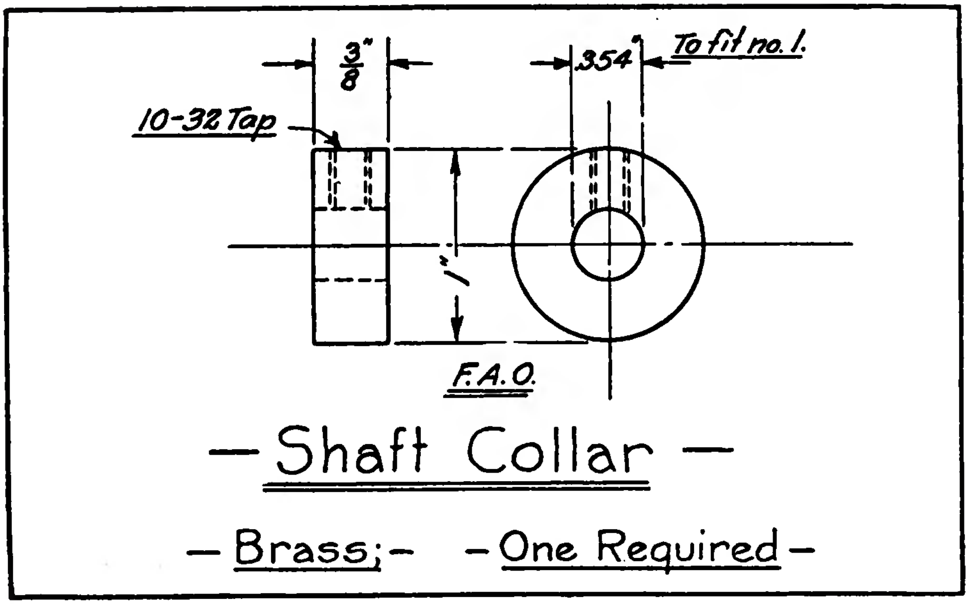


Fig. 11, Second Prize Article

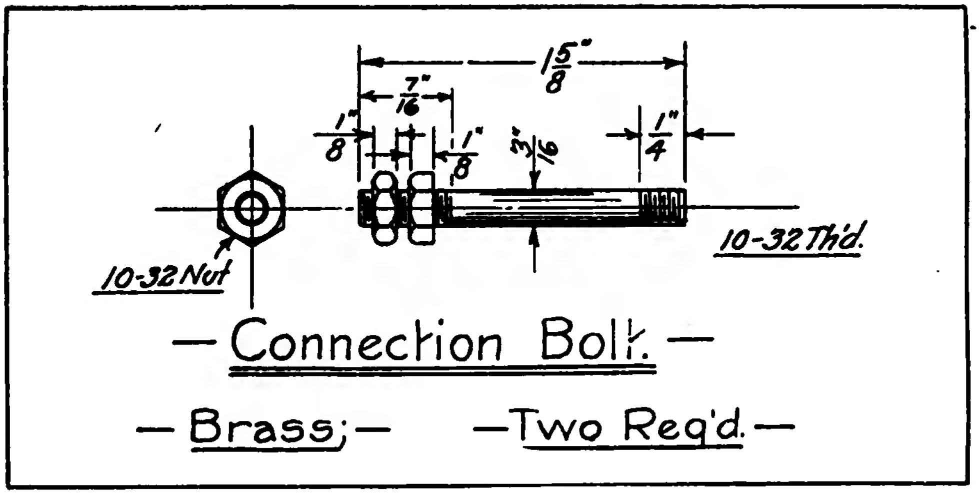


Fig. 12, Second Prize Article

side and out with tinfoil as illustrated in the accompanying drawing at A. I used 8-inch tubes. In order to coat the tube, first wrap a small stick with a couple layers of cloth as shown at B, and by means of this, smear shellac inside the tube. Have ready the inside foil, which should be about 6 inches in length and three and a half times the diameter of the tube in width. Wrap this foil loosely around another cloth-covered stick as shown at C and insert it into the tube. By this time the shellac will have become "sticky" and the foil will stick tight. The end of the foil should be about an inch and a half or two inches from the bottom of the tube before it is pushed against the side and stuck. It is then smoothed out by rolling the cloth covered stick over it a number of times.

The outer coating of foil is much easier to put on. The best way is to lay the foil

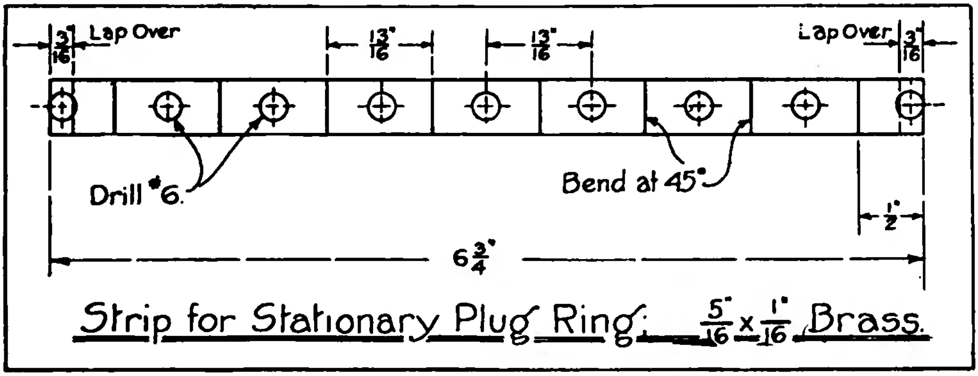


Fig. 2, Third Prize Article

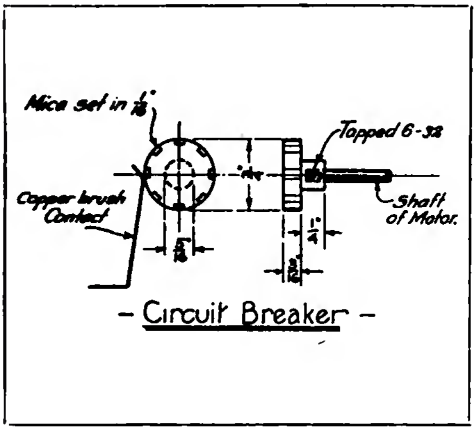


Fig. 1, Third Prize Article

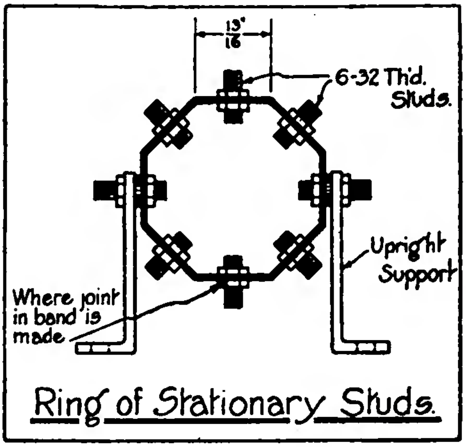


Fig. 3, Third Prize Article

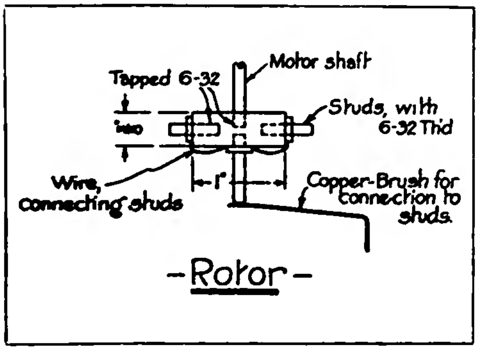


Fig. 4, Third Prize Article

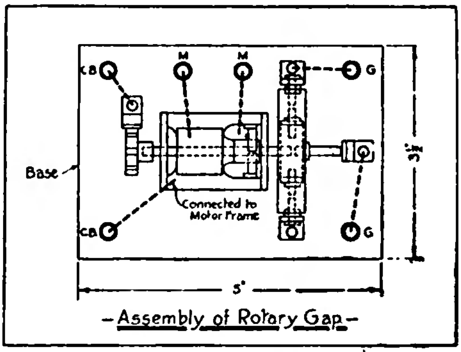
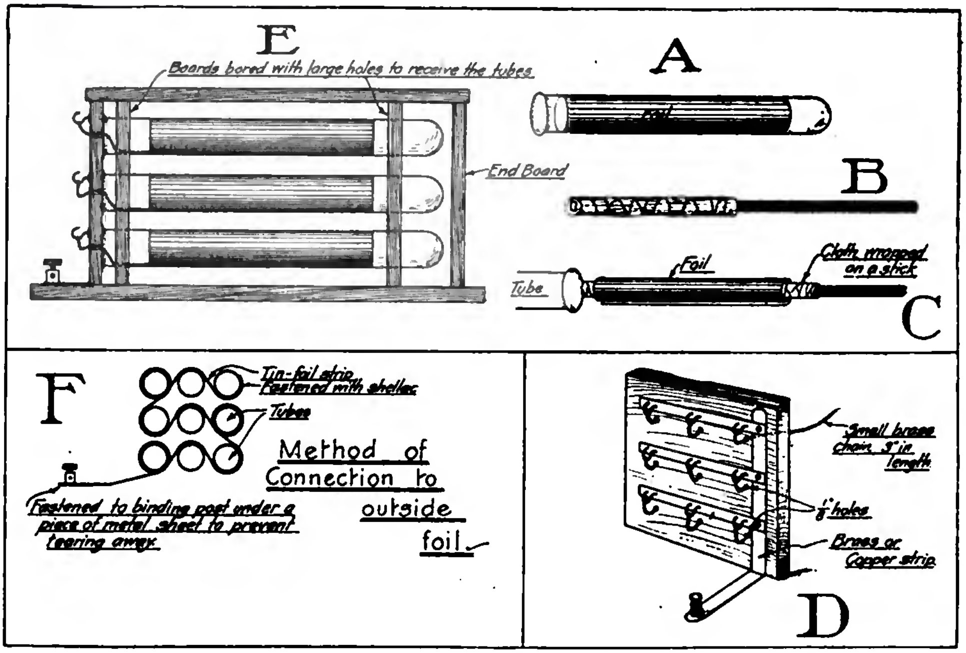
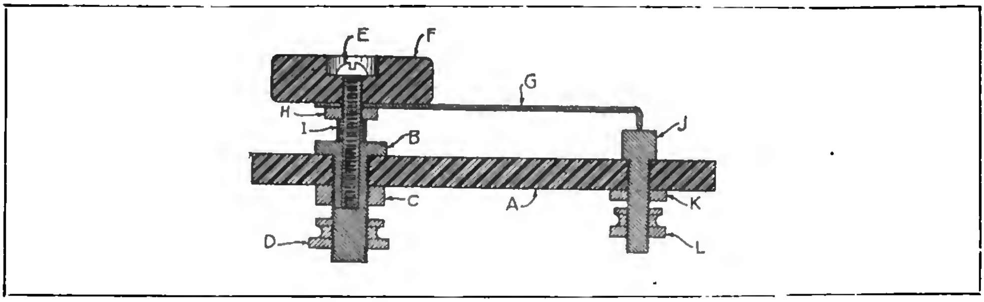


Fig. 5, Third Prize Article



Drawing, Honorary Mention Article, Joseph Dean



Drawing, Fourth Prize Article

out on a smooth board and roll the shellacked tube over it. Six or nine tubes are prepared in this way, depending upon the size of the condenser desired. A rack, as shown in the drawing, is then made. Boards x and y, at E are bored with holes large enough to receive the tubes easily and should be of very tough wood, so as not to split.

Connections to the condensers are made on the inside by chains, and on the outside by wrapping a long strip of foil around all of the tubes. This is fastened to a binding post by laying it under a small piece of sheet metal, so that when the post is turned down tight it will not tear the foil. The chains are hooked on to small hooks which are screwed through small holes in brass strips. These strips are then connected together and brought to a binding post.

The capacity may be varied by pulling out or inserting the chains.

Joseph M. Dean, *Iowa.*

WIRELESS FOR SIGNAL CORPS

A "Must Have" book for every wireless amateur. See announcement, first two pages in this issue.

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 an individual can be answered. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

H. J. D., Sheboygan, Wis., writes as follows:

It will be of interest to your readers to know that the Naval station located at Lake Bluff, Ill., is fitted with a 5 k.w., 500-cycle quenched spark transmitting set as well as the 30 k.w. arc set. The spark set employs a wave-length of 1,000 meters and it is used for sending weather reports for the Great Lakes division daily.

This station may be heard almost any evening between 6:30 and 7:30 P. M., central time

* * *

A. R. M., Greenville, Pa., writes:

Ques.—(1) I constructed a wave-meter in accordance with the instructions given in the book "How to Conduct a Radio Club" and apparently during a test completely ruined my head telephones for any other purpose.

When I connect them to the wave-meter they crack and roar like heavy static discharges. I have examined them carefully for loose connections and find none. Is the fault due to a blunder of my own or should I expect such results every time I use the meter?

Ans.—(1) Apparently you have placed the wave-meter in too close inductive relation to the circuit under measurement and potentials of such value were induced in the wave-meter circuit as to burn the windings of the head telephones. Keep in mind that the telephones should be connected in series with the carborundum crystal, and if this precaution is taken, together with keeping the wave-meter at a sufficient distance from the transmitting set, no injury to the head telephones should result. You will probably find that the windings of the head telephones are badly burned.

* * *

N. C. B., Reno, Nev., inquires:

Ques.—(1) My wireless station is located in a power house and the antenna lies parallel to a 23,000-volt transmission line. The aerial wires and the transmission line are about the same height and, owing to induction, I cannot read amateur stations. I contemplate erecting a mast approximately 15 feet in height on the nearest end of the antenna to the line, so that it will lie at an angle of 45 degrees. Will this tend to decrease the interference from the high tension line?

Ans.—(1) The minimum of interference will be experienced when the receiving antenna is exactly at right angles to the transmission line and, even with this correction in the location of your antenna, you will probably experience the effects of induction. We know of no method by which it can be totally eliminated.

* * *

S. E., Portsmouth, Va., inquires:

Ques.—(1) In Figure 19-b, published on page 861 of the September, 1916, issue of The Wireless Age, are the two secondary coils for the transformer wound one upon the other, or at either end of the primary winding? Is the same size of wire used on all windings and are the secondary coils wound in the same or opposite directions?

Ans.—(1) The secondary coils for this transformer are on the inside and the outside of the primary winding. They are not wound on opposite ends. The same size wire is employed for all three of the windings and they are wound in the same direction.

Ques.—(2) Can stations that are completely inaudible when using a simple vacuum valve detector be heard with a vacuum valve amplifier? A statement has been made that the amplifier only makes audible signals that could already be heard with a single vacuum valve.

Ans.—(2) A properly constructed vacuum valve amplifier will make audible signals that cannot be heard with a single vacuum valve detector, but many of the amplifying circuits evolved do not possess this characteristic because they are not properly designed.

Ques.—(3) Can the various types of vacuum valve bulbs recently appearing on the market be used in the same circuit as the original type of vacuum valve?

Ans.—(3) Yes.

Ques.—(4) In your opinion, will the high voltage battery constructed of pieces of zinc, copper and blotting paper, stacked up in a pile described in a previous issue of The Wireless Age, function properly? Will I be able to obtain results from it?

Ans.—(4) The writer of the article assured us that this battery was continuously operative for the purpose desired.

E. C. J., Jr., Fairmount, W. Va., inquires:

Ques.—(1) What finish is generally used by amateurs on their receiving cabinets and wooden portions of the transmitting apparatus?

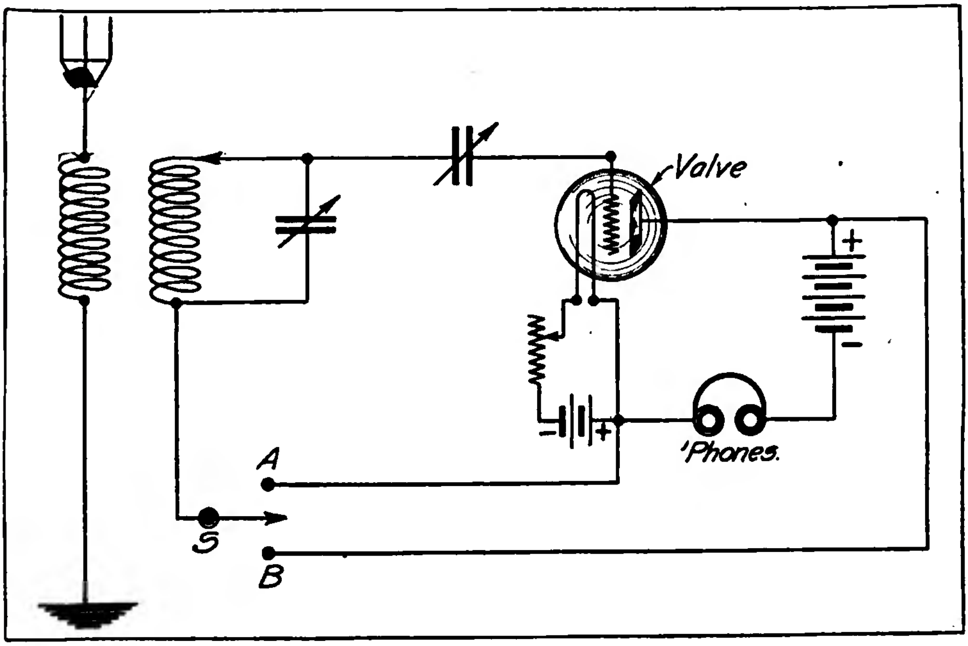
Ans.—(1) Mahogany stain has proved the most popular and seems to present the best appearance. You can purchase stain of any color from paint supply stores, which, when mixed with alcohol, will give the wood the desired tint. After two coats of the stain have been applied and allowed to dry perfectly, two or three coats of good varnish are put on for the final finish.

Ques.—(2) Please publish a diagram of connections for a loud speaking horn attached to a receiving set consisting of a receiving tuner, vacuum valve detector, fixed and variable condensers, etc. I should like a diagram for the apparatus like that described by Chris. K. Bowman in the June, 1915, issue of THE WIRELESS AGE.

Ans.—(2) A diagram of connections for the loud speaker is not necessary. It is simply connected in the circuit at the same point where the ordinary telephones are connected.

Ques.—(3) Can a vacuum valve be connected up to receive either continuous waves or spark signals by merely throwing a switch, or can both be received with the same connection? If so, how?

Ans.—(3) See the accompanying drawing. When the switch, S, is thrown to the point, B, the apparatus is responsive to continuous waves, but when thrown to the point, A, the circuit is correct for ordinary spark signals.



J. P., Sanford, Maine, inquires:

Ques.—(1)) Please publish a diagram of connections for a loose coupler, loading coil, fixed condenser, variable condenser, detector and head telephones.

Ans.—(1) So many diagrams of this character have appeared in previous issues of THE WIRELESS AGE, particularly in the series "How to Conduct a Radio Club" and also in the book "How to Conduct a Radio Club," now on sale by the Marconi Publishing Corporation that it seems unnecessary to redraw the diagram. The article on "How to Conduct a Radio Club," published in the September, 1916, issue of THE WIRELESS AGE, contains a diagram applicable to your requirements.

Ques.—(2) What detector is considered most sensitive?

Ans.—(2) The vacuum valve detector stands at the head of the list.

Ques.—(3) What is the highest wave-length employed by the wireless station at Portsmouth, N. H.?

Ans.—(3) 1,000 meters.

* * *

L. G. D., Keene, N. H., inquires:

Ques.—(1) I have a Marconi type D Tuner No. 224, which is fitted with a carborundum detector and connected to an aerial with a natural wave-length of 200 meters. Please tell me the names of the high-power stations which I should be able to hear with it.

Ans.—(1) If you will use the left-hand coil of this tuner as a loading inductance for the right-hand coil, your equipment should respond to the wave-length of Arlington when the latter is sending the time signals, namely, 2,500 meters.

Ques.—(2) Apparently this tuner was made to operate with a looped aerial and is said to be responsive with this adjustment to wave-lengths of 2,000 meters, but when used in the ordinary manner with a plain aerial, will respond to 4,000 meters. Which method would be the most efficient for all around work?

Ans.—(2) For the shorter range of wave-lengths practically equal results will be obtained with either the plain aerial or looped aerial, but for the longer wave-lengths, the plain aerial connection will give the best results.

Ques.—(3) Is it the custom to use looped aerials at the present time, and if so, how would you connect a four-wire aerial in this manner?

Ans.—(3) The use of the looped aerial has practically been discontinued, but should you desire to use this type, all wires should be connected together at the high potential end. Two wires should be connected together at the receiving station for one side of the loop and the remaining two wires for the opposite leg of the loop.

* * *

J. H., Jr., Evanston, Ills., inquires:

Ques.—(1) Please advise how to connect a Packard ½ k.w. transformer and a Wagner ½ k.w. transformer in series. The Packard transformer is rated at 13,200 volts for the secondary winding and the second transformer at 14,000 volts.

Ans.—(1) If these transformers were intended to be operated on 110-volt circuits, the primary windings should be connected in parallel and the secondary windings in series. The proper connection for the secondary terminals had best be determined by experiment, for if they are connected to oppose, the resultant voltage will be practically zero. The proper connection will give approximately 25,000 volts.

* * *

S. R., New York City, inquires:

Ques.—(1) Has a practical method for transmitting radio signals with a buzzer been found? If so, please publish a diagram of connections.

Ans.—(1) The buzzer has frequently been employed for short distance communication at wave-lengths up to 600 meters. There are several methods by which energy can thus be set up in the antenna circuit, one being to connect the earth and aerial connections across the contacts of the vibrator. Another method is to connect a small coil of inductance in series with the antenna circuit and then continue the circuit from a buzzer and battery through this coil. A change in the lines of force takes place in this coil during the operation of the buzzer which sets up a potential in the antenna circuit causing it to oscillate at its natural frequency. A diagram of connections is not required.

Ques.—(2) Can cerusite be employed in

Ans.—(2) It may be mounted in the usual manner with Wood's metal or other soft metal.

Ques.—(3) Where can cerusite crystals be purchased?

Ans.—(3) From Eimer & Amend, 211 Third avenue, New York City.

* * *

J. B. C., Deering, N. D., inquires:

Ques.—(1) I am situated in a town where there is neither alternating nor direct current. I understand that alternating current is positively necessary for the operation of a closed core transformer. I have also been told that direct current generators only can be had in ½ k.w. and 1 k.w. sizes. In view of the fact that I expect to use either a ½ k.w. or a 1 k.w. transformer, what remedy can you suggest for my trouble?

Ans.—(1) Any reputable manufacturing concern will be able to supply you with a 1 k.w., 60 cycle or 120 cycle generator which can be operated by a gasolene engine. In view of the fact that you have neither alternating nor direct current, we advise the purchase of an alternating current transformer and generator, rather than a direct current generator and induction coil. The Crocker-Wheeler Company, Ampere, N. J., or the Robbins & Meyers Company, Springfield, Ohio, will be able to supply you with a generator of this description.

Ques.—(2) At what time does Arlington transmit on continuous waves and what is the wave-length employed?

Ans.—(2) The continuous wave set is used at irregular intervals throughout the twenty-four hours of the day and may be heard in the afternoon to good advantage, communicating with the Naval station at Darien and other high-power stations. The wave-length employed varies between 6,500 and 7,500 meters.

Ques.—(3) At the beginning of a schedule, Arlington makes use of the letters "Q. S. T." What is the meaning of this signal?

Ans.—(3) This is an international abbreviation and is the "general call for all stations."

Ques.—(4) How many watts does the average ½-inch spark coil consume and is a license required in case it is used in a radio telegraph set?

Ans.—(4) The average coil of this type consumes approximately forty watts and if your station is so situated that the signals from it are apt to be heard beyond the borders of the state, a license is positively required.

Ques.—(5) Can the secondary winding of a ½-inch spark coil be employed as a loading coil in a receiving set?

Ans.—(5) Positively no. The inductance value is too high for the purpose and the presence of the iron core would be detrimental to its efficiency.

* * *

A. B. Fayette, Ala., inquires:

Ques.—(1) I constructed a 3-inch spark

exception that I used a core ⅞ of an inch in diameter, instead of the dimensions given. I also used two pounds of No. 34 enameled wire, winding it in four sections. These sections were connected together to form a continuous winding and the precaution was further taken to boil the secondary winding in linseed oil. I obtain a much better spark from a 1-inch coil than from the designs given in that book. Can you tell me what changes I can make to secure a discharge of the normal rating of the coil?

Ans.—(1) In the first place the condenser across your vibrator is too small. It should have at least 2,000 square inches of foil and preferably 2,500 inches. Likewise, you should use No. 36 wire as advised in the original specifications. It would seem, however, from your communication that the various sections of the secondary winding are improperly connected, for a single section of the dimensions stated should give a spark a fraction of an inch in length. While you may believe your winding to be continuous, it probably, after examination, will be found not to be so. It may also be that the vibrator which you have fitted to the primary winding does not make a clean cut break. This is a very important consideration and unless a vibrator is properly constructed and fitted with a first-class grade of platinum point, the result will be anything but satisfactory. A number of coils have been constructed from the designs given in the book "How to Conduct a Radio Club," and with 8 volts applied to the primary winding, have easily given a spark discharge three inches in length.

Ques.—(2) It was my intention to use the coil referred to without condenser or vibrator on a 110-volt, 60-cycle circuit. What should be the size of the "choke" coil for cutting down the current flow in the primary winding? Also is a protective condenser or resistance rod necessary for protection of the primary circuit?

Ans.—(2) This coil positively will not function on alternating current, as the secondary winding possesses an abnormal value of inductance, while the primary winding has insufficient value. Unless a rather large choke coil is employed, the primary winding will over-heat and burn out.

Ques.—(3) Approximately what would be the rating in watts of the 3-inch spark coil?

Ans.—(3) Under normal conditions of operation it should not consume more than fifty or sixty watts.

* * *

H. P. H., Alton, Ills., inquires:

Ques.—(1) During last winter I employed a Packard transformer designed for a secondary potential of 13,200 volts and when used in connection with the condenser, consisting of twenty sheets of tin foil, 4½ inches by 6½ inches separated by plates of glass ⅛ of an inch in thickness, I secured a good spark with the rotary gap having 12 points, revolving at a speed of 1,750 R.P.M.

With this apparatus my spark note was not ragged, but was, of course, rather low. I then cut down the condenser capacity to about one-half of its original value, which, of course, cleared up the spark note, but even with the speed of 3,000 r.p.m. at the rotary, the safety gap sparks badly each time the key is closed.

The safety gap is set at ⅞ths of an inch, which is ⅛th of an inch in excess of that recommended by the manufacturers. What I desire is to have my spark note remain clear and at the same time prevent the safety gap from sparking. Can you help me out?

Ans.—(1) The average rotary spark gap places an excessive strain on a high potential transformer, due to the fact that the condenser discharges just as soon as the points of the rotary are close enough for the available potential. When you reduce the condenser capacity of your set to one-half, you undoubtedly raise the available potential at the secondary winding of the transformer and perhaps considerable separation exists between the stationary and the moving electrodes of the gap; consequently you secure a continuous discharge at the safety gap. There are two solutions of your problem. You may either construct your rotary gap so that the separation between the moving and stationary electrodes is no more than one-fiftieth of an inch, or allow it to remain as at present and widen out the safety gap until all sparking ceases. It is quite probable that this will not harm the secondary winding.

* * *

L. J. T., New Orleans, La., inquires:

Ques.—(1) Considerable interference is experienced at my receiving station from a local station employing the arc generator. What is the cause of this? Why should this station be heard at all with a crystalline detector? If this is due, as I have heard, to a slight damping of the wave train, what is the probable cause of this damping? With a certain adjustment at my receiving apparatus, only a single continuous sound can be heard, but if a slight change in the coupling is made, the dots and dashes of the telegraph code can easily be distinguished. How do you account for this? Apparently, I only hear the back stroke of the telegraph key.

Ans.—(1) Signals can sometimes be heard from these stations on crystalline detectors up to distances of fifty miles. This is, as you intimate, due to a slight damping of the wave train and is caused by the irregularities in the action of the arc gap. You can readily understand that the ionized discharge path between the electrodes of the arc gap is not one of continuous or constant conductivity. The oscillations, therefore, are not of continuous amplitude, and a small amount of damped energy is accordingly radiated. The phenomenon observed in the last part of your query will be readily understood when you consider the method by which signaling is accomplished at these stations. When the telegraph key is in the "open" position a wave, let us say of 3,000 meters, is radiated, but when the telegraph key is pressed, a few turns of the transmitting helix are cut in the circuit and a longer wave radiated. By extremely careful adjustment of your receiving tuner, you can make the signals of either wave audible, but only one is readable.

* * *

W. E., Waverly, N. Y., inquires:

Ques.—(1) Which do you consider the best arrangement for the lead-ins of an aerial system? Should the rat-tails unite near the flat top portion of the aerial or at the place where they enter the radio station?

Ans.—(1) With the flat top type of aerial it is preferable to bunch the lead-ins the entire distance from the flat top portion to the point where they join the transmitting apparatus.

Ques.—(2) In connection with a small spark coil giving a discharge ½ inch in length, does a helix and condenser increase the range of a set or not? If a helix will increase the range, please give the correct dimensions.

Ans.—(2) It has been the experience of experimenters as a whole that better results are obtained with a small spark coil, by connecting the spark gap directly in series with the antenna system; in other words, use the "plain aerial" connection.

Ques.—(3) Will the tikker detector work successfully with both damped and undamped waves, or is it intended primarily for the reception of undamped oscillations?

Ans.—(3) It responds better to undamped oscillations. Spark stations can be heard on the tikker, but the note of the transmitting station is broken up at irregular intervals, the resulting note being of a very disagreeable pitch and characteristic.

* * *

E. W. M., Keyport, N. J., inquires:

Ques.—(1) Will a straight coupled helix or an oscillation transformer give the greatest efficiency with a ¼ k.w. transmitting set?

Ans.—(1) Practically equal results will be obtained from either type, provided the method is understood for adjusting the plain helix for a loose degree of coupling between the primary and secondary windings. The inductively-coupled transformer is favored because it permits the coupling between the primary and secondary windings to be altered in a very simple manner and without the complications with the straight helix. The matter is fully discussed in the book "How to Conduct a Radio Club."

Ques.—(2) Please give a brief outline of an oscillation transformer which can be constructed to work at the wave-length of 200 meters in connection with a Blitzen ¼ k.w. transmitting set, 4 sections of moulted condenser, a straight gap and an aerial system 85 feet in length, 30 feet in height, consisting of 2 wires.

Ans.—(2) A satisfactory description of an scription is given in the book "How to Conduct a Radio Club."

* * *

W. H. S., Boston, Mass., inquires:

Ques.—(1) As a constant reader of THE WIRELESS AGE I should like to inquire the meaning of the "R. Q.'s" frequently used by the Sayville station in sending messages to Nauen.

Ans.—(1) This is a repetition signal used as a prefix when a number of messages sent on a previous schedule are to be repeated.

* * *

K. D., Defiance, Ohio, inquires:

Ques.—(1) Please give the dimensions for an oscillation transformer and condenser to be used in connection with a ½ k.w. Packard 13,200-volt transformer rotary spark gap in connection with an aerial system 70 feet in length, 40 feet in height, the entire apparatus to be operated at a wave-length of 200 meters.

Ans.—(1) Your condenser should have a capacity of .008 microfarad and it may consist of 4 plates of glass, 14 inches by 14 inches, covered with tinfoil, 12 inches by 12 inches. These plates should be connected in parallel and immersed in oil. The oscillation transformer may have four turns of 3/16-inch copper tubing for the primary winding, made on a form 10 inches in diameter, the turns being spaced 1 inch apart. The secondary winding may be 8 inches in diameter and comprise 10 or 12 turns of 3/16-inch copper tubing spaced ¾ of an inch apart. A good insulating material, such as a first-class grade of hard rubber, should be used as a support for the tubing.

Ques.—(2) Please give the natural wave-length of the aerial mentioned in the first query.

Ans.—(2) The natural wave-length of this antenna is approximately 200 meters and you will require a short wave condenser when the secondary winding of the oscillation transformer is connected in series.

Ques.—(3) On what wave-length does the Great Lakes naval station transmit the time signals?

Ans.—(3) At the wave-length of 1,000 meters.

Ques.—(4) Which is the more efficient, an antenna of the inverted L type or one of the T type, provided both have the same wave-lengths?

Ans.—(4) Practically equal results will be obtained from either type, but the inverted L is the one mostly used.

* * *

R. W. L. T., Lake Hopatcong, N. J., inquires:

Ques.—(1) I have two aerials, one 75 feet in length and the second a hundred feet in length, with approximate height of about 40 feet. I also possess a receiving tuner, the primary of which is 5⅝ inches in diameter by 9¼ inches in length, fitted with thirty-nine contacts. The secondary winding is 9¼ inches mately what is the maximum range of wave-length adjustments and do I require a loading coil for receiving the time signals of Arlington?

Ans.—(1) You failed to give us the size of the wire used in the primary and secondary windings, and consequently we cannot calculate the possible wave-length adjustment, but if these windings are made with the usual sizes of wire, that is, No. 24 for the primary and No. 32 for the secondary, your apparatus should respond to wave-lengths including 5,000 meters.

Ques.—(2) What is the best aerial for receiving waves up to 5,000 meters and also for transmitting at the wave-length of 200 meters?

Ans.—(2) The largest aerial that you can employ is one of the T type, which may comprise four wires, 110 feet in length and approximately 50 feet in height. The lead-in wires are of course attached to the center.

Ques.—(3) What crystal detector do you consider to be the most sensitive?

Ans.—(3) Cerusite and galena seem to stand at the top of the list.

* * *

W. R. M., Bangor, Me.:

The diagram of connections for the receiving apparatus you have sent is applicable to both short and long waves, but it represents a complicated circuit and one that would be confusing to a beginner. If, however, it is well understood by yourself you should have no difficulty in effecting the purpose desired. Keep in mind that it is desirable to employ simple apparatus.

The aerial shown in your second sketch possesses no particular value and in fact has no advantage over the ordinary 4-wire type, with a spacing of about 2½ feet between wires.

The spark coil which you mention will give a secondary discharge about 6 inches in length and will consume approximately 200 watts of energy.

Your aerial, 45 feet in height and 30 feet in length, has a natural wave-length of approximately 135 meters. With the apparatus which you have shown in your first drawing you should have no difficulty in tuning this equipment to the wave-lengths of Sayville and Tuckerton.

* * *

H. B., Walden, N. Y.:

The natural wave-length of your aerial is approximately 230 meters and the loading coils you describe in connection with the receiving tuner have not sufficient inductance to adjust to the wave-length of 10,000 meters. The loading coil in the antenna circuit should be approximately twice its present length and an additional loading coil, approximately 18 inches in length, 6 inches in diameter, wound fully with No. 32 S. S. C. wire, should be placed in the secondary circuit. With the present design of your apparatus it should be responsive to wave-lengths including 6,000 meters. It would probably improve conditions to substitute ... place of the No. 18 copper wire used at present, and put insulators in the guy wires rather than have them grounded direct.

Your inductively-coupled receiving tuner, without the loading coils, will respond to wave-lengths including 3,500 meters.

* * *

M. J. F., Philadelphia, Pa.:

The description you give of your receiving apparatus is incomplete, but if the loading coil and the 2-slide tuning coil mentioned have dimensions similar to those usually supplied for amateur equipments, the apparatus should easily be responsive to the wave-length of 1,500 meters. Your aerial, 50 feet in length and 35 feet in height, has approximately a wave-length of 150 meters and it does not require a coil of large proportions to respond to the wave-length of 1,500 meters.

* * *

M. E. K., Duquoin, Ills.:

It is extremely difficult to give advice concerning the probable decrease in range of your transmitting apparatus caused by the near-by trees. The actual amount of interference or absorption of energy can only be determined by an elaborate series of experiments. Undoubtedly trees, when covered with foliage, do absorb a considerable amount of energy, but in your case we cannot state just how serious this may be nor do we know any method by which you can improve the present conditions. We believe that the fact that your amateur apparatus transmits to a distance of seventy-five miles is sufficient proof that it is working well.

Ques.—(2) What is the capacity of a condenser having plates 8 inches by 10 inches, coated on both sides with tinfoil, 5 inches by 7 inches? There are 7 plates in each bank of this condenser connected in parallel and the two banks are connected in series.

Ans.—(2) Each plate has a capacitance of approximately .0005 microfarad and 7 connected in parallel have a value of .0035 microfarad. The two banks connected in series represent a capacity of .00175 microfarad.

Ques.—(3) At what speed should I run a semi-quenched gap, having 16 electrodes on a disc 5 inches in diameter and used in connection with the condenser referred to?

Ans.—(3) The disc should revolve at a speed of approximately 1,800 revolutions per minute.

* * *

J. E. R., Cuenca, Ecuador, inquires:

Ques.—(1) Is there any particular advantage in regard to the distance that may be covered with a transmitting apparatus located on the top of a hill as compared to one that is situated at the sea level?

Ans.—(1) Generally it is difficult to secure a first-class earth connection at high altitudes and for this reason a station will give better results when located near the sea level. Again, atmospheric electricity is especially severe at the higher altitudes and may seriously interfere with the reception of signals from conlocated on the top of a mountain it is customary to use an artificial earth connection—a large grid of copper wires spread radially over the surface of the earth.

* * *

V. C. De C., Issaquah, Wash.:

Ques.—(1) How is the auto transformer, illustrated on page 77 of the book "How to Conduct a Radio Club," wound?

Ans.—(1) The method for winding this transformer is fully described in the book. It merely consists of an iron core of the dimensions given with the wire wound in several layers. The core is, of course, covered with several thicknesses of insulating paper before starting the winding. Coils of this type can be purchased from the Manhattan Electrical Supply Company, New York City.

Ques.—(2) Where can I purchase a ½ microfarad condenser?

Ans.—(2) Condensers of this capacity can be purchased from any telephone company in your vicinity. It is not essential that this condenser should have exactly that value of capacity; in fact, it may vary from ½ to 2 microfarads. You will find it much easier to purchase a condenser of this type than to construct it.

* * *

R. P. P., Newark, N. J.:

Practically any manufacturing house supplying amateur apparatus can furnish you with an oscillation transformer and condenser for your set. The condenser should have a capacitance of about .008 microfarad and may be made up of a number of glass plates connected in parallel. The method for attaching the tin foil to the plates and the general construction is fully described in the book "How to Conduct a Radio Club."

A helix can be employed in place of the oscillation transformer with practically equal results, but the majority of amateurs favor the inductively-coupled oscillation transformer.

Your aerial has a fundamental wave-length of almost 180 meters and is well suited for transmission at a wave-length of 200 meters.

An oscillation transformer for your set may have a primary winding 10 inches in diameter, comprising four turns of 3/16-inch copper tubing, spaced one inch apart. The secondary winding may be eight inches in diameter and have 10 or 12 turns of the same size tubing spaced ¾ of an inch apart.

Parts and material can be purchased from such concerns as the Manhattan Electrical Supply Company, New York City, or advertisers in the columns of this magazine.

* * *

J. M. C., Camp Greenbrier, Alderson, W. Va.:

The signal A. S. T. is the special abbreviation for "all stations attention," while QST is a general call for all stations, as indicated by the London Convention.

* * *

D. W. W., Montpelier, Ky., inquires:

Ques.—(1) Would a large static or X-ray machine, giving a spark 16 to 20 inches in length, be of any value for transmitting wireless telegraph signals? If so, what distsance could be expected?

Ans.—(1) This machine is of no value for the transmission of radio signals as the potentials are excessive for wireless telegraph work.

* * *

J. R. B., Washington, D. C., inquires:

Ques.—(1) What is the approximate wave-length of an aerial consisting of two wires, spaced five feet apart? It is 115 feet in length, 150 feet in height at one end and 80 feet at the other. The lead-in is 70 feet long and also consists of two wires.

Ans.—(1) The wave-length of this antenna is approximately 400 meters.

Ques.—(2) Will an aerial 80 feet in height at one end and 30 feet at the other, consisting of four wires spaced two feet apart, comply with the law?

Ans.—(2) We might answer this if you had stated the length of the flat top portion, but lacking this we cannot reply.

Ques.—(3) On the building on which my aerial is located is another aerial, the distance between the two being approximately 20 feet. Will these aerials have any effect upon each other?

Ans.—(3) If either of these stations makes use of a transmitting apparatus having considerable power and voltage, you had better arrange some method of signaling each other; otherwise your receiving aerial will pick up considerable potential (when the opposite aerial is sending) and possibly injure the receiving apparatus. In fact the aerials are close enough so that tuning on one during the reception of signals will somewhat affect the tuning on the other.

* * *

J. R. F., Washington, D. C., inquires:

Ques.—(1) Please advise why I cannot hear the time signals of Arlington either at noon or in the evening with the following equipment: The aerial is 70 feet in height at one end and 38 feet in height at the other. It is 75 feet in length and comprises four wires, spaced 2½ feet apart. The receiving apparatus comprises an inductively-coupled tuner rated at 800 meters and a 5,000-meter loading coil. The receiving detector is home-made and the telephones are of the Brandes type, 2,000-ohm. I also have a buzzer testing apparatus.

Ans.—(1) It is likely that although you have placed a loading coil in series with the primary winding of your receiving transformer, you have made no arrangement in the secondary winding to obtain resonance with the antenna circuit. With a properly designed receiving equipment, you should at least hear the signals from this station at the 10 P. M. Eastern Standard Time schedule. You might insert a loading coil in series with the secondary winding as well as the primary winding or place a variable condenser of .001 microfarad in shunt to the secondary winding. By either of these methods you could place your apparatus in resonance and consequently hear the signals from this station.

Ques.—(2) How far should I be able to transmit under normal conditions with the aerial described in my first query, a ½ k.w. E. I. coil, interrupter, condenser and oscillation transformer, together with a stationary gap?

Ans.—(2) The natural wave-length of your antenna system is approximately 200 meters and if properly adjusted to resonance with your apparatus, you should cover from 15 to 40 miles, depending upon the nature of the receiving apparatus used at the distant receiving station.

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N. H. A., Newburyport, Maine, inquires:

Ques.—(1) Will you kindly advise through the columns of your magazine how I may test the efficiency of my 1-inch spark coil transmitting set with condenser and oscillation transformer, in view of the fact that I do not possess a hot wire ammeter. I generally employ a six-volt lamp connected across the terminals of the secondary winding, but I do not find this method reliable.

Ans.—(1) You might connect the six-volt lamp in series with the antenna system and if there is not sufficient energy flowing to light it up, you had better purchase a smaller lamp—one of two volts. If the current in the antenna circuit proves of too great value for this lamp, you might shunt it by a turn of wire six inches in diameter and about six or eight inches in length. At any rate you could easily adjust this shunt until the glow of the lamp was reduced to a value below the danger point. Maximum glow is of course obtained when the two circuits of the transmitting apparatus are in exact resonance.

Ques.—(2) Can I employ this 1-inch spark coil as an open core transformer and thereby secure increased results, and if so, how many 5 by 7 condenser plates would be required?

Ans.—(2) A 1-inch spark coil of usual construction will not function on alternating current and it would be dangerous for you to attempt it.

Ques.—(3) Will the boring of a number of holes in the zincs of a spark gap give a better pitch to the note?

Ans.—(3) We cannot see how this would affect the pitch of the note. If the spark gap is of the correct length, the surfaces perfectly even and smooth and the vibrator in proper adjustment, you should secure a clear note without the use of any special attachment or changes.

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F. B., Newark Valley, N. Y., inquires:

Ques.—(1) Is a 90-foot vertical aerial preferable to a T aerial 60 feet in height and 6 feet in length, if used for transmitting at the wave-length of 200 meters?

Ans.—(1) The 90-foot vertical aerial would have a fundamental wave-length of about 130 meters, whereas the 60-foot aerial has a natural wave-length of approximately 140 meters. We are inclined to believe that about identical results will be obtained from either type of aerial.

Ques.—(2) What type of aerial do you consider best for operation at the 200-meter wave and what should be its overall dimensions?

Ans.—(2) The inverted L or T type of aerial seems to be preferred by the amateur field as a whole. An inverted L aerial, 60 feet in length and from 40 to 50 feet in height, will do for operation at the wave-length of 200 meters. If of the T type, the flat top cannot exceed 110 feet in length and it may vary in height from 40 to 60 feet.

Ques.—(3) Is a receiving tuner with 288 turns of wire on a primary coil 4¼ inches in diameter, too large for the reception of 200-meter signals when connected to an aerial having a natural wave-length of 160 meters?

Ans.—(3) We could answer this question more clearly had you given the dimensions of the secondary winding. You will not require the entire 288 turns to adjust the antenna circuit of the receiving system to the wave-length of 200 meters; in fact, you will require no more than eight or ten turns.

Ques.—(4) Approximately how much does a series condenser decrease the strength of received signals?

Ans.—(4) This can only be determined by experiment. In the average case, however, a decrease in strength of signals does take place when capacity is added in series to the antenna circuit. This is due to the increase of resistance caused by the series condenser.

Ques.—(5) What should be the capacity of a series condenser for an amateur's aerial?

Ans.—(5) The maximum value need not exceed .001 microfarad.

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H. F. W., Chicago, Ills., inquires:

Ques.—(1) What should be the approximate dimensions of a tubular condenser to have a capacity of .0005 microfarad?

Ans.—(1) The outer tube may be 4 inches in length and 1 inch in diameter; the inner tube ⅞ of an inch in diameter with the same length. The inner tube should be covered with a thin sheet of hard rubber or other insulating material.

Ques.—(2) When I shunt a fixed condenser across my telephones, the signals completely disappear. Does this indicate a short circuit in the condenser?

Ans.—(2) If the capacity of the condenser does not exceed .05 microfarad, it should not seriously affect the strength of signals and the fact that it completely cuts out the signals would seem to indicate a direct short circuit.

Ques.—(3) Would the speed of a small Rex motor operated by two dry cells be sufficient to operate an ordinary slipping contact detector?

Ans.—(3) Yes.

Ques.—(4) Does the station WGO at Chicago, Ills., use undamped or damped oscillations?

Ans.—(4) Spark apparatus is employed at that station.