October, 1918

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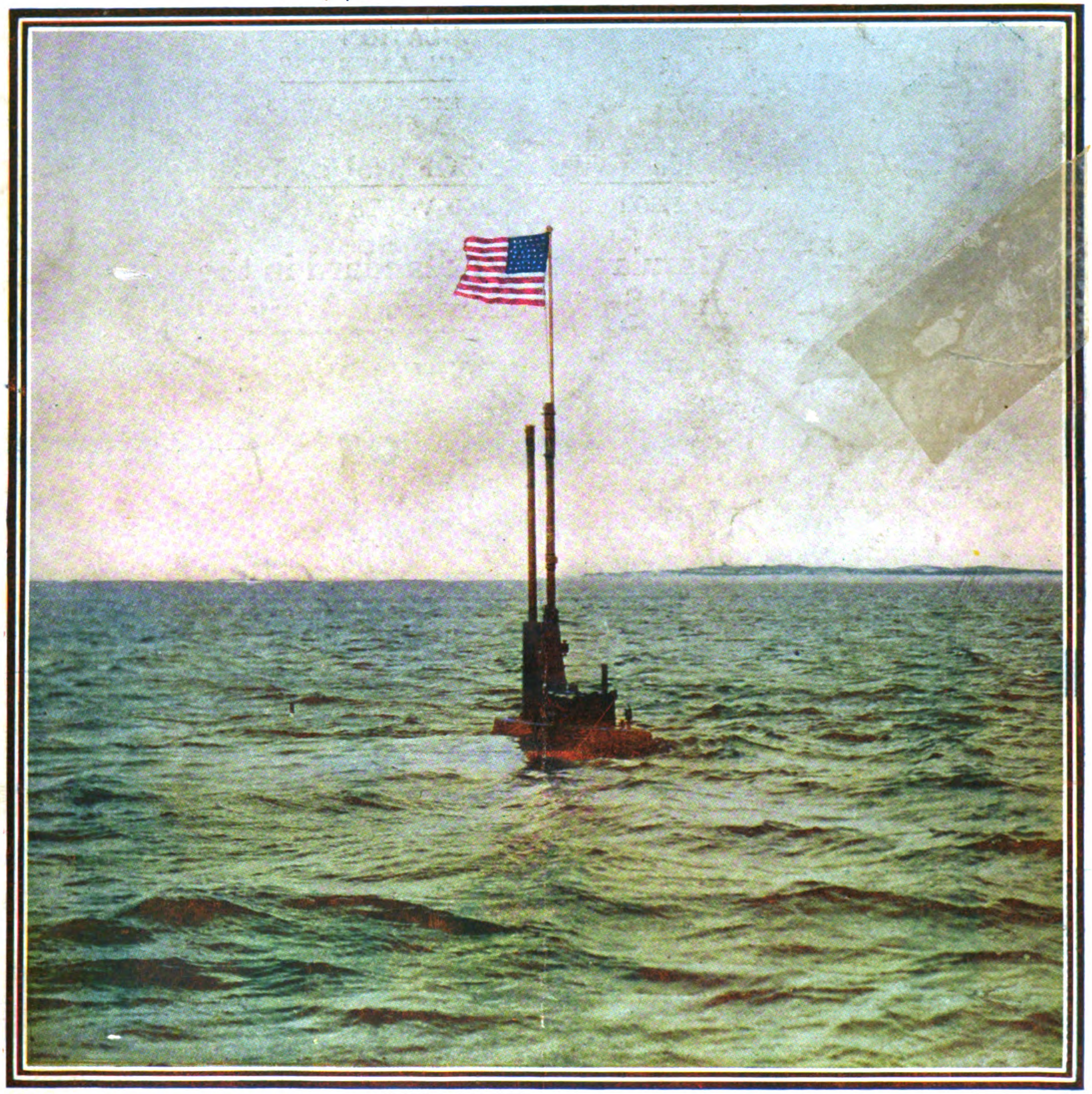
The WIRELESS AGE

Volume 6

Number 1



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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 6 — Contents for October, 1918 — No. 1

Index of Equipment

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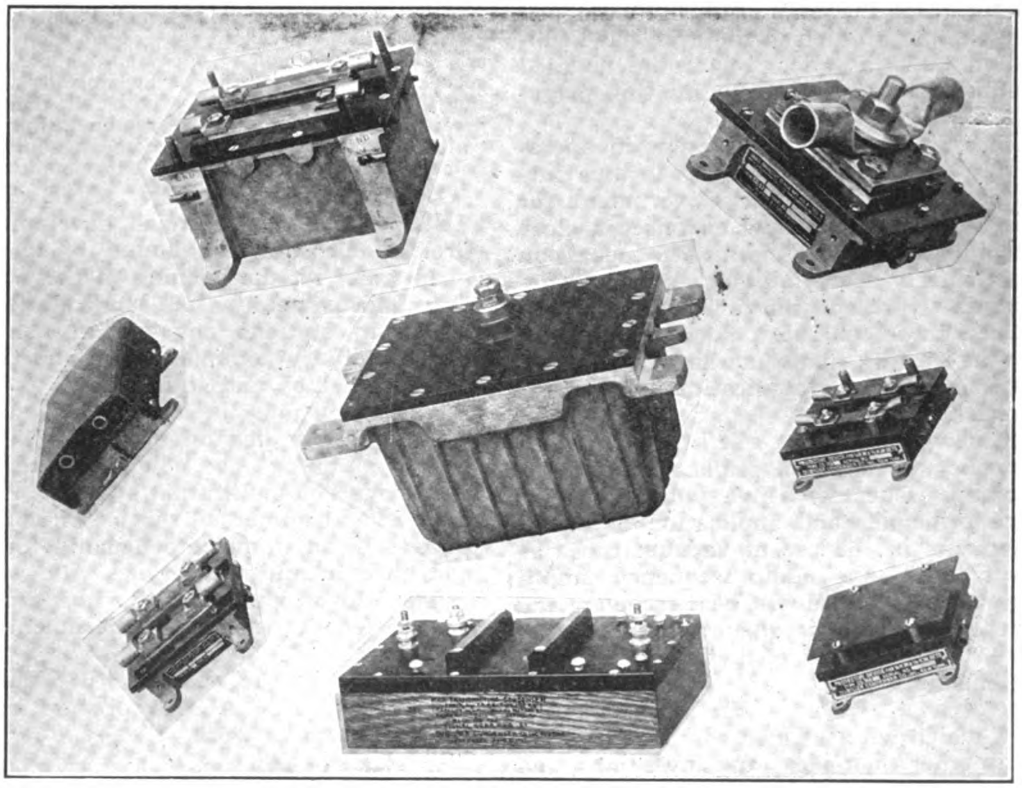


DUBILIER CONDENSER CO., Inc.

217 CENTRE STREET NEW YORK

To Our Readers

THE new appearance of The Wireless Age, in the large size and lighter weight, is a step taken in co-operation with the War Industries Board to aid in the conservation of paper. It is also a step in advance, the first step for a broader editorial policy and a better magazine for our readers. The opportunities to display illustrations to better advantage is but one of the many merits of the new size; typographical arrangement and more equable division of features will also recommend it to readers. Then there is the editorial policy.

Since our country entered the war wireless work has been concentrated on war interests; since the beginning, and, in fact, even before the declaration of war, we have made the Age of direct practical value to readers who have gone into the service and those looking forward to a call to the colors. The progressive study courses in arts of war have been carefully followed by thousands of men with deep interest, and with appreciation, too, as shown by their letters. Entire Signal Corps battalions, from the Major down to the privates, including all men in the unit, have subscribed in bulk in order to get the detailed instructions given exclusively by this magazine.

Another draft of fighting men is in operation. The magazine's usefulness is thus further increased. While our Government for most excellent reasons now exercises a close censorship over the art, both as to operation and particularly as to military and naval developments at present, the time is not far distant when there will be a flood of most intensely interesting data marking marvelous advances in, and new applications of, the art of wireless.

Much new information, not in conflict with public policy, is ready for publication and our forthcoming issues will give you an insight into the principles and application of recent developments in the use of vacuum tubes as detectors, radio and audio frequency amplifiers, regenerative receivers, beat receivers and generators of radio frequency currents, together with applications of these tubes in wireless telephony.

The Wireless Age is the only medium through which wireless men can communicate to one another their ideas and inventions, and find out what is going on in the art during this extraordinary period.

HIGH-POWER STATIONS for trans-oceanic work, about which the layman knows little or nothing, will continue a live subject, handled, as in the past, by the engineers in charge of the Marconi system. The value of these exclusive articles is instanced by the detailed observations which have already been given of the power circuits, the control of currents from 300 k.w. alternators, the special antennae circuits for sending and receiving, amplified and made clear by data compiled in operation on both Atlantic and Pacific Coasts.

RADIO SCIENCE—This department is the most widely quoted source of wireless information among technical magazines. In it all developments of importance are recorded, both in mechanical advances made in design of apparatus and discoveries which establish new principles. The careful selection of subjects and the world-wide aspect of the research make this a distinctive and tremendously valuable feature. Representative of the best thought abroad and in the United States, it opens up new avenues for personal and patriotic experimental research, and will keep Age readers in advance of the recorded progress of the art.

PAN-AMERICAN STATIONS—The new commercial era dawning in Pan-America is demanding a wireless service spanning vast distances and for continuous operation. Extensive plans now being executed will be covered in exclusive articles containing descriptions and illustrations of the new wireless circuits and the opportunities the new services will create in the radio field.

EXPERIMENTERS' WORLD—By reporting in a broad way the latest advances in electrical and mechanical apparatus, this feature supplies an inspirational source for all electrical workers. Special attention is given to the contributions of readers, affording excellent opportunities for them to secure public recognition of meritorious work and for the exchange of ideas with all those of an inventive turn of mind. The remuneration for such contributions may readily become a source of income for carrying on further experimenting.

OPPORTUNITIES IN THE RADIO FIELD—Great commercial development in wireless telegraphy is bound to follow the world war. At the opening of the war there were approximately 700 land stations and 4,500 ship stations engaged in commercial service, military communication and the service of lightships and lighthouses.

Vast extensions have since taken place. Wireless is installed on thousands of vessels and all continents are now connected into a world-wide communication system which will be open for commercial service after the war.

There is an immediate demand for skilled radio men in military service, who will have a wide field of opportunity in future commercial and federal and local government service after the war.

You can use the opportunity presented in THE WIRELESS AGE to prepare for useful and remunerative work.

Government restrictions on newsstand distribution, to conserve paper supplies, make it desirable that each reader now subscribe for one year, sending subscriptions through their local newsdealer, or direct to us if more convenient.

THE PUBLISHER

Vol. 6. No. 1. October, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Telegraph and 'Phone for Lighthouses

GREAT BRITAIN is establishing on her coast radio lighthouses, equipped with combination wireless and phonographic instruments. These lighthouses are particularly valuable in thick weather, when the light is frequently invisible. The name of the lighthouse is repeated automatically by wireless every five seconds, the intensity of the sounds being so regulated that ships equipped with an ordinary wireless receiving apparatus will hear the signal the same approximate distance that the light could be seen in clear weather.

Skilled Radio Operators Needed in Tank Corps

SPECIAL opportunity to enlist in the tank corps, the only branch of service now open, is to be given drafted men between 21 and 31.

Men in deferred classification will be accepted, but none in Class 1 will be taken unless especially trained as a radio wireless operator or acetylene welder.

No person wearing glasses will be taken, and the minimum height and weight is 5 feet 6 inches and 130 pounds.

Blacksmiths, cooks, stenographers and wireless operators are especially desired.

Indications of the Growth of the Wireless Industry

IT IS well known to those engaged in the wireless art that few outsiders have any appreciation of the size of the industry. While many published accounts of increased use of radio appear in the newspapers and periodicals from time to time, the haze of romance which envelopes wireless seems to prevent these items from registering on the public consciousness. It is safe to say, for example, that the average business man would be greatly surprised to know that one branch of the military establishment purchased in a two weeks' period ending July 25th, the following wireless equipment: 9,500 complete wireless sets, 6,365 motor-generators, 20,000 sets of head 'phones, 10,000 antennae systems, 125,000 insulators, and great quantities of electrical supplies such as wave-meters, potentiometers and rheostats.

Considering the many branches of the army organization and that these purchases were for but a single branch, some idea may be gained of the quantities of equipment being made for the navy and merchant marine.

It is significant, too, that the report of the committee on education and special training announced at the same time that of 47,243 soldiers in the United States being given vocational training for service overseas, 6,693 were in the electrical class, engaged largely in radio operation.

Wireless Versus Long-Distance Cables

AT THE annual meeting of the English Marconi Company, Managing Director Godfrey Isaacs made the following statement:

"We have many important negotiations in many parts of the world of which it would not be wise of me to

Sykes in Philadelphia Evening Public Ledger. Copyright, 1918, by the Public Ledger Co.

"Lightning trained Yankees iss right"

speak today, but I think one may fairly contemplate that the business of wireless telegraphy will be no less important when peace comes than it has been during the war. In speaking with a very eminent officer of the United States Navy Department a day or so ago, he told me that, although before the war he was of a very different opinion, he has now come to the conclusion that no new long-distance cables will ever again be laid; that, in his view, wireless telegraphy is thoroughly efficient for all telegraphic purposes. It would not be, perhaps, altogether advisable for me to express such views, but I think you will be glad to hear those of a practical man holding such an important position in so great and progressive a country as the United States.

German Clandestine Radio Apparently Silenced

GOVERNMENT agents now feel sure they have stopped all means of clandestine cable or radio communication between the United States and Germany.

After investigation they have found it takes usually four or five weeks for information published in this country to be published in Germany or Austria.

This is about the time required to carry newspapers or mail matter to Germany through the north European neutral countries. Repeated tests, officials say, have shown that important news reached the German government only through American newspapers, copies of which were actually carried to Germany or the adjoining neutral countries.

The Kaiser: Can't we make some of that American "Pep?"
Chemist: Not in an imperial laboratory, your majesty

Army's New Radio Schools Supplant French

TRAINING schools for radio work have been established by the division of military aeronautics at West Point, Ky., and Camp McClellan, Ala., field artillery firing centers, and instruction work along these lines will eventually be extended to Fort Sill, Okla., and Camp Jackson, S. C., and also to field artillery firing centers where observation schools of the division of military aeronautics are now working in co-operation with the artillery branch of the service.

These are only a few of the first steps in co-ordination that are now being instituted by the different branches of the service in the camps of this country. Heretofore advance schooling was to be obtained only when the American troops reached France.

Instruction in radio covers wireless communications between the fliers in the air and the gun crews on the ground below. By means of radio the fliers are able to signal for barrages, the location of batteries, ammunition dumps, infantry, trains, and other targets and also to "spot" for its own particular battery, which means to tell that battery whether its shells are landing to the right or left, over or under the target fired at.

Norway-American Wireless Link Forged

THE Farmand, a Norwegian trade journal, has the following article concerning the Stavanger wireless telegraph station: "The great wireless station erected near Stavanger by the Norwegian government for telegraphic connection with the United States has recently been completed. Trial messages have been exchanged between the station and the Belmar wireless station, near New York, and had the very best telegraphic results. The Stavanger wireless is one of the most powerful stations in the world and, as far as equipment is concerned, no doubt the one most up to date. The Norwegian-American direct telegraphic connection will afford considerable advantages to men of business on both sides of the ocean. Thus the wireless service will, according to the contract between the Norwegian Telegraph Department and the American Marconi Company, highly reduce the rates for telegrams between the two countries, and it will likewise save time for the business world, the station being of the duplex type and able to work in both directions simultaneously and at a higher telegraphic speed than attainable in the Atlantic cable service."

Torpedo Freak or Wireless Control?

WAS the Sommerstad sunk by a dirigible torpedo? The question was raised by the fact that after missing the steamer the deadly weapon swung about and this time struck. Capt. Hansen expressed no opinion, thinking that the swerve may have been due either to wireless control or to defective mechanism. Naval experts at Washington are said to ridicule the suggestion of wireless control, and explained that the mechanism can be so set that the torpedo will come back like a boomerang to the hand of the thrower. Thus set, they are quoted as saying, a torpedo becomes almost doubly effective, because if it fails to hit the mark it has a second chance.

Some of the reports, however, are not consistent with this theory, for they describe the torpedo as appearing to port, passing under the ship, circling with a radius of less than 100 feet, and striking the steamer on the port side where it was first seen. This might point either to a vagary of the mechanism or to wireless control, which occurs to everybody because so many inventors have been working for it, and with some measure of success. But if the Germans possess a really effective device of this sort, it will soon be made manifest; the cases which suggested dirigibility have been just frequent enough to make it probable that a new case is but one more freak of an automatic torpedo.

Antenna Springs for Minimizing Shock

ACCORDING to The Electrician of London, there has recently been patented an invention which reduces to a minimum the risk of wireless aerials on vessels being broken and the wireless apparatus thus put out of action when a ship becomes mined or torpedoed.

The invention is stated to be simple and inexpensive, and utilizes one or more long extension springs specially constructed and fitted at each end of the present aerials, these springs automatically extending and contracting to allow the aerial to lengthen or shorten to take up the varying distances between the top of the masts when they spring out of position through an explosion. These springs do away with the present necessity of lowering the aerial when a ship is being loaded, as they allow for the vibration of the masts caused by working the derricks, and their use would in some cases save the aerial being blown away by shell fire.

Secret Station Near Cartridge Works Discovered

A POWERFUL wireless outfit was seized at Bridgeport, Conn., on September 5th by army intelligence officers, following a two week vigil from the shelter of a cornfield. The plant was discovered on the upper floor of a house and had a sending radius of 150 miles.

A youth describing himself as Charles Mudry, 18, a wireless student, was arrested during the raid. He declared he received instructions from an older man. The plant, which is located next door to that of the Union Metallic Cartridge Co.'s factory, has been in operation over six months.

British Seaplanes Use Wireless Extensively

WHAT could be more natural than that the airman who forces the hidden power of the atmospheric air to maintain his craft aloft, should employ that same ether to carry his message to earth. There are other methods of communication, of course, but wireless telegraphy is predominant.

The wireless branch is a very highly specialized department, says Lieut. W. A. Robson of the Royal Air Force. Its work is of first importance.

At sea wireless is extensively used in connection with submarine chasing. Seaplanes, flying boats and airships carry out long patrols in co-operation with destroyers. Immediately the aircraft sight a U-boat the destroyers are informed by wireless of its exact location. This method is highly successful, for a submerged submarine which is invisible from sea level can be seen clearly from the air in good weather. It is a significant fact that every German submarine is fitted with an anti-aircraft gun.

Every pilot in the British air service must pass certain tests in wireless telegraphy before he is allowed to graduate; and in consequence at practically every home training station the air is made musical by the sound of many practice "buzzers."

Disabled Soldiers Taught Radio in Atlanta

THE most advanced work in the new science of "reconstructing" disabled soldiers is under way at Fort McPherson General Hospital 6, Atlanta, Ga.

Thirty different courses of instruction are given now to help cure sick men, to put them back into active service, or to begin their training for some vocation in civil life.

This hospital, created since we went to war, has an exceptional advantage in the re-education of disabled soldiers because the Fort McPherson reservation contains the great industrial shops of the quartermaster corps, which repair all kinds of army equipment.

More than 500 patients have taken curative courses of some kind—60 of them taking only light bedside or ward work; the rest going into classes that range all the way from newspaper reporting to farming.

Under the commandant of the hospital, Col. T. S. Bratton, the work is being carried on by Chief Educational Officer John L. Riley. He has 20 assistants, and many convalescents have trained to act as instructors.

Motor mechanics, telegraphy, radio, typewriting, mechanical drafting, sheet metal work, plumbing, stove repairing, steam fitting, blacksmithing, electric wiring and clerical work are some of the courses that are being given.

In many cases the men go back into certain branches of army work. A man who has lost a foot or a leg is just as valuable as a telegrapher as a whole man.

In other cases, he has laid the foundation for a trade through which he can earn his living in civil life.

Nauen Wireless Range Now 6,000 Miles

THE German wireless station at Nauen has been greatly improved since the outbreak of the war, says the Frankfurter Zeitung. Instead of a single transmission tower 300 feet high, it now has ten towers ranging in height from 890 feet to 360 feet, while the distance through which messages can be transmitted has been extended to 6,200 miles. The German paper is quoted as saying that the Nauen station's services have proved invaluable for instructing cruisers and U-boats and that both the Goeben and Breslau received through Nauen instructions to steam into the Bosphorus.

Tuthill in St Louis Star

Another Garabad motor

A New Japanese Long-Distance Station

THE installation of a new high power wireless system between Japan and the United States is actively engaging the Japanese department of communications. Officials announce that the project is a result in part of the very great congestion and delay in cable transmission which prevents the desired freedom of communication between Japan and the United States.

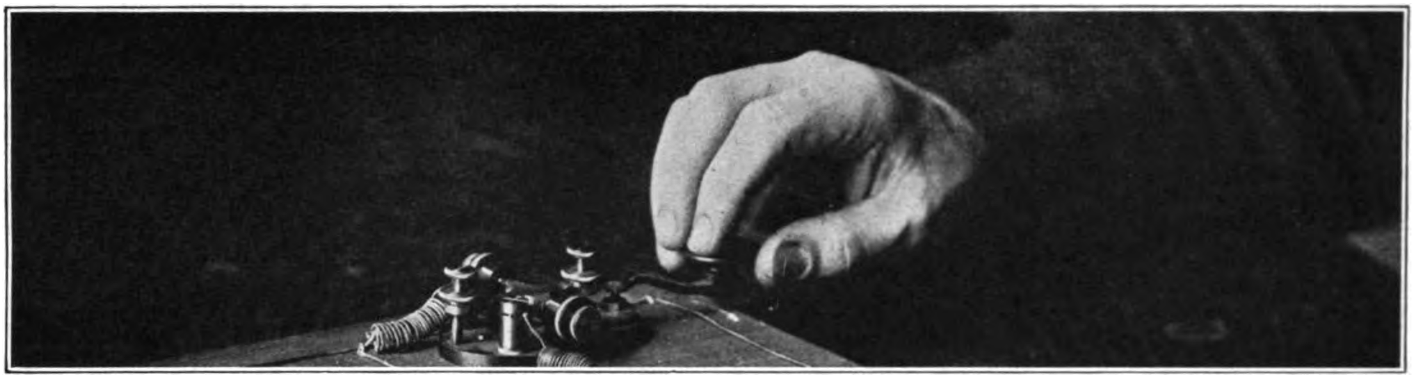
The present Japanese high power station communicated direct with the Marconi station in Hawaii. The proposed station will work with a station on the Pacific coast, the site of which probably will be near San Francisco, a distance of 4,600 miles. This will be one of the longest direct wireless services in the world. The estimated cost of a new wireless system is about $400,000.

While another cable linking the two hemispheres is desired, a line from Japan to Guam alone would cost $3,000,000. It is expected that details of the new wireless project will be announced shortly.

Compulsory Wireless Ordered By Greece

THE Greek Government has required wireless equipment on all passenger vessels of 300 or more tons dead weight capacity and on all cargo vessels of 1,000 or more tons.

(Continued on page 36)



The correct position for telegraphing, a matter of greatest importance to beginners

How Code Sending Is Taught

By Gordon Lathrop

Of the Marconi Institute

AMONG the batch of applicants for enrollment in the New York school of the Marconi Institute, on a Monday morning several months ago, were two young men who shall be named, for the purpose of this article, Dunbar and Baxter.

They came to the enrollment desk together. They aspired to become army aviators; each had just turned eighteen years of age. They lived within a few doors of each other in a Long Island suburb of the metropolis, had been classmates in the same prep school and were of the same social status—of clean, unaffected, all-American stock. The war-time spirit of each was equally high; the plans of their parents had been to send them to one of the great universities, but the boys had elected instead to enter the service of their country. In the Marconi Institute they expected to become proficient in the radio requirements demanded of all military aviators.

Their first day at the school found them memorizing the code in dots and dashes. They were told that each succession of dot or dash, or combination of dot and dash, produced a distinctive cadence which they must learn to recognize. They listened to the reproduction of Instructor Chadwick's sending contained in Victor-Marconi record No. 1. They learned the proper "grip" for sending. In the respects noted in the foregoing paragraphs the boys had points of contact in common. But here the resemblance ended.

Telegraphically, as indicated in their "form" in sending, these two students illustrated the extremes of faulty production of the signals. Land line telegraphers have the phrases "in the mud" and "in the air" to designate these two extremes. When sending comes to a receiving operator with scarcely recognizable distinction of dot and dash, with loose construction of components, in a heavy, "sticky" style, he says it is "in the mud." When it is too light, with "split" dots and unrhythmic relationship, one to the other, of the components, the sending is said to be "in the air."

"Pull it up," the receiver will demand when the sending is "in the mud." "Let it down" he will direct if the trouble is of the opposite nature.

Often the source of the trouble is in poor adjustment of the apparatus. A correct balance is then a matter of technical knowledge and skill. If, however, there is nothing wrong with the balance of the apparatus, the responsibility of making the correction rests with the sender. The writer, using Dunbar and Baxter as examples, hopes to indicate the way to achieve the happy mean which lies between the two erronenous extremes.

Because with both boys the trouble was largely temperamental, a description of each is necessary. Dunbar was shorter than Baxter, but heavier. He was sturdily set up; an ideal build for guard or center of a football eleven. Baxter was built like a sprinter, with slim waist and long legs. Nervous energy seemed to radiate from him. Dunbar, mentally as well as physically, was of less speed but greater endurance than Baxter. Dunbar's tendency was to think first, carefully and in detail, and act afterwards. Baxter, on most occasions, acted first and thought afterwards; fortunately his instincts guided the majority of his acts in the right direction. Dunbar's heavier features and slower manner of speech in contrast to Baxter's flashing animation suggested to an observer lessened dynamic force. But on better acquaintance Dunbar convincingly showed a potentiality fully as great as his more brilliant friend. Their service-rendering capacity—if that phrase may be used to measure intrinsic worth—was equal, but one was expressed in brilliant, forceful spurts, the other in steady, even-tempered plodding.

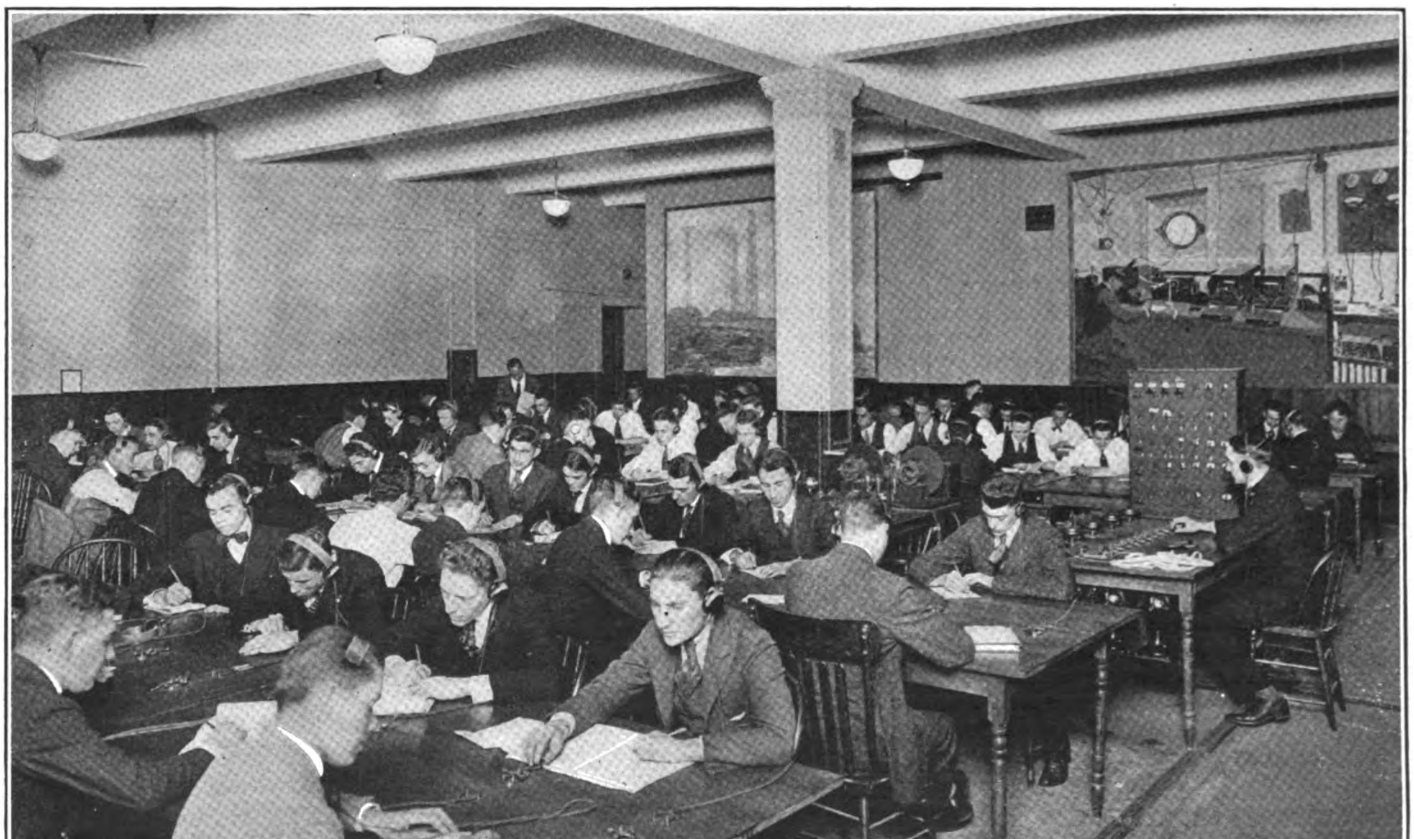
In precisely the ways indicated by the terms "in the mud" and "in the air" each boy began to produce the cadences of the dot and dash combinations in the beginners' room of the Institute. No doubt it would be absurd to state that an analysis of the sending style of a telegraphic aspirant will serve as an infallible guide to that aspirant's personality. In the cases of the two young men who are used here as illustrations, however, their strikingly opposite personalities were so accurately reflected in their opposite methods of faulty production of the code that the sketches of their personalities are worthy of note.

Dunbar's temperament, influencing his production of the code, caused him to cling to the idea that he had to visualize each letter in dots and dashes before he began to send it. He did this persistently, notwithstanding the instructor's efforts to induce him to conceive each signal rather as a cadence—of the letter "A," for example, as a staccato note and a legato note, occurring in quick succession, rather than to consider it as "dot" plus "dash." His mind's tendency toward inertia lost him the facility to adapt himself quickly to varying circumstances or unaccustomed processes of thought. The mind appeared to wrestle with his hand, wrist and arm; he produced the dots and dashes coarsely, heavily, "in the mud." He "let down" in the tension of the members which have to do with sending, or, better expressed, he failed to "pull up" with them sufficiently, so that he was continually without the proper "spring" of wrist and hand to make the immediate recovery of hand after each downward pressure. Physically, the focus point of trouble was in his wrist, the physical source of the trouble with nearly all poor senders. He couldn't seem to strike the correct degree of action at the wrist. His first impulse was to try to construct the signals with completely relaxed hand, with wrist barely clearing the table. That threw the responsibility of making the downward pressures upon his fingers. He concaved his index finger and second finger and tried it that way with negative results. Then he would swing to the other extreme, stiffen his wrist and raise the under part three inches above the table. That is more than twice too high a position for the wrist, as it bows the arm at that point and necessitates a full arm motion. With his wrist at that position, Dunbar's production of the dots and dashes was with a ponderous, punching motion of the arm from the elbow, as impossible a method as that of the fingers alone. His sending was "in the mud," heavy, loose in construction, without individuality of each separate dot and dash and each separate signal.

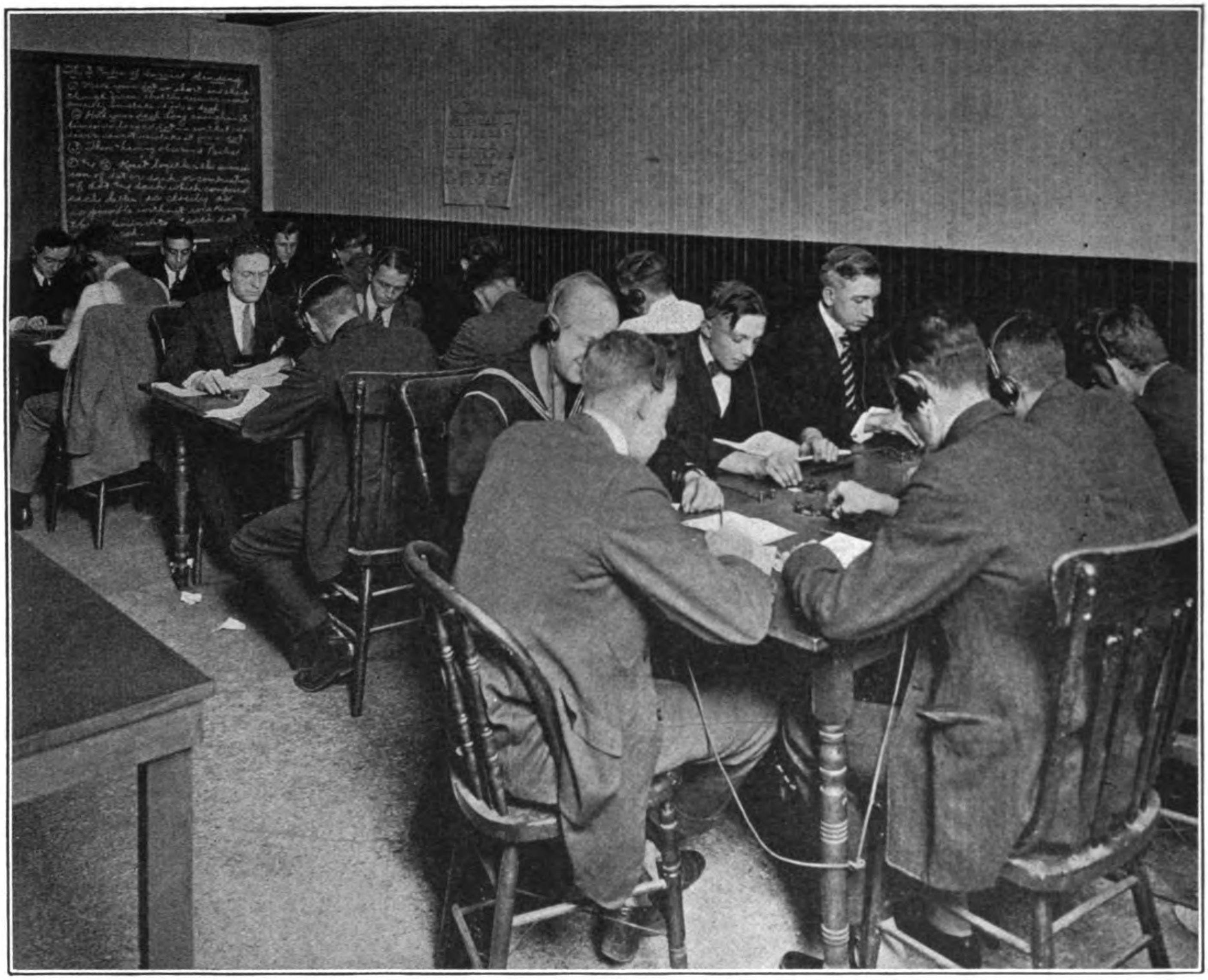
Baxter had been keenly interested in his friend's struggles at the key. His quick mind had grasped at once the significance of conceiving each signal as a sound, to be dealt with in its entirety. His error was that he wanted to begin immediately at the fourth stage of the development of a sender, before he had mastered the first, second and third stages. He wanted to take up the morning newspaper and send page one before luncheon. The details which produce the proficiency to do that meant little to him. His temperamental impatience manifested itself immediately in his sending. Not having achieved that fine balance of hand, wrist and arm which comes from long apprenticeship at the key—which is necessary before one can send with speed and style, and endure—he called upon his abundance of nervous energy. He was not content to learn to make each downward pressure, whether a dot or a dash, with a distinct action of his wrist. He could not do this speedily enough. So he stiffened his wrist and hand, and drew on the nerves of hand and arm to make the dots. As is always the case in "nerve sending," most of the dots he made lacked substance. They were "split." His sending came jerkily, erratically. He would make a "V," for instance, with a speed of construction that would entail a pace of twenty-five words a minute to be in proper relationship to the other letters. Then he would make an "O," immediately following, perhaps, at a ten-word a minute pace. A plotted line of the progress of his sending would look like the trail of one of those loud-buzzing insects which dart this way and that, covering fifty feet to progress a straight line distance of ten feet. His style was up in the air; too tense, too highly geared, too light in substance and erratic in progress.

Physically, as with Dunbar, the focus point of trouble was at his wrist. There was nothing wrong with the position of thumb, index finger and second finger on the key knob. His hand made the proper, graceful curve on the key. His index finger was properly convexed when he began to send, and his second finger lay easily in place over the edge of the key knob. Third finger and little finger were curved without tension, clear of the key, to give his hand the proper balance. He proved to be a proficient telegrapher later, while the progress of Dunbar was slow and painful. The latter, in his mental make-up, was considerably more of the analytical type, without marked keenness of perceptions. Baxter's perceptions, on the other hand, were so keen that he was under continual temptation to exercise them to the neglect of his reasoning faculties. Telegraphically speaking, Dunbar was a trifle "in the mud," while Baxter was "in the air."

To correct the telegraphic errors of each, the instructors gave them "follow copy" practice, to register the sound of each letter in their minds, sending was arranged for half-hour periods at a time, then they were made to listen over and over to the Victrola reproduction of Mr. Chadwick's sending. That, with repeated corrections of the tendency of each to use a finger motion, instead of an up and down motion at the wrist, was all



This view of the northwest corner of the main code room of the Marconi Institute shows the students arranged at progressive tables according to the radio telegraphing speed they have acquired. The equipment provides for 250 students daily, all of whom are preparing for military service. Seated at the master table, right center, is the author, exponent of the physical and psychological study of pupils to determine the best method of correcting telegraphic errors



A corner of the beginners' room of the Marconi Institute, where men training for military service are made proficient telegraphers by the individual instruction plan. The practice sets are arranged in pairs, and as soon as the students acquire fundamentals, those with opposite faults take the paired keys and head telephones and spend hours sending to each other. In this way the faults of one are made plain to the other, and by discussion and practice each acquires flawless sending.

they could do. The burden of correction lay with the boys themselves through the experience gained from day to day.

* * *

In the beginners' room of the Marconi Institute the practice sets are arranged in pairs, a pair of keys and a pair of head telephones on a separate circuit. Until both boys had achieved a speed in receiving of six words a minute, they spent most of the hours of code practice sending to each other. There they worked out their telegraphic problem, in the same manner, no doubt, in which they have worked out other problems, of both less and greater importance than learning the code. One boy's faulty extreme was checked by the other, and a degree of balance was attained. Dunbar gradually "pulled up," while Baxter "let down." From the aviation ground school has come the report that Baxter's work at the front will probably be in a combat plane, while Dunbar's greater capacity for detail work has indicated that he will do better in a plane giving directions to the artillery.

Leaving the two young men at this point in the care of their instructors at the ground school, the writer will note what, in his opinion, are the necessary four stages of development to produce a first class sending telegrapher.

The first is when learning to construct each letter, numeral and punctuation mark in accordance with what he terms Rules 1, 2 and 3. They are:

"Make your dot so sharp and short, though firm, that the receiver cannot possibly mistake for a dash; make your dash long enough—three times as long as a dot—so that the receiver cannot possibly mistake it for a dot; knit together the components of each succession of dot or dash, or combination of dot and dash as closely as possible without weakening the individuality of each dot or dash."

The second stage is when the sender is learning to make a succession of letters to compose a dictionary word, code word or a cipher combination in rhythmic steadiness.

The third is when he is building up strength and power enough of hand and wrist to endure the sustained strain of sending which practical telegraphy calls for.

The fourth is when he puts the final touches to his sending which produce style and speed.

That the word "speed" occurs but once in the outline of these four stages, and then as the last word, should be held significant, as the chief cause of the great number of mediocre and poor hand senders in both land line and radiotelegraphy is that "speed" becomes of too great importance in the telegrapher's mind before he has earned the right to use it.

Progress In Radio Science

Langmuir's Method of Constructing Gas-Free Electrodes for the Vacuum Tubes

IN order to obtain the exceedingly high vacuum so essential in connection with the operation of the vacuum tubes, it is necessary that the metallic elements inserted in the envelop be gas-free. Various methods have been described by which a cathode in a vacuum tube could be disintegrated so as to form a coating of metal on the inside of a glass bulb to act as one of the metallic elements, but in these processes there must necessarily be present a gas at a pressure of about 1 micron. Under these conditions the metal film is strongly adherent, and since a certain amount of gas appears to be fixed on the metal, it will consequently be given up, and prevent the emission of pure electrons from the filament.

Dr. Langmuir has recently shown a method whereby the anode of the vacuum tube consists of a coating of metal sprayed on the inside of the bulb by incandescing a refractory metallic conductor such as tungsten in a partial vacuum. To accomplish this the temperature must be sufficiently high to actively vaporize the refractory metal. This vaporized metal is deposited on the walls of the vacuum bulb as a hard strongly adherent film, which even when so thin as to be transparent, is a good electrical conductor, and capable of carrying relatively heavy currents. In fact Langmuir has described a three-electrode vacuum tube, in which an anode made in the foregoing manner was capable of receiving plate currents of 100 milliamperes or more.

In the tube shown in figure 1, one of the filaments can be employed as the cathode of a two-electrode vacuum tube, and the other to supply the vaporized metal for coating the interior of the tube. The device then becomes a two-electrode valve, and can be employed as an oscillation detector or as an ordinary rectifier.

The tube shown in figure 2 is essentially a three-electrode vacuum tube. Dr. Langmuir mentions that it is not necessary to supply an extra filament to be vaporized, but that the main filament 2 can be made large enough that part of its metal can be deposited on the inside of the bulb to act as the anode; in other words, the grid and filament of the vacuum tube are inserted during the original construction, but the metallic coating for the anode or plate is deposited by bringing the temperature of the filament up to a high degree of incandescence.

The process of manufacture is as follows:

Referring to figure 1, the envelop 1, consisting of glass, quartz or similar non-conducting material, is provided with two vaporizable conductors 2, 3, consisting of tungsten, tantalum, or molybdenum and provided, respectively, with leading-in conductors 4, 5 sealed into a stem 6 in the usual manner. One of these filaments 2, 3 may be used for the cathode of the completed apparatus and the other may be vaporized by heating it to incandescence by passage of current. The particles of vaporized metal travel outward in all directions in straight lines. In order to avoid the formation of a continuous conducting film over the entire inner surface of the container and in electrical contact with the cathode, provision should be made for intercepting the vaporized metal near the cathode so as to "cast shadows" on the envelop wall which will be free from deposited metal. This may be done by shaping the stem 6 so that it will in part bulge outwardly, also by providing knobs or rings on the leading-in wires as shown at 7, figure 1, or 8, figure 2.

The container is first exhausted to a good vacuum as may be obtained by means of a pump by chemical exhaust or other means, the envelop being heated during pumping to remove water vapor. The preliminary exhaust should reduce the pressure to one micron (0.001 m.m.) or less. The completion of the vacuum may be

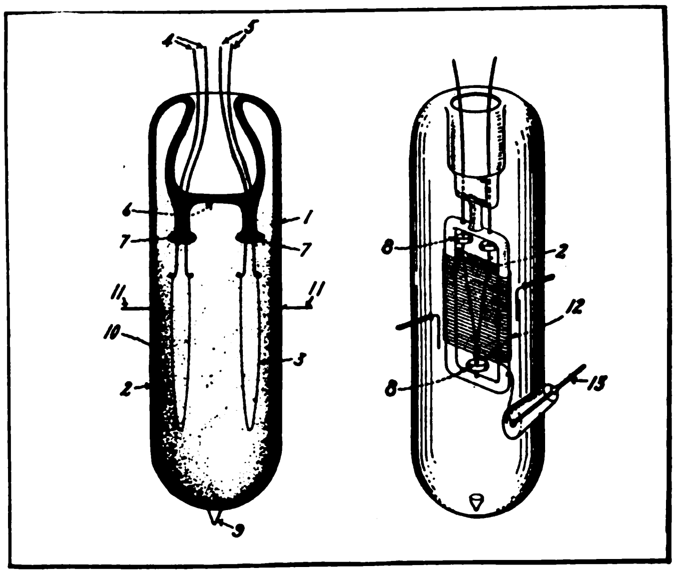


Figure 1 (left)—Tube which can be employed as an oscillation detector or as an ordinary rectifier
Figure 2 (right)—Three-electrode vacuum tube constructed by Langmuir's method

carried out by the active vaporization of a tungsten conductor in a side chamber by heating it electrically to about 2700° to 2900° C., preferably in the presence of a small amount of anhydrous pentoxide of phosphorus. The envelop is then sealed off, as indicated at 9, and one of the refractory conductors, for example, the filament 3 is heated to about 2700° to 2900° C. by passage of current, thereby depositing the desired gas-free film as indicated at 10. Contact is made to the film 10 of vaporized metal by sealed-in wires 11, two being provided to insure a good contact. This film is gas-free and so hard and coherent that even when no more than 10^{-6} m.m. in thickness it can only with the greatest difficulty be scratched off the glass with a knife.

This device may be used as a relay by providing a discharge controlling grid 12, figure 2, connected to a leading-in conductor 13. In the device shown in figure 2 no separate conductor for producing the anode film has been provided, as the cathode 2 may itself serve to provide the vaporized metal without serious damage when an extra heavy filament has been provided to serve as cathode.

Langmuir's Method for Preparing the Three Electrode Vacuum Tube

MUCH time and thought have been expended by various investigators in the preparation of the three-electrode vacuum tube to insure that previous and during the process of exhaustion the tube will be free of all air or occluded gases. Dr. Langmuir has previously shown in the Proceedings of the Institute of Radio Engineers, the construction of the three-electrode tube known as the pliotron, which he has been successful in developing. A recent modification of the construction of this tube is shown in figures 1 to 4 inclusive, figure 5 showing the use of the new tube in a particular circuit. Figure 1 illustrates an electron discharge tube completely assembled. Figures 2 to 4 inclusive show alternative forms of electrode grid construction in accordance with recent researches, figure 2 showing the construction of the cathode.

The cathode consists of a substantially straight filament 4 of highly refractory material, preferably tungsten, and provided with terminals 5 and 5′. The filament is attached to a light spring 6 between two oppositely disposed supports 7 and 8 constituting a frame-work, which is made of insulating material, such as glass or quartz. A number of turns of wire 9 are wound closely in such a way as to be out of contact with the hot cathode. This element constitutes the usual grid, which by means of an external potential exerts a static control upon the electron discharge of the tube. The anode is strung in a zig-zag manner over hooks 12 upon fork-shaped supports 13 and 14. The anode and the grid are preferably made of tungsten, but other gas-free metals may be employed.

One advantage of constructing the anode in this manner is that inasmuch as it makes a continuous conductor, it can be conveniently heated by the passage of a current during the evacuation of the tube, suitable terminals being supplied at 15, 15′.

It is not necessary for all purposes to provide connections for each end of the grid as shown, but it is desirable to do so when the potential applied to the grid is small and in the case of a straight or linear cathode the potential gradient along the grid may be made the same as that on the filament. In some cases this is of great advantage.

The connections of the new tube for use as an amplifier are shown in figure 5, in which a battery 18 supplies the heating current for the filament 4, and a battery 19 of the same voltage as battery 18, is applied to the terminals of the grid element 9, so as to produce a potential gradient along the grid the same as that along the filament. The current or potential which is to be amplified may be applied to the coil 20 which is connected between the grid and filament of the tube. A battery 21 may also be connected in this circuit to impress upon the grid a potential at which the device will amplify to its best advantage.

It is obvious that with this arrangement the difference of potential between any point on the cathode and the portion of the grid nearest thereto, will be the same along the entire length of the cathode. As usual a battery 22 connected between the plate and filament furnishes current for the operation of a telephone receiver 23.

In preparing the apparatus, the preliminary exhaust is carried out by methods such as used in incandescent lamp manufacture. The anodes are then subjected to an electron discharge or bombardment by impressing a suitable voltage between the cathode and anode. When the anode consists of a conductor such as wire 11, figure 1, it is preferably heated by passage of current either before or during the bombardment. If desired the grid 4 may also be heated during the evacuation of the device. When the anode is plate shaped heating may form part of the treatment by electron bombardment, the discharge current being made heavy enough to heat the anode. The voltage should be so chosen at the beginning of the electron dis-

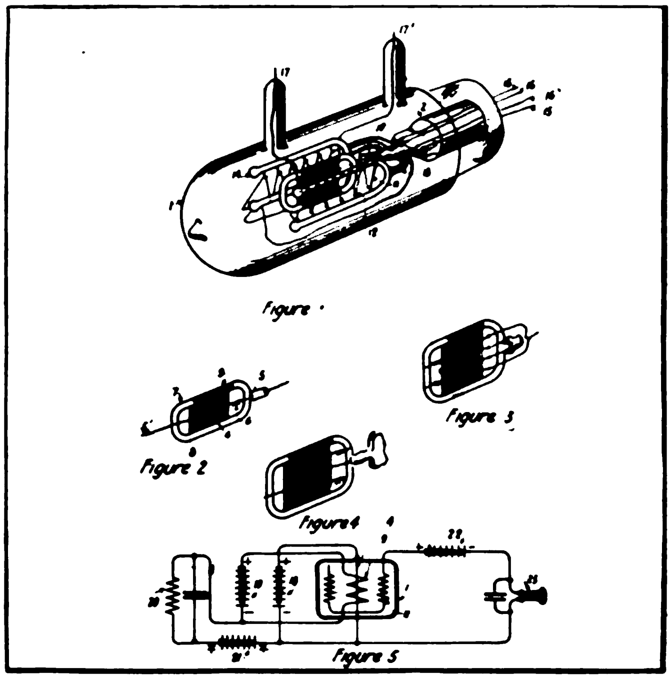


Figure 1—Electron discharge tube. Figure 2—Cathode. Figures 3 and 4—Two types of electrode grid construction. Figure 5—Use of tube in a circuit

charge treatment that blue glow is absent in the tube. This indicates the ionization of the residual gas by collision of gas molecules with electrons is taking place and under these conditions disintegration of the cathode is apt to take place. The discharge voltage is progressively increased, the gas being removed as fast as evolved, preferably by a Gaede molecular pump. This treatment is ordinarily continued until the discharge voltage is higher than the voltage at which the device is normally operated, but this rule will not hold true when the operating voltage is very high as substantially all the gas may be removed before the operating voltage is exceeded. Evacuation of the device should preferably be carried to a pressure as low as a few hundredths of a micron or even lower, although no definite limits may be assigned. In any event, the evacuation should be so low that no appreciable gas ionization takes place during normal operation. When the cathode and anode are very close together and the discharge is confined to a direct path, a greater gas pressure is permissible than when the opposite is true.

An electron discharge tube may be used in receiving systems for radio telegraphy. The passage of electron current across the evacuated space between cathode and anode is controlled by the static potentials impressed upon the grid. A tube prepared as described may be used to transmit currents limited in potential only by the dielectric strength of the glass, quartz or other material of the tube and the mechanical strength of parts subjected to static forces.

A Vapor Arc Generator for the Production of Radio Frequency Currents

BENJAMIN LIEBOWITZ has recently shown a novel apparatus for the production of oscillations of constant amplitude through the use of enclosed vapor discharge tubes. Two methods for use of this apparatus are shown in figures 1 and 2. In one form the apparatus consists of a vapor electric arc device having two cathodes

(*Continued on page 39*)

Torpedoed!

By Alfred S. Cresse

WHAT does the ominous word of the title mean to you? Press accounts usually tell of ships being sunk by giving brief data, such as the time, place and tonnage, leaving the fuller details to the imagination of the public.

Running through the U-boat blockade to allied ports has been an almost continuous job for me since the beginning of the war and I have met with varied experiences which have left within me no tender feeling for the Boche.

To give a clearer idea of what submarine sinkings mean I will tell of my experiences on board a torpedoed ship.

I was assigned as chief Marconi operator to the steamer Owasco. This vessel was formerly the Allemannia of the Hamburg-American Line, taken over by the United States Shipping Board, and loaded with a cargo of high explosives and gasoline for Genoa, Italy. We sailed from New York on November 17th for Norfolk, Va., to take on bunker coal for the voyage. We left Norfolk on the 23rd and had a rather uneventful voyage, arriving at Gibraltar thirteen days later. But Fate had yet to play her hand.

Two days after our arrival we left for Genoa with a convoy of three other merchant vessels with orders to run close to the coast of Spain. The first day everything ran clear; then, a few minutes before midnight, I heard a muffled explosion. I was on watch copying war warnings from a French station, so I quickly switched off the lights—a necessary precaution to be taken when opening a door or port while in the war zone—and looked outside. All was quiet. I returned to my work and called my assistant, Operator Decker, telling him what I had heard and advising him to dress quickly.

I had no sooner readjusted my receiver when a distress signal came in. I never received the name of the ship, for an instant later there was a deafening crash beneath us. The whole ship shook and trembled from stem to stern, and seemed to shudder at the death blow. Fixtures and fittings were torn from their bases and thrown to the decks. The wireless cabin was shifted several feet off its base.

A deafening explosion followed. The torpedo had entered the hatch forward of the bridge where the gasoline was stowed. Instantly the gas fumes exploded with great violence, blowing the hatch covering several feet in the air. A few seconds later flames were roaring out of the opening with a sound like one would expect from a gigantic blow torch.

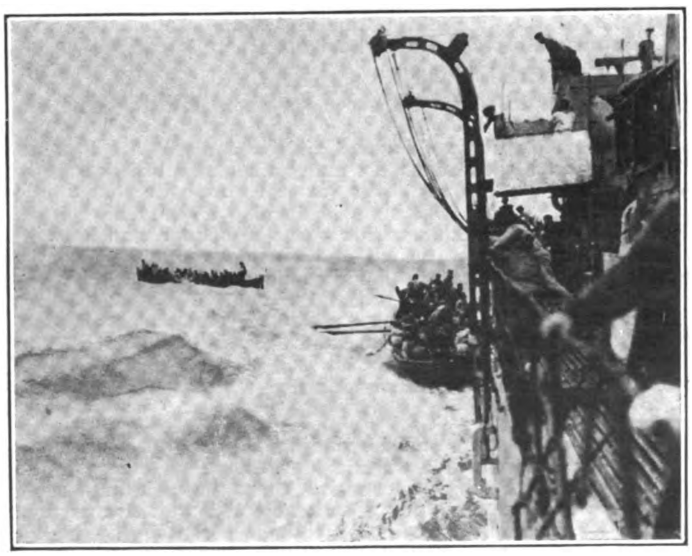
The wireless transmitting apparatus was disabled by the explosion. I got this in what I considered temporary working condition, only to find that the current was cut off from the mains, when the wireless cabin was torn from its place.

During the period when I was attempting to make repairs I had given little thought to the perilous situation. It was my job to get the set in working condition and flash out an S O S—that alone occupied my mind. Now, the roar of the conflagration penetrated my consciousness.

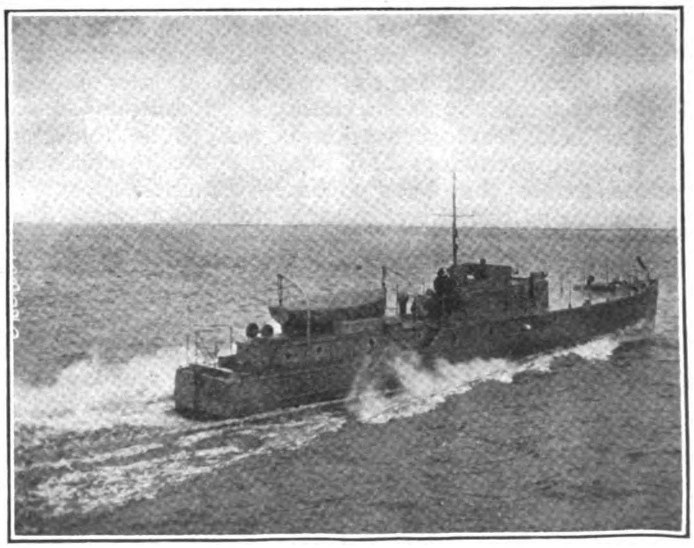
I decided to find the captain and consult him as to my next move. Upon going out on deck I found conditions much worse than I had expected. The canvas around the bridge was in flames and the ropes were blazing. The lifeboats had already been lowered. Apparently Decker and myself were the only ones left aboard.

We rushed to the starboard side and looked over. Number one boat was already lowered. I called to the captain, asking him if there was room for us; he answered that there was. Decker went first; leaping from the deck to the boat he fell a distance of about eight feet, then slid down into the boat. I followed in the same manner. We then pulled away from the side and lay off a safe distance. The ship was sinking fast on an even keel. Fourteen minutes after being struck the tops of her masts sank beneath the waves. All that remained

(*Continued on page* 18)



Operator Cresse's ship caught fire when torpedoed; the crew took to the boats before he arrived on deck



Returning home, on January 13th, a French submarine patrol was picked up off Bermuda. Twenty Frenchmen on board were near starvation

How To Become An Aviator

The Fifteenth Article of a Series for Wireless Men in the Service of the United States Government Giving the Elements of Airplane Design, Power, Equipment and Military Tactics

By J. Andrew White
and Henry Woodhouse

Instruction In Flying—First Flights

THE theory of aviation may now be said to be fully covered and the student ready for text on actual flight. If the preceding installments have been carefully studied there is no evolution of the airplane which is not entirely understandable to the reader. The function and operation of the airplane as a whole, and its controlling means as separate and unified parts, will be clear without further explanation in the description of the various flight maneuvers. One point may well be repeated here, however, to fix the matter clearly in the student's mind. That is the results of operation of the stick control and rudder, which may be simplified as follows:

To go down, push the stick control forward.
To rise, pull it back.
To tilt to the left, push it left.
To tilt to the right push it right.
To turn left, rudder with left foot.
To turn right, rudder with right foot.

Thus it is seen that the movements are the natural ones; for example, if the airplane is tilted sideways to the right the natural tendency is to lean left. Pulling the stick to the left rights the plane; and so on, each motion being the automatic one, so to speak.

During early stages of flight training the pupil must not hesitate to tell the instructor if at any time he feels physically or temperamentally unfit. Flying when not mentally inclined for the instruction will quickly ruin an aviator's prospects for later success, and any hesitancy about stating his condition for fear of a "cold feet" accusation is not to be tolerated. Aviation instructors and students are sympathetic, earnest men; they have no time for taunts.

Acquiring confidence in early stages is a tremendous help; until it is acquired the first solo flight should not be attempted; usually, after five hours dual-control instruction, the elementary machine may be flown solo. Some fifteen or twenty flight hours on various elementary types is generally sufficient, and the faster airplanes may then be used. Take-offs and landings should be frequent in practice, for nothing more quickly instills confidence than knowledge that the matter of alighting has been mastered.

TURNING

Turning with the novice almost invariably reveals one fault, i. e., the banking is too steep. This must be corrected before the aviator attempts the steep turns. The following general rules will prove useful in learning to turn the airplane correctly.

A good altitude margin should be allowed, so there will be at least 500 feet to correct for bumps or side-slips.

First turns should be very wide and not through more than 180 degrees, or half-turn.

While turning, speed should be kept up to at least level flying speed, and the airplane nosed down to its normal gliding angle. If flying speed is lost, the machine will side-slip or stall, getting into the cabré, or tail down, position which is dangerous to the novice.

As the natural tendency is to lose height, it is best to turn the airplane against the wind at first.

Aileron and rudder controls should be handled gently and first turns made gradual ones.

Figures 93 and 94 show turns improperly made. A turn too flat causes an outward side-slip, and too steep banking an inward side-slip. Either of these faults are perceptible to the aviator by the feel of the wind on his face. During a right turn, for instance, a noticeable wind on the opposite, or left, cheek indicates an outward side-slip. This is corrected by gently pushing the stick to the right for more bank or turning the foot bar for less rudder. When the opposite effect on the cheek is noticed, more rudder and less bank is required.

Gradually, turns may be made smaller until a 2½-turn spiral in 1,000 feet is accomplished. Turning while volplaning may then be tried.

In gliding turns the airplane's nose should be kept below the line of the horizon. Climbing turns require the nose of the machine above the horizon.

STRAIGHTENING OUT

A few simple rules will serve to teach how to come out of a turn properly.

Theoretically, the rudder and aileron controls are brought back to central positions. In many airplanes, however, they must first be brought over to the opposite bank and centered when the machine is level. The stick control should be moved a trifle sooner than the rudder, and brought past center, being returned to central position when the rudder is at center and the airplane at a horizontal level.

Coming out of a steep turn these control movements are made greater, the stick being given a semi-circular action. Special care should be taken that the rudder is not swung over opposite too early, for this will throw the nose of the airplane up and an inward side-slip will result.

S-TURNS

These are a series of descending Figure 8s or S-turns, useful for landing in a restricted area. Two rules should be followed. During the entire turn the aviator should keep his eye on the landing spot selected and always turn toward that point. The turns are made increasingly smaller as the ground is approached for the final glide.

Turning near the ground should be avoided; speed should be maintained by keeping the nose down.

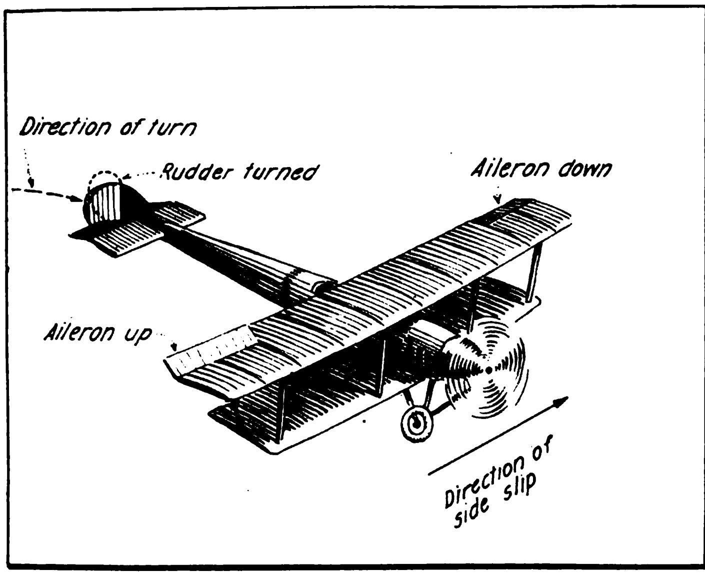


Figure 93—A too-flat turn, causing outward side-slip

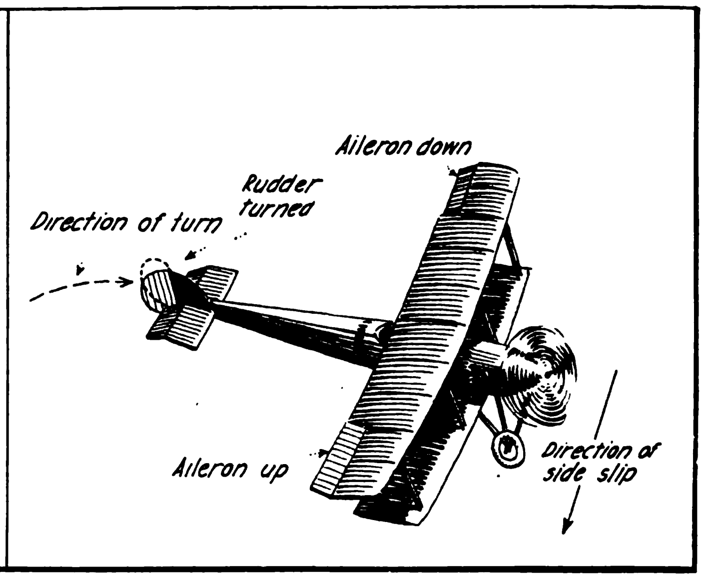


Figure 94—A turn too steep, causing inward side-slip

RIGHT OF WAY IN THE AIR

The student aviator should acquaint himself with the air rules of the flying school to which he is assigned. The courses are usually prescribed and the direction of circuits and pylon markings clearly stated. While slight variations may be encountered at various flying fields, the following general rules are almost universally observed:

MEETING AN AIRPLANE

When an airplane is encountered coming in the opposite direction, both machines keep to the right and pass at a minimum distance of 100 yards. See Figure 96.

OVERTAKING AN AIRPLANE

The faster machine coming from the rear maintains the same minimum distance, 100 yards, by steering clear, care being taken that the overtaking machine is not brought within the zone of influence of the backwash, for in the disturbed air rough going will be encountered. See Figure 95.

MEETING AT AN ANGLE

In a situation such as illustrated in Figure 97, where two airplanes approach at an angle, the aviator who finds the other machine on his right gives way.

LANDING SITES

The United States Army requires a flying field for testing aviators a minimum size of 800 by 100 feet. The general area of a field is about 9 acres, 200 yards square. Area allowances are added for obstacles, proportionately based on the obstacle's height, 12 times the height being added to the area, or 12 feet of field depth added for every foot of obstacle height.

The above regulation applies only to machines of slow landing speed. When fast airplanes are used, the 200-yard depth is added to as follows: 40 m.p.h., 60 yards; 45 m.p.h., 120 yards; 50 m.p.h., 360 yards; 55-60 m.p.h., 960 yards. These dimensions are based on landing and taking off against the wind.

Plowed fields, soft ground and ditches are dangerous to the inexperienced aviator and should be avoided as landing places.

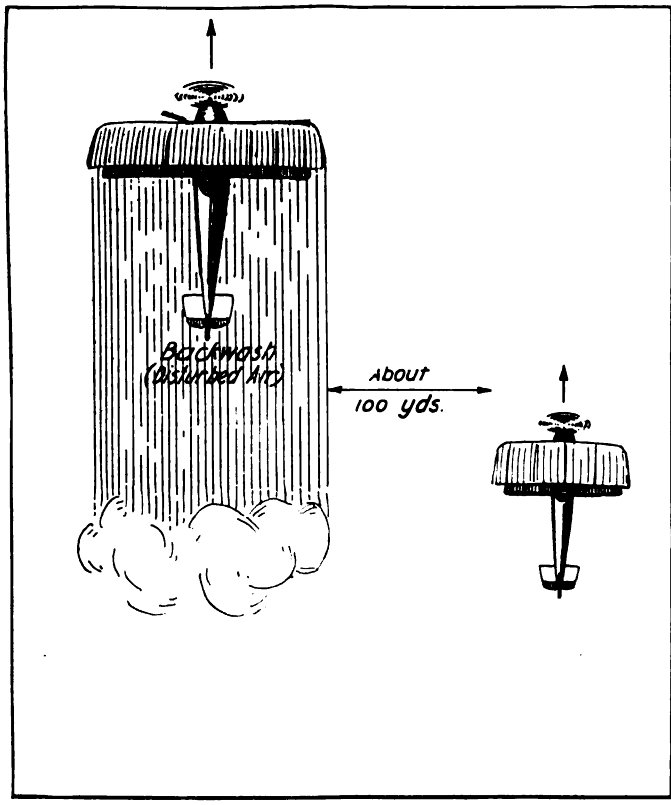
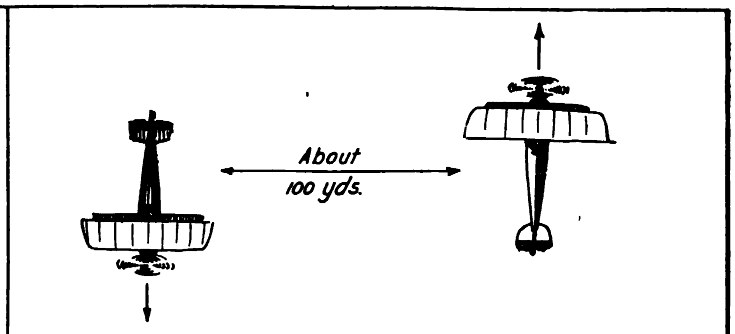


Figure 95—A fast machine overtaking a slower one leaves 100 yards interval between wing tips and avoids the backwash



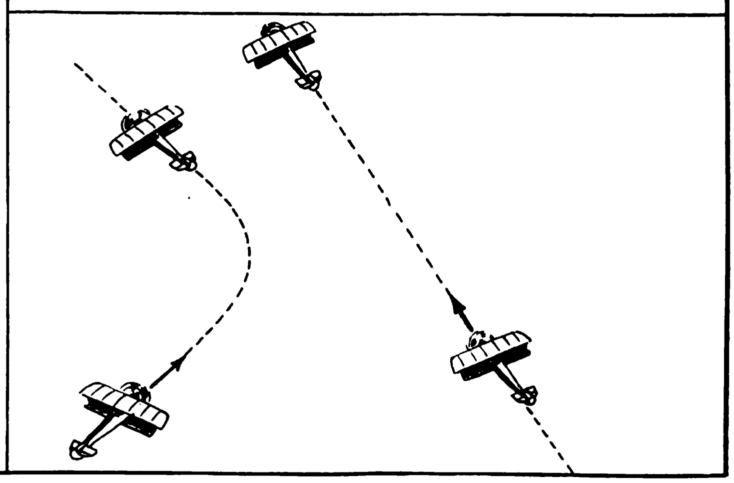


Figure 96 (Upper)—Interval for passing in opposite direction
Figure 97 (Lower)—Giving way when meeting at an angle

Canvas strips, 15 feet long and 3 feet wide, are usually employed to identify landing sites. These are visible to the pilot at altitudes up to 9,000 feet and indicate to the airman the direction for approach. The strips are arranged in the form of a T, the approximate outline of the airplane; a long strip is laid crosswise below the T to mark the point of contact with the ground, the machine being brought to full stop when on the T itself.

LANDING

Making a proper landing is one of the most difficult and most important tasks that confronts the student aviator. The success of the landing is largely dependent upon nosing the machine down at the proper distance from the landing field and choosing the proper gliding angle. Thus, if the angle is 1 in 6½ and the machine is at 200 foot elevation the maximum distance allowed for the descent would be $200 \times 6\frac{1}{2} = 1300$ feet from the landing spot selected. If a greater distance is allowed, the machine is liable to fall short. A distance less than this maximum is preferred, since a spiral may be made to kill extra height and a correction of gliding angle made if the angle selected is not the best. All airplanes are designed to assume their gliding angle with power and thrust cut off.

OPERATION OF CONTROLS

When the descent is to be made the engine is throttled down to relieve strains on the airplane and insure flexibility of controls. Since the proper gliding angle is determined by the speed, the tachometer or the air speed indicator should register the determined speed within 5 miles an hour. The machine should be headed directly into the wind, the direction of which may be determined by observation of chimney smoke or flags below. When within 15 feet of the ground the tail control is gently pulled back, elevating the tail until the airplane is in its horizontal position for slow flight. This should be accomplished when 5 feet above the ground and the control then held; the airplane will thereafter descend without further assistance. The control should be held lightly, however, to correct for bumps.

When about to effect a landing a glance should be directed to the horizon or the indicator, and the aileron control used to keep the airplane laterally level. Swerving as the machine touches the ground is corrected by the rudder or the tail skid.

BAD LANDINGS

If when the airplane is about to land, it assumes the position of flight shown in Figure 99 it will bounce when it strikes the ground, the running gear breaking on the second impact. Also, if brought out of gliding position when too high off the ground it will drop, due to lack of speed, and the same break follow. These landings are known as the "pancake." The remedy is to speed up the motor to regain velocity and flying position, then throttle down and land.

The most dangerous landing is caused by failure to pull the airplane from gliding to flying position, the running gear striking the ground at a forward inclined angle. The motor must be instantly opened wide after the first bounce, flying speed being regained before the rebound.

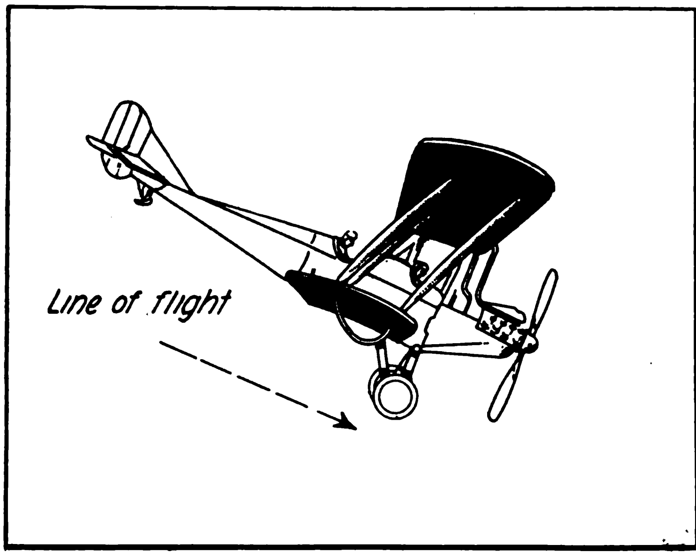


Figure 98—Airplane gliding to landing spot

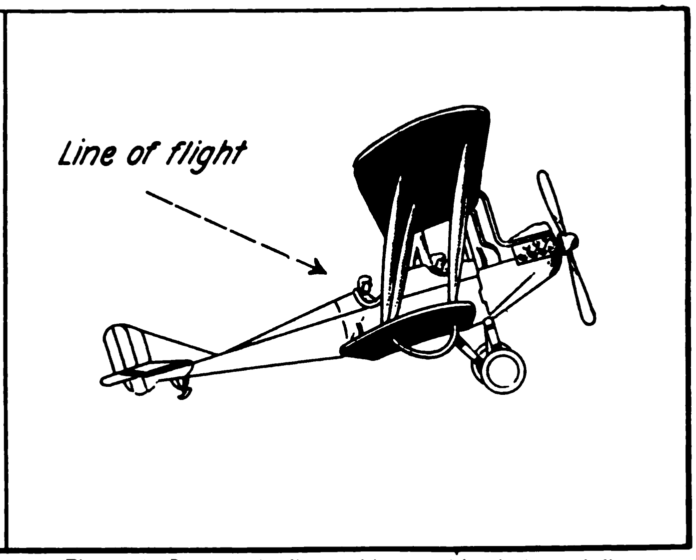


Figure 99—Incorrect landing position, resulting in "pancake"

A bad landing which severely strains landing gear and causes wheels to buckle, follows contact with the ground when the rudder is turned, causing a swerve, or when the airplane is not level laterally.

Torpedoed !

(*Continued from page* 15)

was a large area of flaming gasoline marking the grave of another victim of German ruthlessness.

Distant explosions at frequent intervals informed us that there were other victims. We now began rowing toward a light on shore. There was a strong wind blowing against us, making rowing difficult and progress slow.

After two hours we beached our boat at Villa Joysa, a small Spanish fishing port, with a population of about eight thousand. Within the next half hour all the lifeboats, except one in charge of the third officer, reached shore. Local officials took us to a hotel where we were made as comfortable as possible under the circumstances.

None of us slept during the remainder of the night. About daybreak the crew of a Norwegian steamer, one of our convoy, arrived at the hotel. They, too, had been torpedoed. Later we learned that a British steamer, the third of our convoy, had met with a similar fate. The Germans had destroyed three of our number. The fourth was fortunate enough to escape.

In the early morning we were agreeably surprised by the arrival of the third officer with the rest of the crew. They had made for a different light and spent the night in a small village a short distance up the coast. After mustering the men it was found we had all survived with the exception of one sailor and a messman.

Later in the day the American Consul at Valencia sent his representative for us. We arrived at Valencia after dark and there we stayed until December 26th in rooms engaged for us by the Consul at the Pension Paris, an excellent hotel on the main street. Then we sailed on the steamer Manuel Calvo, of the Spanish trans-Atlantic Line, for New York via Malaga and Cadez.

Our adventures were not yet over. During the voyage we had extremely rough weather. The steering gear was disabled several times, and while this was being repaired we were in constant peril, being tossed about in the trough of the sea. It was at this time that several

(*Continued on page* 35)

Aviation News

Lieutenant Douglas ("Doug") Campbell

There is a happy coincidence in the fact that Lieutenant Douglas Campbell, of Mount Hamilton and France, should have been the first American trained aviator to become an "ace." Campbell is the son of the famous astronomer who has served for years as chief of the Lick Observatory, presiding over the most powerful telescope in the world. It was in this aerie that the future ace grew to manhood. After receiving an education in California young Campbell went east and became a student in the Boston School of Technology. It is such training as this which turns out aviators equal to any in the world.

Lieutenant Campbell is twenty-two years of age and has already received the much coveted Croix de Guerre. As a result of a recent successful encounter he also wears a wound stripe. He brought down his first boche on April 18, 1918. His record in air fighting has few equals. On the following day he bagged a second German, and a third on the 27th of the same month. An ace, it is hardly necessary to state, is an aviator who has downed five or more enemy airplanes in air encounters. It is not required that the enemy brought down should be actually killed, but there must be undisputed evidence that the enemy was brought down out of control.

One of Campbell's air battles was especially thrilling and attracted considerable attention even in France where such encounters are commonplace. He had engaged a German airplane at a high altitude. The boche soon got all that he wanted of the American's airmanship, and turning, beat an inglorious retreat. Campbell followed and was soon far over the enemy lines, which is always a hazardous thing to do. The battle was observed and five hostile airplanes joined in the engagement. By daring airmanship Campbell succeeded in shooting down one of these and making good his escape.

In a recent air battle Lieutenant Campbell was wounded, but he has already returned to active service. By the time this sketch appears our first American trained ace will probably have added new victories to his record.

* * *

Colossal Flying Schools Abroad

The New York Times' special correspondent, in conclusion of the first authorized description of the work accomplished by the American forces since they landed in France, writes of visits he paid to several of the new American flying schools. He says:—

"At another point some distance away I was equally impressed with both the work in progress and the working plans of one of the extensive so-called 'air service production departments.' This important centre of activity, which is typical of several now in course of construction, covers a tract of land over six miles long by a mile and a half wide, where the construction, assembling, testing, and repair of American airplanes will soon be going ahead full tilt on a scale never before known. The work splits into four main divisions—transportation, production, construction, and supply."

Lieut. Douglas Campbell,
first American "Ace"

Trapshooting for Aviators

Trapshooting has been started for the benefit of the cadets at all aviation schools. The Government thus officially recognizes the value of a knowledge of trapshooting to the men who are training for this branch of the service. The most important part of their work will be shooting at a moving target, and trapshooting is designed to develop their skill in this direction.

* * *

Special Compass Courses

A number of commissioned officers of the Aviation Section, Signal Corps, have just completed special courses in compass adjustment and air navigation. The Department of Military Aeronautics recently organized a school at Camp Dick, Dallas, Texas, for this advanced instruction. The two courses were conducted at the same time and completed in two weeks. The two British officers who were the instructors have expressed themselves as pleased with the results accomplished and the spirit of the men. Captain S. T. Fripp, Royal Air Force, was in charge of the compass classes. This course was designed to give engineer officers special instruction in the adjustment and compensation of airplane compasses. Those instruments get out of order because of the local magnetic field set up by magnetos and engines and from the jarring due to rough landing. The students who took this course were selected from graduates of the engineering ground officers' school at Massachusetts Institute of Technology. The course in navigation was conducted by Naval Instructor W. T. Farr, R. A. F. It consisted in instruction in air navigation, or flying by dead reckoning, the method of flying followed when the ground is not in view. Each of the flying schools in this country was represented in this course by an officer who had had charge of cross-country flying. The officers who finished this training will now return to their respective flying fields to instruct cadets in the subject.

* * *

John D. Ryan Made Air Service Director

The Secretary of War authorizes the following:

With the concurrence of the President I have today selected Mr. John D. Ryan to act as Second Assistant Secretary of War in the place of Mr. Edward R. Stettinius, who is now in France. Mr. Stettinius will continue the special representative of the War Department in France, with full power to carry out special missions with which he is charged and will exercise as such special representative all the powers he has heretofore had.

Mr. John D. Ryan, as Second Assistant Secretary, is designated director of air service and is charged with the responsibility of procuring and furnishing to the Army in the field the matériel and personnel required for the air service, and is given supervision, control, and direction over the Bureau of Aircraft Production and the Bureau of Military Aeronautics with full power completely to co-ordinate their activities and to develop and carry out the air program.

The Post Office Department authorizes the following:

Cost of Operating Air Mail About Fifty Cents Per Mile

The first report of the comparative cost of the operation and maintenance of the Air Mail Service shows that the airplanes used in this service have broken all records for economy of gas consumption.

The total of all operating expenses of nine airplanes covering flights aggregating 7,234 miles, was $3,682. The total consumption of gas representing 113 hours and 8 minutes of flying was 1,377 gallons, which is $32.50 per hour—something over 50 cents per mile. The total cost of gas was $405 in flying 7,234 miles.

The best performance in flying was made by a Curtiss J-N-4 machine, which flew 26 hours and 40 minutes at a cost of $28.01 an hour and covered 1,719 miles at a cost of 43½ cents per mile. A plane equipped with an Hispano-Suiza 150 horsepower engine used approximately 8 gallons of gas per hour, and a plane equipped with a 400-horsepower Liberty motor used 17 gallons per hour. This shows 40 per cent less gas consumed than generally required for airplane engines of these sizes.

The calculation of operating cost includes departmental overhead charges, interest on investment, replacement of parts, deadhead time of mechanics, gas, lubricating oils, office force, motor cycles and trucks; rent, fuel, light, and telephone; pay of pilots, hangar men and mechanics.

The average consumption of gas for the nine planes was 12 gallons per hour.

* * *

The War Department authorizes the following:

Deaf Mutes Not Accepted as Flyers

The Division of Military Aeronautics has announced that applications of deaf mutes would not be accepted for war service in aviation and that directions have accordingly been issued to so inform hundreds of young men who have been encouraged to seek such enlistments.

The erroneous idea has apparently been deliberately circulated that since deaf mutes possessed little, if any, sensitivity of the inner ear, they would be little subject to dizziness, and, therefore, make good flyers. So persistently have these unauthorized statements appeared from time to time recently, that two separate investigations were started three weeks ago; one to determine the source of this misleading information and the other to make special tests of accuracy of deaf mutes in sensing motion.

The first investigation is not yet finished, but, so far, it is believed, that German propaganda is at the bottom of the agitation. The second investigation, completed by the Medical Research Laboratory at Mineola, L. I., included a number of tests during airplane flights to ascertain what effect, if any, the absence of the delicate balancing apparatus that exists in normal inner ears has upon persons who are without them.

At the Mineola tests the same plane was flown by the same pilots over the same course in each test. First, 10 normal men who had never flown were blindfolded, seated in planes, and told that after reaching a certain level the pilot would execute a number of evolutions which he, the passenger, was to record and to make particular note in which direction the plane had been turned to the right or left, up or down. The flights included stretches of level flying, climbing, left and right turns, dips and banks.

With very few exceptions the passengers with normal internal ears made correct notations of the different directions in which the pilots took them, noting each turn and dip correctly. Seven deaf mutes were then blindfolded, given the same instructions, and taken over the same course by the same pilots, to note the movements of the planes.

Being blindfolded, and minus, as they were, of the equilibrium of balancing organs in their ears, the deaf mutes failed to note changes of even as much as 90 degrees. Nor could they differentiate the deepest right from the deepest left banks, nor notice the difference between climbing or diving in a practically vertical position. Some of the passengers with normal ears, on the other hand, reported changes in direction as slight as 5 degrees, and were apparently sensitive to the slightest deviation.

After the tests, several of the deaf mutes admitted that they had been entirely in the dark as to their position while in the air.

* * *

The Aviation Program

A pamphlet has recently been issued by the Smithsonian Institution containing extracts from the Report for the year 1917, of the War Cabinet of Great Britain relating to supply of aircraft.

The description given of the difficulties in the way of obtaining a supply of aircraft is so accurate and is so general in its application to all countries that it is believed it should be given as wide a circulation as possible in America. Its application to the American aircraft situation is evident if we remember that Great Britain has been at war since August, 1914, and that every resource of the country, famous for generations as the center of mechanical developments, has been applied to the problem of the production of aircraft. This enables us to appreciate more clearly the progress made by the United States in 1917-18.

"It is rather the fashion to criticise the quality of our machines. Most of the critics, however, are ignorant of the technical and manufacturing difficulties which have to be overcome in order to keep up a constant and increasing supply of the most up-to-date machines. Not only are the technical difficulties and the resultant research and experimental work formidable in themselves, but the task of building up in war time, without seriously affecting the requirements of other services, a new industry of a most highly skilled character necessarily puts a heavy strain upon the organizing and manufacturing ability of the country.

"The science of aeronautics is in a state of constant and rapid development; improvements in engines, aeroplanes and their numerous accessories are constantly being worked out. But the interval between the discovery of an improvement and its introduction into the service is, owing to technical considerations, very much longer than is commonly supposed. Experience shows, that, as a rule, from the date of the conception and design of the aero-engine to the delivery of the first engine in series by the manufacturer, more than a year elapses; the corresponding period for an aeroplane is about one half as long. Consequently, plans have to be laid for a long period ahead, and these plans are liable to be upset by many uncertain factors. The hopes based upon the promising results given by the first experimental engines of a new design are frequently disappointed owing to difficulties of bulk manufacture or to defects only developed after long trial in the air; new types of aeroplanes favorably reported on when first tried are found on longer experience not to give complete satisfaction, and yet it is impossible, if we are to keep ahead in the keen struggle for aerial superiority, to wait for full experience before placing orders. Risks must be run, and new types must be adopted at the earliest moment consistent with reasonable assurance that they will constitute a substantial improvement on what is already in use. Orders must be placed, moreover, for considerable numbers and for delivery over many months, as the large output required for our present flying services can

(*Continued on page* 41)

Signal Officers' Training Course*

A Wartime Instruction Series for Citizen Soldiers Preparing for U. S. Army Service

By Major J. Andrew White
Chief Signal Officer, American Guard

Seventeenth Article—The Signal Corps and General Coast Defense

THE United States, unlike other great nations of the world, has never established, and may never need to establish, permanent fortifications on the land frontiers, since the real frontiers are the seas. But even without the obligation of defense against neighbors to the north and south, the vast extent of the coast imposes upon the country a duty which can but grow greater as population and wealth advance, and as the power and number of commercial ships and of navies increase. Types, speed, and size of ships are bringing alien shores yearly into more intimate relations and are making sea attack more easy, more swift, and more dangerous than ever before. The weight and range of floating batteries, the number and speed of merchant vessels and their great transporting power, the swarms of rapid and dependable auxiliaries, the submarine, the airplane, and the dirigible, leave all but strongly protected coasts without the chance of defense in war, except by airships and submarines and of course the mobile army, and fixed defenses in addition to a navy whose duty at the outset may call it into distant seas. The probability of the absence of the navy at the very moment when coast protection becomes most necessary is so strong as to amount to a certainty.

Regarding the defense of the seaboard of the United States, it appears clear in retrospect that the inertia which for years followed the close of the civil war and the later days of tranquility, prevented the making by the nation of any serious effort to protect the coasts of the country from foreign attack until some thirty years ago, when indifference began to give way to the demand for an efficient navy. The growth of the navy in turn emphasized the need of protected harbors and of permanent defenses; and as the fortifications required soldiers to man them attention was at last directed more and more strongly to the personnel of the defense. At last the coast artillery was given a working, if still a skeleton, organization; efficient armament and satisfactory equipment were added; systems of fire control and directions were devised and at least partial lines of information installed. Finally it began to be understood, though dimly at first, that defenses themselves must be defended; that the eyes and the hands of men must assist in coast protection and that two important factors of the defense, namely, the coast patrol and the mobile army; must form a front for any adequate system of protection.

For convenience in considering what follows, it is assumed that in war the coast defense, which combines the military and naval dispositions and operations necessary to resist attack on any part of the coast line, may be divided into six factors, each related to the other in operation and all dependent upon co-ordination of action to bring out their full value. These are, first, the fixed and floating defenses of the artillery, consisting of the armaments, submarine defenses and materials, coast and scout ships, and to some extent air craft, torpedo, submarine, patrol, and picket boats; the personnel, including all troops assigned to duty in connection with the fixed defenses. Second, the general defense troops of the regular or volunteer army, or of the organized militia, not including the supports of fixed positions. Third, the air service, including the necessary aero squadrons of various types, with their auxiliary tractors and the dirigible when used for coast patrol and defense. Fourth, the coast patrol, including the coast guard. Fifth, the service of the lines of information; that is, the Signal Corps of the army. Sixth, the navy.

Although each of these factors supplements the others, it is evident that the one which binds them all into a working whole, and without which the other five will have rather less cohesion and connection than so many reeds shaken by the wind is the Signal Corps in control of the lines of information and the service of air craft.

To arrive at a proper understanding of the extent and character of the lines of information necessary to keep in brain touch the elements of the defense of a great seaboard like our own, it will be well to first outline the general scope of the defense and to indicate the part played by the other factors in war.

The first of the factors of defense to be considered is that of the fortified positions.

In general terms, the permanent defense of a coast or harbor consists in the adequate protection of a number of distinct positions, which from their importance to the country or value to the enemy must be guarded against injury, occupation, or capture. Such positions are either actually or potentially guarded permanently by a number of fixed artillery emplacements, the fighting or tactical units of which constitute a chain of command. The artillery defense as a whole is made up of a series of tactical areas, each measurably complete and independ-

*The articles in this series are abstracted from the complete volume, "Military Signal Corps Manual," by the same author.

ent in itself, but separated usually by considerable distances of coast from the others, and the whole kept in touch by lines of information, usually commercial, which form a chain encircling the country.

On the coasts of the United States there are eighty-one separate forts where modern defenses are installed or are in process of installation; in the Philippines there are six; in Hawaii, four; in the Canal Zone, five; a total of ninety-six. It is evident, therefore, that the fixed defenses alone required a vast number of lines of information and, further, that for the purpose of control of its vast coast line these positions must be kept in communication not only with great centers of population and with the capital of the country but with each other, and that under certain probable conditions of war the chain of defense from Portland to Galveston, from San Diego to Puget Sound, or perhaps from Quoddy Head to the Straits of Fuca, must be kept in constant and immediate touch by telegraph, telephone, or radio. This, of course, is largely a problem for the existing commercial lines to solve.

The Mobile Army of Coast Defense

It is probably evident to all who have considered the matter that the most necessary factor of the land defense of the coast is the mobile army, together with its auxiliaries. Even to the unthinking it must be obvious that without such forces there can be no real and substantial protection for the coasts, except at those positions which have been selected beforehand for fortification, which of necessity will be few in number. Even if these fixed defenses could stand alone, which they cannot do, they will of necessity form but a partial and interrupted protection to an extended seaboard and will leave open to attack many important towns, serviceable harbors, and landing places that may be used by an enemy as a base or as coaling and supply stations. The fortified positions are really harbor defenses only. It is clear also that a country with some 5,700 miles of coast line offered to attack, indented with innumerable minor harbors and anchorages and dotted with important towns that invite destruction, cannot protect all its vulnerable points by costly and extensive armaments; as a consequence, minor positions must be otherwise defended or left to shift for themselves. While the defending navy remains within reasonable distance of the coast the minor positions will be free from danger, but a navy, if efficient, will not remain at home. In a serious war, therefore, protection for the less important positions must fall to the care of such of the floating defenses as may be withheld from distant seas; to the troops of the mobile army, aided by such land batteries as can be hastily constructed and armed; to the submarine and to the air craft. Such partial defenses may not prevent attack and local injury, but they can, at least, prevent destruction and an occupation that may provide the enemy with a naval base and perhaps threaten invasion of the country at large. Protection against this danger rests with the mobile army alone, once a foothold has been established on our coast.

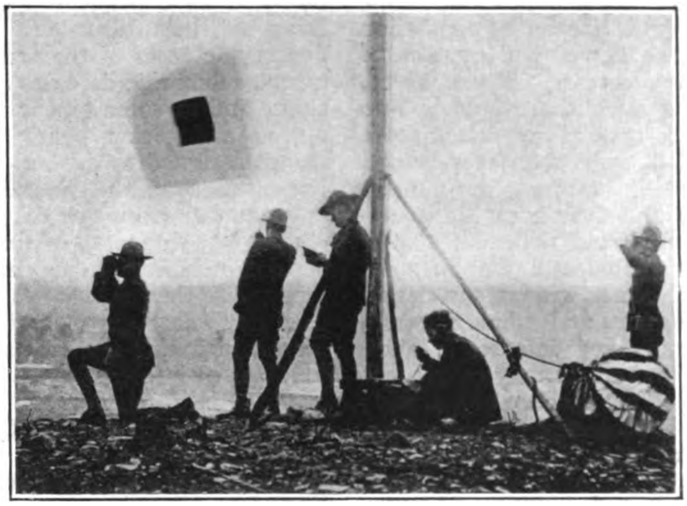
The need of a mobile army in coast defense is not, however, confined to the protection of the lesser positions and harbors unprovided with effective fortifications and armament, for it is to be remembered that coast fortifications of today, unlike the permanent works of an earlier time, look only toward the sea, and of themselves are helpless against land attack; hence they must be protected at flank and rear from approach by hostile troops and landing parties.

In these days every serious sea attack, to be successful, must be accompanied by land operations, a fact well illustrated by the fall of Tsingtau and especially by the desperate sea fights of the Dardanelles and of the Gallipoli Peninsula and the subsequent land attacks. It is evident that though ships unsupported may cause great damage and even destroy cities or fortified positions, they can produce but little effect upon the ultimate result of a campaign unless combined with land operations, by means of which the defense is not only destroyed, but overwhelmed, the objective occupied, together with the surrounding regions.

It appears, then, that the country must be prepared to prevent throughout the vast extent of its seaboard the seizure and occupation of any one of many important points, both fortified and unfortified, and of all of its harbors and landing places useful to an enemy. This implies the existence of a mobile force so placed and so large and effective in organization as to insure, on the one hand, the safety of exposed positions by proper dispositions of troops immediately needed; and, on the other, by concentration of the major part of these mobile troops in reserve at strategic positions of the coast or possibly of the other frontiers as to permit the use of an overwhelming number of defense troops at any threatened point.

In the defense by a mobile army the plan adopted may well be somewhat as follows: The Atlantic, the Gulf,

A signal station for visual communication captured from the Germans by American signalmen



Men of the 104th Field Signal Battalion, U. S. Army, communicating by wig-wag and wireless telegraphy at Camp McClellan, Anniston, Alabama

Where a plank must serve to cross the stream over which telegraph lines are thrown and the Pacific seaboards will be divided into defensive areas, the extent and boundaries of which will depend upon strategic, geographical, and economic conditions. These areas will not, as a rule, be coextensive with military departments, since they depend upon different conditions and lie mainly along the sea. They will be controlled by their own general officers, acting presumably under one chief. In each area there will exist in war a mobile force adequate not only for its defense proper—that is, for land defense of fixed positions, unprotected harbors, and other vulnerable points within the area itself—but for service with other troops mobilized and held as a general reserve. Within defensive areas there will be placed a sufficient number of men of the regular army, of the trained citizenry, and of the organized militia of the state or neighboring states to form a nucleus of the force required. In addition to the aero squadrons, which form part of a division of the mobile army, there should, of course, be gathered together all of the flying men who can be brought into service with the militia or the volunteers, and to them should be allotted the duty of watching the coasts, so far as practicable.

It should be evident that of this force the men most needed in the preliminary work of the defense are not coast artillerymen alone, but engineers, and signal troops, especially of the aviation section, since the first step in mobilization is the establishment of lines of information, of which soldiers alone should be in control, and the training of airmen.

The mobile troops of the coast defense obviously require ample strength in engineer and signal troops, field and horse artillery, and a due proportion of cavalry to erect and defend the field works on the land fronts of fixed positions, to establish and maintain lines of information, to check sudden attempts at coast landing, and to perform the duties of mounted troops in the field and for air service.

It is certain that if so trained the small quotas of state troops, are of the utmost value to the defense at a time when the lines of information—the telegraph, the telephone, radio and air service—are urgently needed in the organization, disposition, and control of newly organized levies. Together with the signalmen of the regular army, they may well undertake the organization of additional signal troops from the citizenry called to the colors.

If it becomes necessary to put forth the strength of the country by calling to the colors the larger part of the mighty reserve available for national defense, it is certain that the total number of men of the ultimate levy will be so enormous that occasion for mobilization of the whole can hardly arise. But though the *leve en masse* may never be resorted to in this country, a force called to the national defense in a great war is no small thing, and the work of turning it into an efficient army and of supplying it with an adequate force of technical troops properly equipped for the field requires the best efforts of every trained man of the service.

General levies are certain at first to be weak in these very arms, since they are of necessity almost nonexistent with the organized militia of many of the states in ordinary times. Lack of the assistance of technical troops hampers the defense, gives to the troops little mobility, and compels them to remain tied to their base or semipermanent camps. This condition will doubtless be corrected as time goes on, but its existence at first multiplies the lines of information and the duties of signal troops. It is certain therefore that the communications by which the first line and the reserves will be linked together and to the permanent works should from the early efforts at concentration be ample and effective, and so continue, for without them the whole army of the defense becomes a mere aggregation of inert units.

Supports

A third class of troops organized are, if not large in number, at least of vital importance in coast defense; they are the support of artillery positions proper. These men, placed at stations suitable to the defense of fixed positions against land attack, act in concert with the coast artillery and are under the immediate command of artillery officers, presumably of posts or districts, since it is evident that they must be kept as directly in touch with the officers fighting the positions as are the marines aboard ship. The supports may well be drawn from the mobile troops proper and be composed of the first and best men called to the general defense; that is, of such troops of the regular army as can be assigned to the duty and of the flower of the organized militia. Made up almost entirely of infantry and field artillery, with as many machine-gun batteries as may be available, there should be added a far larger proportion of signalmen than is usually considered necessary for an army in the field, since upon these men falls the service of information not merely with other elements of artillery defense, but with the fixed positions, the mobile troops, coast guard, and with the navy.

The lines of information of these supporting troops are those of the field army. They will be mainly dependent upon the buzzer, airplane—or perhaps the dirigible—the radio, field telegraph or telephone, and visual signaling.

In considering defense against invasion, it should appear that the mobile troops indicated will stretch over many miles of country and operate under widely varying conditions. Even more than for a well-organized army in campaign, therefore, the lines of information for the, at first, somewhat unorganized forces of the general defense must be ample and widely extended.

Indeed, except in emergencies, these lines are more necessary in the early days of the defense than later when the machine moves smoothly, but at all times the mobile troops, without an adequate service of information, have rather less direction and mobility than a collection of tortoises. Properly laid, the lines of information not only form a network throughout the defense area but tie each theater of operations to the others and provide the entire army with the lines heretofore shown to be essential in the field.

With headquarters of the defense and those of mobile troops fixed at the places best suited tactically for the purpose—and it is reasonably certain that these positions lie at centers of commercial activity—they will be distant from the camps of divisions and brigades and still farther separated from the smaller commands and detachments, from the artillery headquarters and from observation stations and outposts of coast defense. Yet with all these commanding officers of the mobile forces must be kept in constant and immediate touch, as well as with the military commanders of departments, should the latter not be in command of the general defense—and with Washington. In turn, army, division, and brigade headquarters must be kept in communication with dependent and outlying commands; these with the observation stations and coast patrol; and the latter given the power to communicate readily with the floating defenses, with artillery districts, and with ships.

For the mobile coast army the systems of information needed are even more extensive and varied than is considered necessary for a field army in campaign; and it follows that the proportion of signal troops to line soldiers in coast defense should be increased.

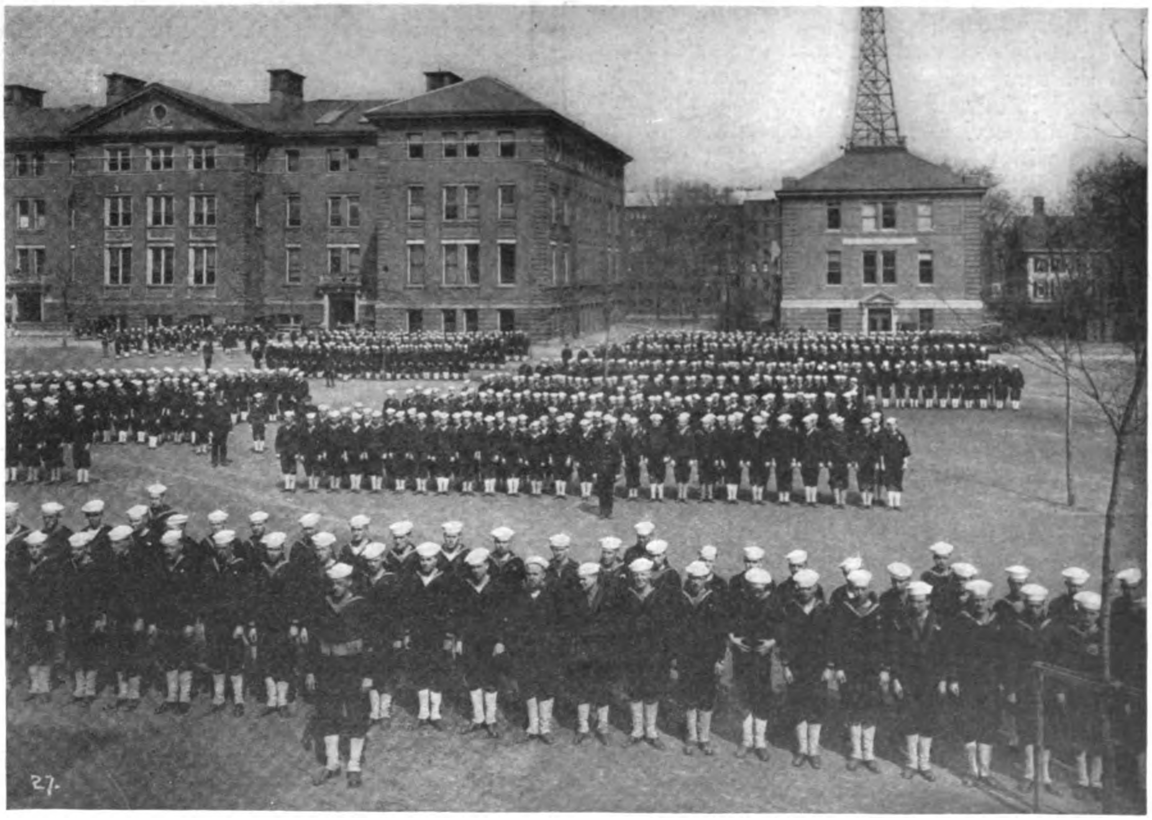
It is hopeless to suppose that the Signal Corps of the regular establishment can ever supply more than a leaven for the mass of men needed, especially for the air service, or even that the militia possessing signal troops of ap-

Harvard Radio School

Photos: Edwin Levick

Above: receiving instruction in manipulation of various types of tuners in a room which presents to the student the many parts of assembled wireless sets

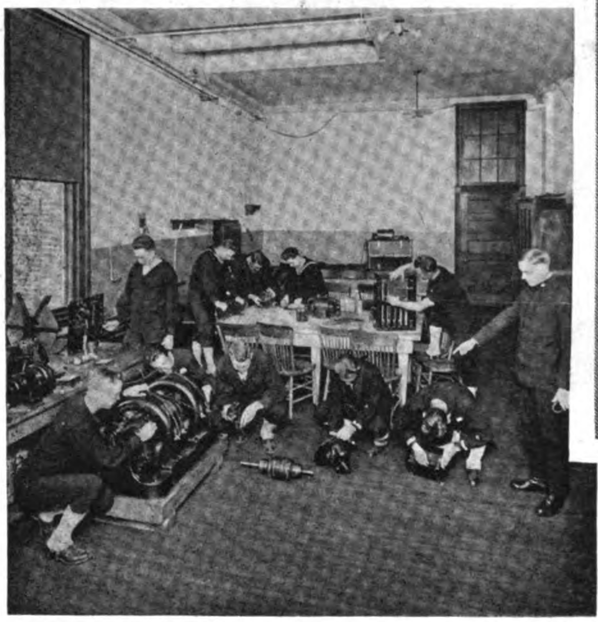
To the left: an outdoor demonstration of portable radio equipment, a suitcase pack set and hand generator in field operation



A stirring sight is the assembly for inspection and review with historical buildings and laboratories forming a background

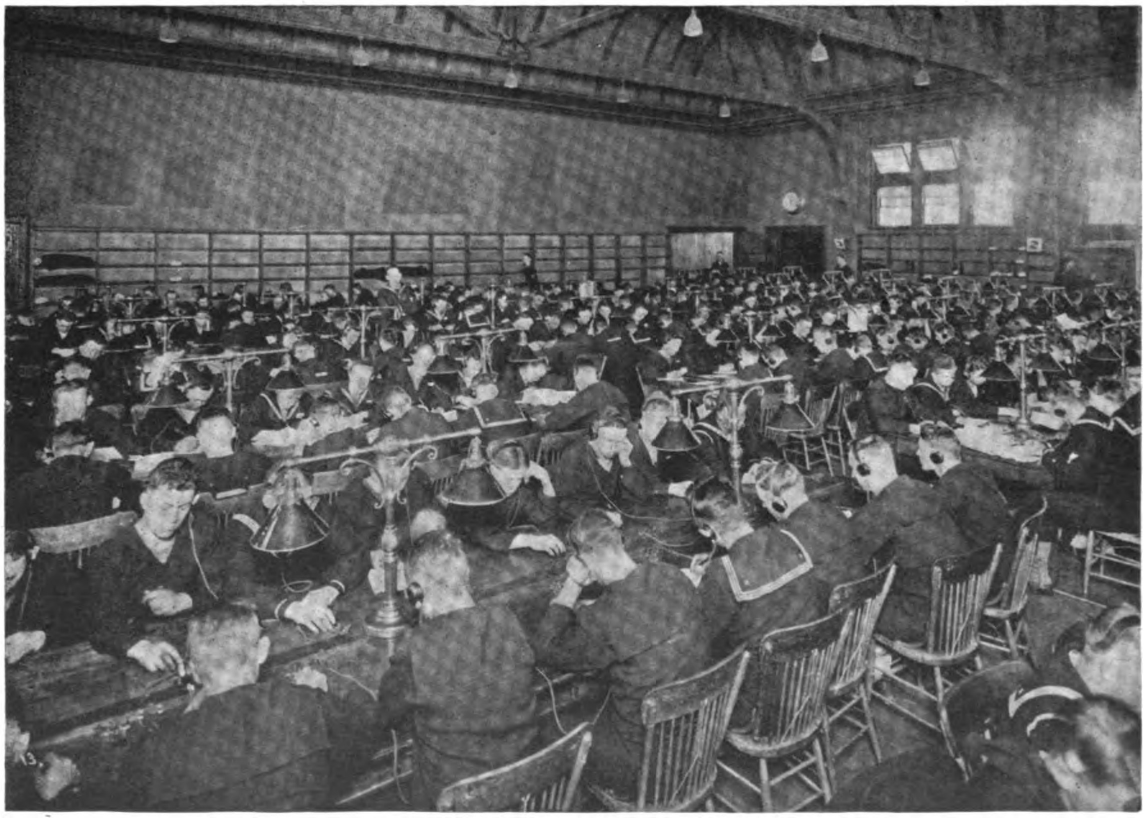
Six Views of Some of the Thousands of Young Men Who are Training at Cambridge, Mass. as Wireless Operators for the U. S. Navy.

(See also page 44)



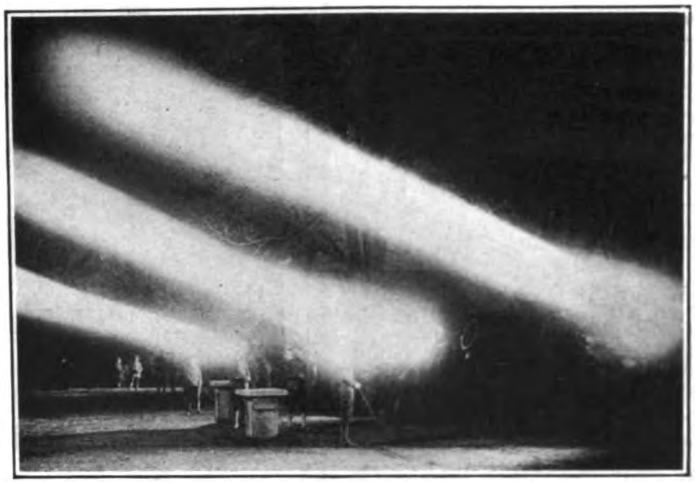
Above: a class of stalwart youths intent on mastery of the circuits of a wireless telegraph set

To the left: the practical application of class-room instruction carried out in the assembling room, where motor generators, gaps and transformers are taken apart and put together



One class of 800 boys learning how to send and receive in the code instruction room

proved efficiency can provide more than the framework of the organizations required. The signal troops mobilized for war must be filled in by men drawn direct from civil life. But excellent and abundant as the material for these troops undoubtedly is among the men engaged in the electrical and mechanical pursuits, and from the few trained in airplane work, such men before they can be of any real value must be made into soldiers. The Signal Corps of the army will never have the numbers or the opportunity to take upon itself alone this training, and the assistance of the organized militia and of suitable and willing men in civil life must be asked and given. The training must be quick and effective, and therefore be performed by men who have themselves been drilled in peace in the methods of the Signal Corps of the army. Unfortunately, trained militiamen and airmen are at present few and are confined to a small number of states, and even where signal organizations exist, they are not always given, be it said without disparagement of the troops themselves, the strength in numbers, the equipment, nor, up to now, the training to make them immediately valuable in coast defense.



Powerful searchlights such as these are now vital to coast defense, the problems of which and their relation to the Signal Corps are discussed in this article

Service of Aircraft in Coast Defense

A third and very important factor in coast defense is the service of air craft, and it is becoming increasingly evident that in addition to lines of information laid or worked on land, there must now be recognized and carefully considered the part played in coast defense and observation by aerial fleets. It is not intended here to speak of the airplane merely, but to suggest also the potential value of the lighter-than-air craft, whose special use is now thought to be in scouting or reconnaissance work, which means, of course, its use as a coast patrol.

Divided into areas or districts patrolled by dirigibles or airplanes, all communicating back to central stations and maneuvering far out to sea, such scouts should make impossible a hidden approach or surprise attack by an enemy. The captive balloon also finds a useful place in service of this kind. But the time has not yet arrived to indicate definitely what form the defense air service will take. It has been suggested that the coasts of the country be divided into sections or areas, each of which should contain an aerodrome or center from which scouting land and sea planes could operate at sea and send reports by radio, if satisfactorily installed, to the central stations regarding the movements of enemies' or friendly ships.

Whether this air patrol shall eventually be installed and conducted by the army, the navy, or the coast guard is undecided, and in the present condition of affairs is not a matter requiring consideration here. There is involved, however, a vast and important field of Signal Corps work, not alone in this aviation service, but in the transmission by wire, radio or otherwise, news received from aircraft at central stations, often located at isolated points to the proper headquarters.

The fourth factor of the coast defense, and that one which depends for its value, if possible, even more closely upon the lines of information than others, is the coast patrol, or coast guard, as it is now called.

To a student of the present condition of our defense it will perhaps appear that the important subject of coast observations, or coast patrol, has not received from the army the attention it deserves. Radio and signal stations have been erected within artillery districts, and by the navy; but great stretches of coast, often containing good harbors, landing beaches and magnificent lookout stations remain without the means of rapidly communicating their news to the telegraph and telephone lines of the country. At many of the lookout stations valuable information of friend or enemy at sea may be gathered, yet they remain in general unprepared for service in war. The need of the co-operation of the trained men and efficient equipment prepared by the Signal Corps for just this kind of work is important.

Without the full co-operation of the Signal Corps of the army and the participation of troops trained in the service of lines of information and in the use of the airplane; the establishment of signal stations, and telegraph, telephone, and buzzer lines; cables; the captive balloon and the dirigible, it is hard to see not merely how the best methods of gathering intelligence in war can be employed by a coast guard, but how, when so gathered, the information obtained can be transmitted to the centers of control, to artillery fixed positions and their auxiliaries, and to the mobile army from distant observation stations, coast islands, and lighthouse, or from the floating auxiliaries and passing ships, with the speed and certainty which alone make such information valuable.

In the November Issue

A special feature of greatest value to men in the aviation section of the Signal Corps.

Cross-Country Flight

Its difficulties and the equipment required—How a compass is adjusted—Military maps and how to read them—and other practical information for the military airman.

Signal Corps News

Citations for Bravery

The following is a list of officers and men cited by the Commanding General of the French Army in which our First Division is serving, for heroism and gallantry in action displayed during recent operations at Cantigny.

Pvt. John J. Poole, distinguished bravery in repairing telephone lines under heavy shell fire and in maintaining communications.

First Lieut. Volney B. Bowles displayed great courage in stringing wire and in maintaining communications under exceptionally heavy shell fire.

Pvt. (First Class) Oscar A. Bondlid, great courage and bravery in repairing, under heavy shell fire a telephone cable between the division machine-gun officer and his group commander. Although hit by shell fragments, he continued his work regardless of danger.

Capt. William T. Crook, displayed courage in maintaining telephone communications and great efficiency in enabling the command to follow, all the time, the progress of the fighting.

Pvts. Roy Sage and Earl Arnold, worked 12 hours on the night of May 27 laying telephone lines which were cut three times, compelling them to return for more wire under terrific shell fire and gas bombardment.

Pvt. Charles D. Fair, was killed while repairing telephone lines under shell fire.

Pvts. Joseph Beck, Ernest U. Becker, Henry C. Franz, Edgar A. Hartmen, Robert E. Carson, Mike Vujnovick, for repairing telephone lines under shell fire; all wounded.

* * *

Staff Duty in Washington

General Orders, No. 53:

III. Induction into military service for duty with the General Staff and bureaus in Washington is authorized only in cases of men technically qualified for such duty, physically disqualified for general military service, and physically qualified for special and limited military service only.

* * *

Service and Wound Chevrons

General Orders, No. 53:

IV. Subparagraphs (c) and (d), paragraph 1, and paragraphs 7 and 8, General Orders, No. 6, War Department, 1918, are amended to read as follows:

1. * * * (c) War-service chevrons.

A gold chevron of standard material and design, to be worn on the lower half of the left sleeve of all uniform coats, except fatigue coats, by each officer, field clerk, and enlisted man who has served six months in a theater of operations during the present war as an officer, field clerk, or enlisted man of the armies of the United States, and an additional gold chevron for each six months of similar service thereafter.

A sky-blue cloth chevron of the same pattern and worn in the same manner as the gold chevron by each officer, field clerk, and enlisted man who has served under the conditions prescribed for the gold chevron, but has left the theater of operations prior to the completion of six months' service therein. Should a person subsequently return to the theater of operations for duty therein, the blue-cloth chevron will be replaced by the gold chevron upon the completion of a total of six months of service in the theater of operations, after which only gold chevrons will be worn to indicate war service. The right to wear war-service chevrons is limited to those officers, field clerks, and enlisted men whose official duty requires their presence in a theater of operations, as distinguished from those who may visit such a theater without having been ordered thereto for duty. The term "theater of operations" is as defined in Field Service Regulations, 1914, as corrected to April 15, 1917.

War-service chevrons of the same material and design and similarly placed will be worn on the coat, overcoat, or waist of their prescribed uniform by all other uniformed personnel of the authorized Military Establishment. They will be worn under the same conditions as prescribed for officers, field clerks and enlisted men.

(d) Wound chevrons.

A gold chevron of pattern identical with that of the war-service chevron, to be worn on the lower half of the right sleeve of all uniform coats, except fatigue coats, by each officer, field clerk, and enlisted man who has received or who may hereafter receive a wound in action with the enemy, or as the result of an act of the enemy, which necessitates treatment by a medical officer, and an additional chevron for each additional wound; but not more than one chevron will be worn for two or more wounds received at the same time. Disablement by gas necessitating treatment by a medical officer shall be considered to be a wound within the meaning of this order.

Wound chevrons of the same material and design and similarly placed will be worn on the coat, overcoat, or waist of their prescribed uniform by all other uniformed personnel of the authorized Military Establishment. They will be worn under the same conditions as prescribed for officers, field clerks, and enlisted men.

A group of officers of American Guard, N. Y. Division, in training camp at Bear Mountain. Left to right seated: Captain C. Jones, West Point; Major C. S. Nyman; Major W. H. Elliott, Adjutant General; Major J. A. White, Chief Signal Officer (Editor, The Wireless Age); Captain W. Farrington, Post Adjutant; Seated, in front: Captain C. P. Young, West Point, and Captain W. R. Brewster, West Point. Standing, left to right: Lieutenants Solomon, Cogan and Schloss; Captains Horn and Bloom; Lieutenants Tropani, Henle and Keeler

Wartime Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

ARTICLE XVIII

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

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

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

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

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

This series began in the May, 1917, issue of **The Wireless Age**. Beginners should secure back copies, as the subject matter presented therein will aid them to grasp the explanations more readily. If possible, the series should be followed consecutively.

THE VACUUM TUBE OSCILLATION DETECTOR

(1) A heated metal in a vacuum gives rise to the emission of small particles of electricity called **electrons.**

(2) These particles of electricity are **negatively charged** and may be influenced by an electrostatic or an electromagnetic field.

(3) About 1800 electrons constitute an **atom,** which is the smallest particle of matter that can take part in chemical action.

(4) The **normal atom** is assumed to consist of a definite number of **electrons** grouped about a nucleus having a **positive charge** and so long as none of the component electrons are driven from the atom, it possesses no detectable electrical charge.

(5) If electrons are driven from a normal atom, **ionization** is said to take place and the atom then possesses a **deficiency of negative electricity.** It therefore takes on the characteristics of a positively charged body and is then called a **positive ion.**

(6) If electrons are added to a normal atom, the latter possesses an excess of negative electricity and it takes on the properties of a negatively charged body.

(7) It is believed that the **flow of current** in a conductor is the **movement of a great number of electrons.**

(8) Electrons driven from an atom by raising, for example, the temperature of metal to incandescence, may act as carriers of electricity between two metallic elements in vacuua.

THE OSCILLATION VALVE

(1) The electronic emission of an incandescent lamp filament can be put to a useful purpose in connection with the reception of radio telegraphic signals. They were first employed in this way by Dr. J. A. Fleming.

(2) Fleming's original oscillation valve comprised a **lamp filament** and a **metallic plate** sealed in an exhausted tube. He found that when the filament was brought to incandescence, **electricity could readily flow from the plate to the filament but it was opposed in the opposite direction**; that is, the tube proved to be an efficient **rectifier** and it performed this function at frequencies up to several million cycles per second.

(3) It should be kept in mind here that in accordance with the electron theory, electrons flow oppositely through a circuit to the formerly accepted assumption as to the flow of current. For example in terms of the electron theory, negative electricity flows from the filament to the plate in the vacuum tube; but in accordance with the old theory, electricity can pass from the plate to the filament but not in the other direction.

(4) To secure the valve effect connection must be made to the **negative side** of the lamp filament and to the plate.

(5) The Fleming valve may be used as a simple **rectifier** for the **detection** of **radio frequency currents** or advantage may be taken of its **non-uniform conductivity** as with the carborundum rectifier. In the latter case, the E.M.F. of a local battery is applied to the space between the plate and filament.

(6) By placing a metallic element called a **grid** between the plate and filament, a wider range of circuits may be employed adapting the tube to a great variety of uses. A tube so constructed is called a "three-electrode" valve.

(7) Such tubes may be connected for **cascade or regenerative amplification.**

CASCADE AMPLIFIERS

(1) The vacuum tube acts as a **repeater of alternating currents** and it will perform that function at frequencies up to several million cycles per second. That is, if an alternating current be impressed upon the grid and film of the three electrode tube, the plate current (supplied by a local battery) will rise and fall at the frequency of the impressed E.M.F. In a properly constructed tube, the current will be repeated with **amplification.**

(2) The **output current** of the tube may in turn be impressed upon the grid and filament of a second tube for further amplification. This process may be continued through several steps. This is called **cascade amplification.**

(3) If radio frequency currents are to be amplified progressively through several steps, **air core radio frequency transformers** are connected between the **output circuit** of one tube and the **input circuit** of the next tube. For the amplification of audio frequency currents **iron core transformers** are connected between successive steps.

(4) If the plate circuit of the tube is coupled inductively, conductively or electrostatically to the grid circuit, **regenerative amplification** results; that is, part of the energy released in the plate circuit is **fed back** to the grid circuit to amplify incoming radio signals. Circuits of this type were first disclosed by Capt. Armstrong. They are termed **regenerative circuits** and may be used for the **self-amplification** of audio or radio frequency currents. Such circuits are often termed **"feed back"** circuits.

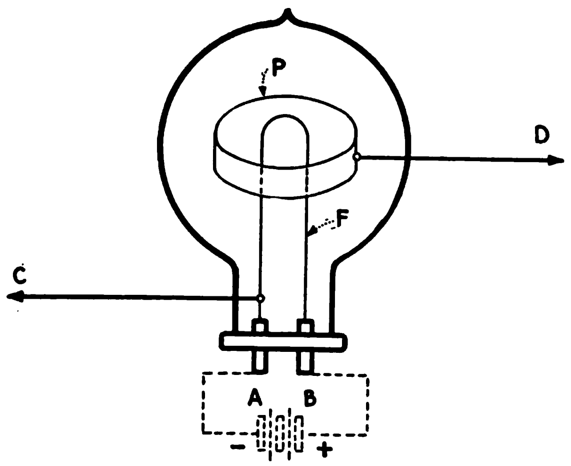


Figure 167—Simplified sketch of Fleming's oscillation valve. A lamp filament F and a metallic plate P are sealed in a highly exhausted tube. The filament is brought to incandescence by a 4 to 12 volt battery. To secure the valve effect, connection is made to the terminals C, D. The tube acts as a rectifier of alternating currents at frequencies up to millions of cycles per second

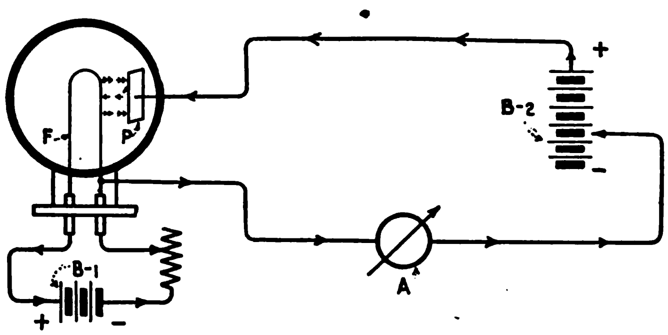


Figure 168

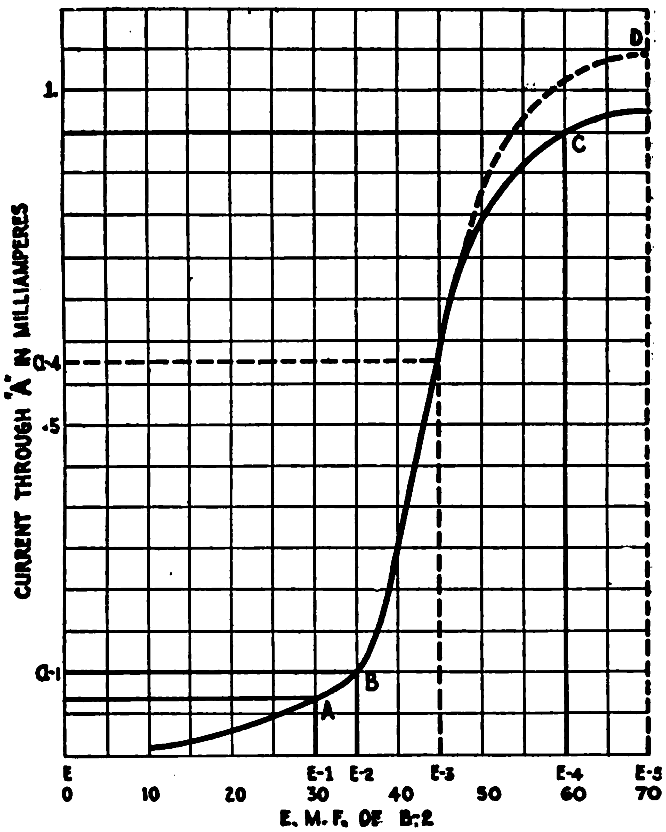


Figure 169—Characteristic curve of the two-electrode tube. This curve shows the relation between the plate current and the E.M.F. of the battery B-2. The curve indicates that the conductivity of the valve is not a constant, but that it varies with the current flowing. At point B a slight increase in the local E.M.F. causes a very great increase of the plate current, but at point C the current begins to fall off. This is called the point of saturation. As an oscillation detector the valve is generally more sensitive, that is, it will give greater response in a telephone, from a radio frequency signal when the local potential is adjusted to correspond to points B or C. What amounts to a rectified current will then pass through the receiving telephone. With some valves other points on the characteristic curve give good response in the telephone

OBJECT OF THE DIAGRAM

To indicate the connections of the apparatus for demonstrating the rectifying properties of the Fleming valve.

PRINCIPLE

An electrical current can pass from the plate to the filament in the vacuum valve, but it is opposed in the opposite direction.

DESCRIPTION OF THE DRAWING

The negative side of the filament F and the plate P are connected to the negative and positive poles of a high voltage battery B-2 respectively. Filament F is rendered incandescent by a battery B-1. A milliammeter is connected in series with B-2.

OPERATION

When plate P is connected to the positive pole of B-2, the meter A will indicate the passage of current through the valve (from P to F), but if the negative pole of B-2 is connected to the plate the meter will not register.

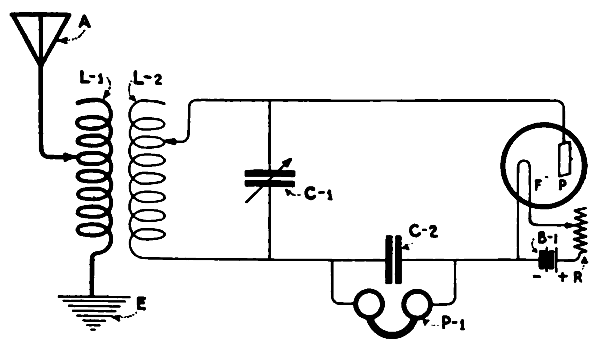


Figure 170

OBJECT OF THE DIAGRAM

To show the use of the two-electrode Fleming valve as a simple rectifier.

DESCRIPTION OF THE DRAWING

The primary coil of a receiving transformer is indicated at L-1 and the secondary coil at L-2. The usual secondary condenser is shown at C-1, the telephone condenser at C-2, and the telephones at P-1. The valve contains the filament F and the plate P. Filament F is fed by the battery B-1 and the incandescence of the filament is regulated on the rheostat R.

OPERATION

When the receiving transformer is tuned to a distant transmitter, an E.M.F. at a radio frequency is impressed between the plate P and the filament F. When P is charged to a positive potential, electricity can pass from P to F, but when P is charged to a negative potential, no electrons are drawn over to the plate, and consequently no current passes the valve. The telephone condenser C-2, therefore receives a uni-directional charge over the duration of a wave train, and at the termination thereof discharges through telephone P-1. Groups of radio frequency currents are thus converted to uni-directional pulses which actuate the telephone diaphragm.

SPECIAL REMARKS

To obtain the correct operating adjustment of the tube, the operator regulates the incandescence of the filament F by means of the rheostat R until the loudest signals are obtained.

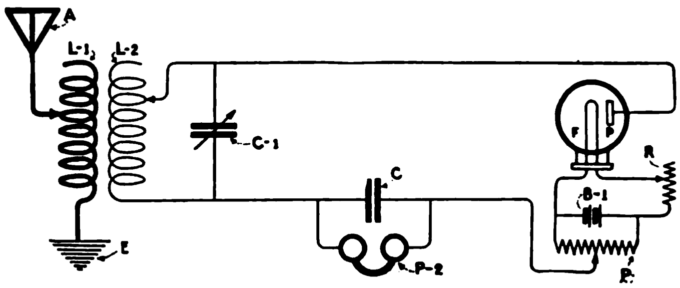


Figure 171

OBJECT OF THE DIAGRAM

To disclose the circuits for the Fleming oscillation valve, in which advantage is taken of the non-uniform conductivity of the tube.

DESCRIPTION OF THE DRAWING

The radio frequency elements of the receiving tuner are indicated by the usual notations. Battery B-1 is shunted by a potentiometer P-1 through which the plate P may be charged to a positive potential. If the sliding contact on P-1 is moved to the right, P is charged positively, but if moved to the extreme left the potential of P in respect to F is reduced to zero. That is, in the former case current flows from the positive pole of the battery B-1 through P-2 through L-2, from the plate P to the filament F, back to the negative pole of the battery.

OPERATION

The best operating adjustment is secured by sliding the variable contact along P-1 until the loudest signals are heard in the telephone.

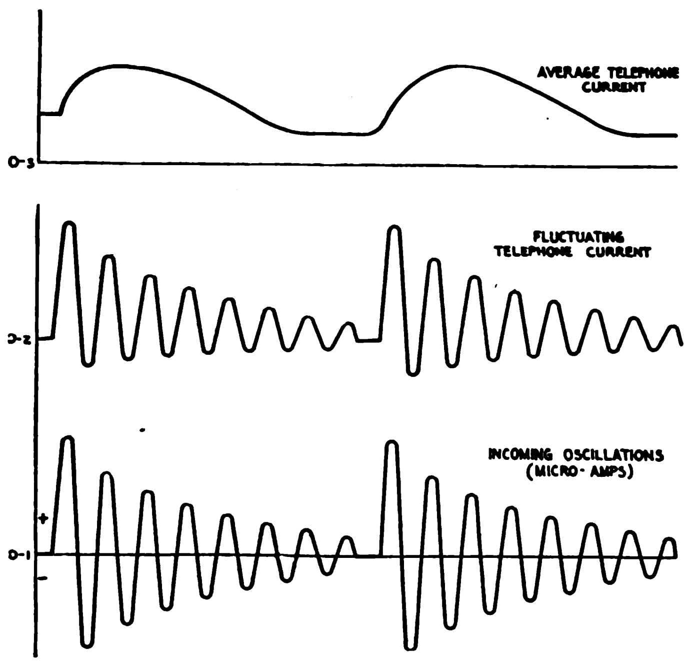


Figure 172—Showing the phenomena involved in the detection of radio frequency oscillations by the two-electrode vacuum tube connected as in figure 171. Graph 0-1 indicates the incoming radio frequency oscillations; graph 0-2, the fluctuating telephone current, and graph 0-3, the average effect of the current supplied to the telephone. This is the effect obtained on the lower bend of the characteristic curve shown in figure 169. At the upper bend of the curve the incoming signals will cause a large decrease in the telephone current. The effect on the telephone in either case is the same.

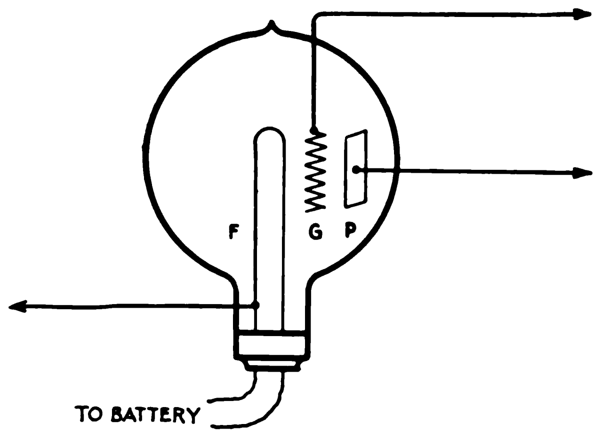


Figure 173—Simplified sketch of the three-electrode vacuum tube, often called the electron relay. The glass envelop contains the filament F, the grid element G, and the plate P. In certain types of tubes, the filament, plate and grid are made of tungsten. Other metals, however, are often employed. One popular type of tube contains a platinum filament, a tungsten grid and a nickel plate.

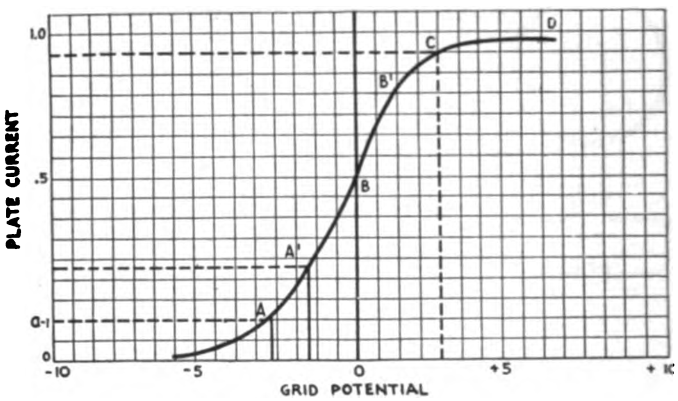


Figure 174—Showing one characteristic curve of the three-electrode vacuum tube. The horizontal axis indicates the potential of the grid in respect to the filament, and the vertical axis the current flowing through the plate circuit. This particular curve indicates that when the potential from grid to the filament is approximately zero, the plate current is 0.5 milliampere. On the other hand, with the grid potential at 5 volts negative, the current in the plate circuit is practically zero. The point of saturation occurs in the region of C; in other words, the maximum plate current flows when the potential of the grid in respect to the filament is about 3½ volts positive.

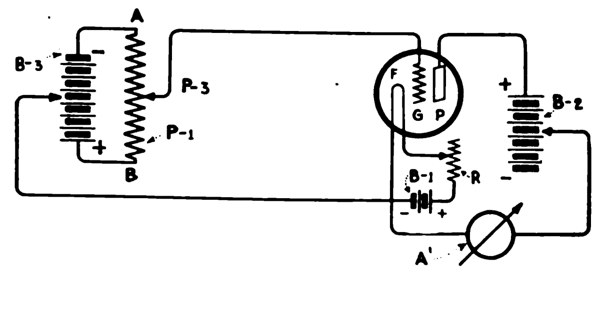


Figure 175—Connections of the apparatus for obtaining the grid-potential, plate-current characteristic of the three-electrode tube. A variable E.M.F. supplied by the battery B-3 is impressed upon the grid G, and the filament F. A battery B-2 supplies current for the plate circuit, the path of the plate current being from the positive side of B-2, from the plate P to the filament F, back to the negative terminal of B-2. A low-range milliammeter A' is connected in series with the plate circuit. By sliding the contact of the potentiometer P-3 towards A, the grid G will be charged negatively in respect to the filament; but by moving the contact in the opposite direction, the grid G will be charged positively. The strength of the plate current under different values of E.M.F. applied to the grid circuit, is shown in figure 174.

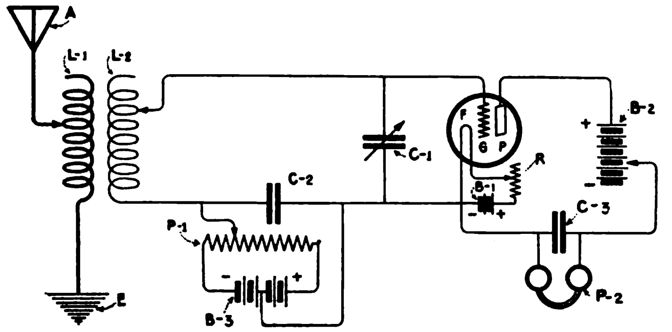


Figure 176

OBJECT OF THE DIAGRAM

To show the fundamental construction and one circuit for use of the three-electrode vacuum tube as an oscillation detector in radio telegraphy.

PRINCIPLE

A metallic element called a grid inserted between the filament and the plate of the vacuum tube may be employed to control the strength of the plate current.

If the grid is charged positively by an external E.M.F., the plate current is increased, but if charged negatively, the plate current is decreased.

Any variable E.M.F. impressed upon the grid circuit will be repeated in the plate circuit with amplification.

DESCRIPTION OF THE DRAWING

The tube contains the filament F, the grid G, and the plate P. The plate current is supplied by the battery B-2 and the filament current by the battery B-1.

The grid G and the negative side of the filament F are connected to the secondary terminals of the receiving transformer.

In order to control definitely the voltage of the grid G in respect to the filament F, a grid battery B-2 shunted by potentiometer P-1 is included in the grid circuit.

OPERATION

To obtain the best adjustment of the vacuum tube the operator regulates the incandescence of the filament by the rheostat R and adjusts the voltage of the battery B-2 until, for example, the loudest signals are obtained in the telephone P-2 from a test buzzer in inductive relation to some part of the receiver circuit.

During the reception of the signals, the sliding contact on the potentiometer P-1 is moved back and forth until the loudest signals are obtained. In some tube receiver sets the incandescence of the filament is regulated by an ammeter connected in series, but if the ammeter is not supplied the correct adjustment is obtained by test.

SPECIAL REMARKS

(1) When the operator adjusts the circuit of figure 176 for the maximum strength of signals, he works the tube at either point A or point B on the characteristic curve of figure 174.

(2) When the receiving transformer is tuned to the distant transmitter, an alternating E.M.F. is impressed between the grid G and the filament F. If the potential of the grid in respect to the filament F is adjusted by the battery B-3 to point A on the characteristic curve, the negative half of the incoming cycle will reduce the plate current and the positive half will increase it. But as the curve indicates the increase will exceed the decrease and therefore what amounts to a rectified current will flow in the plate circuit which charges the condenser C-3. Condenser C-3 then probably discharges in one direction through the head telephone P-2.

(3) It is clear from the curve that if the potential of the grid in respect to the filament is regulated to point C, then the negative half of the incoming oscillation will cause a large decrease in the plate current and the positive half a slight increase. In either way the telephone diaphragm will be impulsed once for each group of incoming oscillations.

(4) It is clear from the curve of figure 174 that if the potential of the grid in respect to the filament lies along the region from A-1 to B-1 and a radio frequency current is impressed upon the grid circuit, it will be repeated in the plate circuit substantially without distortion; that is to say the increases and the decreases of the plate current will be equal. But at other points along the curve, the plate current will either increase to a greater extent than it decreases, or vice versa, with the result that the telephone P-2 is traversed by uni-directional currents.

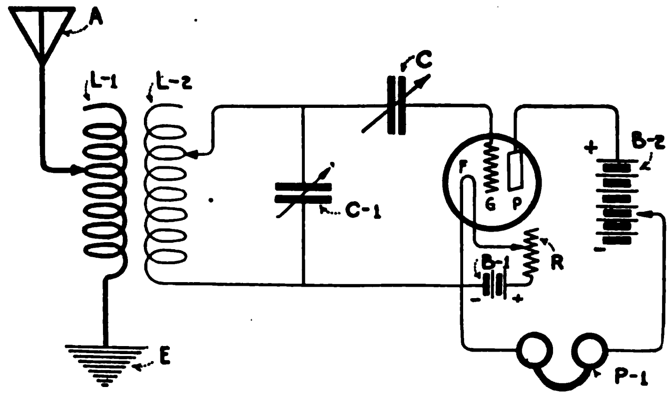


Figure 177

OBJECT OF THE DIAGRAM

To show the circuits of a three-electrode vacuum tube as an oscillation detector, employing a grid condenser.

PRINCIPLE

By connecting a condenser in series with the grid, incoming radio frequency oscillations are rectified and a charge accumulates in the condenser which leaks out at the termination of each wave train. The alternate increase and decrease of the grid potential by this action causes the plate current to vary at the spark frequency of the transmitter.

DESCRIPTION OF THE DRAWING

The receiving transformer is indicated by the usual radio frequency tuning elements, and there is included in series with the grid, a grid condenser C. As usual current from B-2 flows from the plate P to the filament F through the head telephone F-1 to the negative side of the battery.

OPERATION

When the receiving transformer is tuned to the distant transmitter, alternating currents are impressed between the grid G and the filament F. By the usual valve action these currents are rectified between G and F and a uni-directional charge is stored up in the condenser C which is negative on the grid side. As is clear from the characteristic curve, this reduces the plate current, but at the termination of a group of incoming oscillations, the charge leaks out the condenser C through the valve, or through a special leak resistance. The plate current then returns to normal value. This reduction and subsequent increase of the current follows the spark of the transmitter.

As in the circuit of figure 176, the radio frequency currents flowing in the grid circuit are repeated in the plate circuit, but these currents are not heard in the head telephone. They are put to account, however, in the regenerative circuits to be described further on.

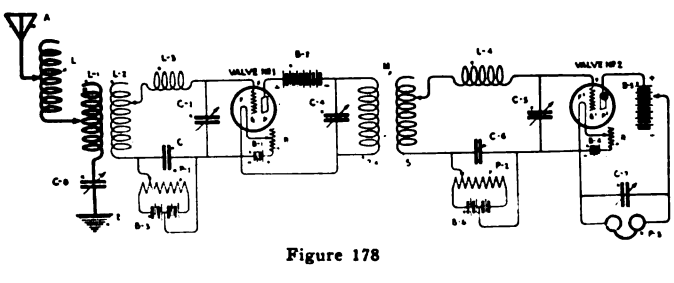


Figure 178

OBJECT OF THE DIAGRAM

To show the connections of vacuum tubes for cascade amplification at radio frequencies.

DESCRIPTION OF THE DRAWING

The plate circuit of valve No. 1 and the grid circuit of valve No. 2 are coupled through a radio frequency transformer M having the primary windings P-4 and the secondary windings S. The grid circuit of valve No. 1 includes the grid battery B-1 and the potentiometer P-1; similarly the grid circuit of valve No. 2 has a grid battery B-6 and a potentiometer P-2.

The antenna, grid and plate circuits of the first valve and the grid circuit of the second valve are tuned to the frequency of the incoming signals.

OPERATION

Assuming the voltages of batteries B-2 and B-5 to be properly adjusted, and the filament temperature of F and F-1 to be regulated by their rheostats, the operator adjusts the potential of the grid to filament of the first valve by means of potentiometer P-1 so that the incoming radio frequency currents are repeated in the plate circuit P-4, C-4 with amplification. The radio frequency current repeated into the plate circuit is impressed upon the grid circuit of the second valve through transformer M, the grid circuit being tuned to the frequency of the signal by the secondary inductances S, the loading inductance L-4, the variable condenser C-5 and the fixed condenser C-6.

The potential of the grid in respect to the filament of the second valve is adjusted by potentiometer P-2 so that the radio frequency current impressed upon the grid circuit is repeated in the plate circuit with distortion; that is, the grid potential is adjusted so that the repeated plate current in the second valve increases to a greater extent than it decreases or vice versa. Then what amounts to a rectified current flows through the head telephone P-5.

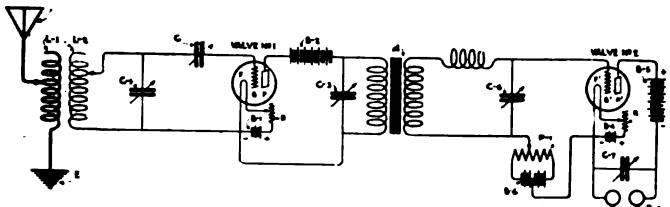


Figure 179

OBJECT OF THE DIAGRAM

To show the circuits of a cascade audio frequency amplifier.

DESCRIPTION OF THE DRAWING

The plate circuit and the grid circuit of the tubes are coupled through an iron core transformer M. A grid condenser C is inserted in the circuit of the first valve to secure an audio frequency relaying effect upon the plate current. The audio frequency current in the plate circuit is impressed upon the grid circuit of a second valve through the iron core transformer M. This circuit includes the battery B-6 and potentiometer P-1 through which the operator adjusts the potential of the grid in respect to the filament to secure the maximum strength of signals in the head telephone.

OPERATION

The capacity of condenser C, the temperature of the filament and the voltage of battery B-2 are adjusted until the maximum possible variation of current is obtained in the plate circuit of B-2 as may be determined by connecting a head telephone in that circuit. The primary and secondary windings of the transformer M are closely coupled. These circuits may be tuned to the desired audio frequency by shunting the primary coil with the condenser C-3 and the secondary coil with condenser C-6. By careful adjustment of the potentiometer P-1 and by variation of the capacity of the condenser C-7 the maximum strength of signals will be obtained.

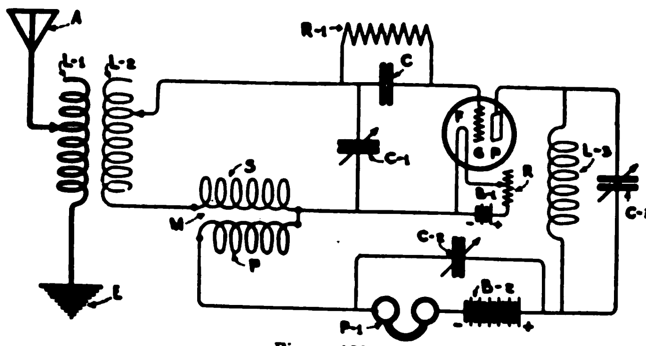


Figure 180

OBJECT OF THE DIAGRAM

To show the complete circuits of Armstrong's regenerative receiver for the amplification of audio or radio frequency currents.

PRINCIPLE

By coupling the plate circuit of a vacuum tube to the grid circuit, either through an iron core or an air core radio frequency transformer, part of the energy liberated in the plate circuit can be fed back to the grid circuit for increased amplification.

DESCRIPTION OF THE DRAWING

The primary winding of the receiving transformer is indicated by L-1, the secondary by L-2 and the plate and grid circuits are coupled through the transformer P, S. The usual shunt secondary condenser is indicated at C-1 and a grid condenser at C. In the case of highly exhausted vacuum tubes condenser C is shunted by a leak resistance of several hundred thousand ohms.

The plate circuit is tuned by the inductance L-3 and the shunt condenser C-3. In order to by-pass the radio frequency current around the head telephone P-1 a condenser C-2 is shunted across the battery and the telephone.

OPERATION

The receiving transformer is tuned to the distant transmitter in the usual way. The correct operating adjustment of the vacuum tube having been obtained, and resonance having been established with the transmitter, the coupling between the coils P and S is carefully varied until the maximum strength of signals is secured.

This coupling must be carefully regulated so as to amplify the incoming signals only, for otherwise the complete circuits of the tube will be set into oscillation at a radio frequency and it will then become a beat receiver.

SPECIAL REMARKS

(1) The production of beat currents is evidenced by the fact that the normal spark note of the spark transmitter is lowered in pitch, but by careful adjustment of the coupling between P and S these signals can be amplified without the production of beats.

(2) If the audio frequency current in the plate circuit is to be amplified, the windings P and S may have an iron core. The inductance of P and S may then amount to several henries each.

The Future Wartime Wireless Series

Part II of this Wartime Wireless Instruction will begin in the November issue. It will deal with undamped wave transmitters and vacuum tube receivers for the reception of continuous oscillations. The direction finder and other special appliances will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

Where There's A Will

How Men Were Prepared for Wireless Duties to Meet the Nation's Emergency—Some High Lights on the Cincinnati Effort

By Maurice Henle

"SMILING BILL" Frankenstein is somewhere on the ocean, headed eastward. On his collar is the insignia of the Signal Corps, and in his fertile brain a wealth of dots and dashes which will be turned to Uncle Sam's advantage against the Hun on France's soil.

"Smiling Bill" couldn't and wouldn't stay out of the service. Nature, however, had gambled heavily with his chances, and apparently was winning. At any rate she was smiling broadly. "Bill" was way underweight.

He had his eye on the navy, and some months ago steered for the recruiting station. No luck. He interviewed the army physical examiners, with an equal amount of misfortune. He grew very depressed.

As luck would have it, he happened one day to meet H. Serkowich, an instructor at the Cincinnati Continuation School of Radio Telegraphy, and also connected with the Cincinnati Chamber of Commerce; he told the instructor of his unsuccessful attempts at getting into the service.

"Come to the Radio School, and fit yourself for the radio service," Serkowich advised, "it will fit you for a place in the Signal Corps."

"But I'd have to pass a physical examination to get into the army, and they have turned me down once," Frankenstein said.

"Never mind that," Serkowich reassured him, "you leave getting into the service to me."

So Bill enrolled at the radio school, which is operated under the auspices of the United States Government and the Cincinnati Board of Education, preparatory to taking his place in the ranks of the Signal Corps. Everything went smoothly; he sailed through the course like a clipper ship through water.

Soon the day came when he was to apply with his certificate of proficiency at the army recruiting office. He approached Serkowich.

"Well," he said, "tomorrow I try to get into the army. I am still thirteen pounds under weight."

"Follow my instructions and before tomorrow night you will be in the army," Serkowich told him.

"Bill" gulped when he heard the instructions.

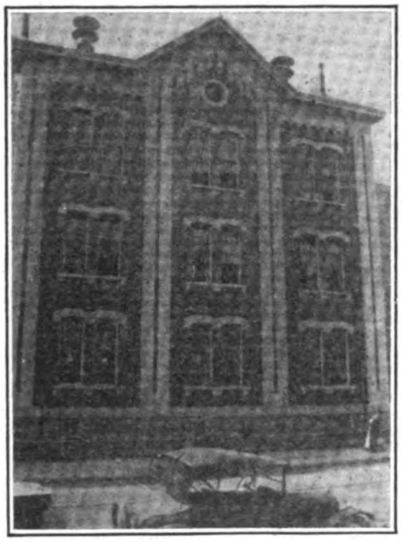
"Buy a dozen large bananas," Serkowich said evenly, "eat them slowly, and between each, drink a full cup of water. You can do it."

A few days later "Bill" again sought Serkowich.

"Well," he said, smiling, "I leave tonight for a port of embarkation. I had hardly arrived at camp when they asked for volunteers for immediate service overseas. I'm happy—but say, listen—I will never again be able to look a banana in the eye!"

Just before sailing, and after a few weeks in an eastern camp, "Bill" wrote back to Serkowich, telling him that he was now legitimately up to the required weight, thanks to the outdoor life.

Shortly after April 6, 1917, when President Wilson spoke the words which were to start the mobilization of a mighty nation's resources, men, money and ships were seen to be the great needs. Millions of each had to be obtained.



Left—Cincinnati Continuation School, where radio classes are held

Right—Charles H. Elston, assistant prosecutor, Hamilton County, who heard the call of radio and is now an army aviator

Below—Certificate of training issued to men called in the draft

CERTIFICATE OF TRAINING AS RADIO AND BUZZER OPERATOR

(See reverse of this certificate.)

THIS CERTIFIES that ______________________

draft number ____________, residence ______________________ was in training for radio and buzzer operation under supervision of the FEDERAL BOARD FOR VOCATIONAL EDUCATION, in cooperation with the SIGNAL CORPS OF THE ARMY, for ________ hours, at ______________________ (Name of school.)

in ______________ (City.), ______________ (State.),

that he developed a proficiency of ________ words of five letters each per minute, sending and receiving; and that he undertook this training under the assurance that he would upon reporting at the cantonment, be assigned to radio and buzzer service.

(Signed) ______________________ (Name of school authority.)

The war was 4,000 miles away and miles of water separated Verdun from New York. We had to have ships to take the men and food to France. The cry for ships grew. "We must have ships, ships, and yet more ships!" and the Emergency Fleet Corporation sprang into existence. Men were needed to man the vessels. Wireless operators were needed aboard. "Give us ten thousand radio operators; for the navy, for the land army, and for aviation!"

And it was to help supply this need that the Cincinnati Continuation School for Radio Operators began.

The Federal Board for Vocational Education broadcasted a general appeal to all school boards, asking their co-operation in supplying operators, requesting that the facilities of the school buildings be placed as much as possible at the disposal of the Government.

Cincinnati had the advantage of other cities, in that a somewhat similar work had already been started at the Continuation School, operated by the Cincinnati Board of Education. Telegraph messengers, below the age limit required by law, had to come to the school part of the working day. A course in Morse telegraphy was offered, along with other studies, so that the boys received a fairly practical education.

It was comparatively easy for Superintendent of Schools Randall J. Condon, a famed educator, to broaden the scope of the school.

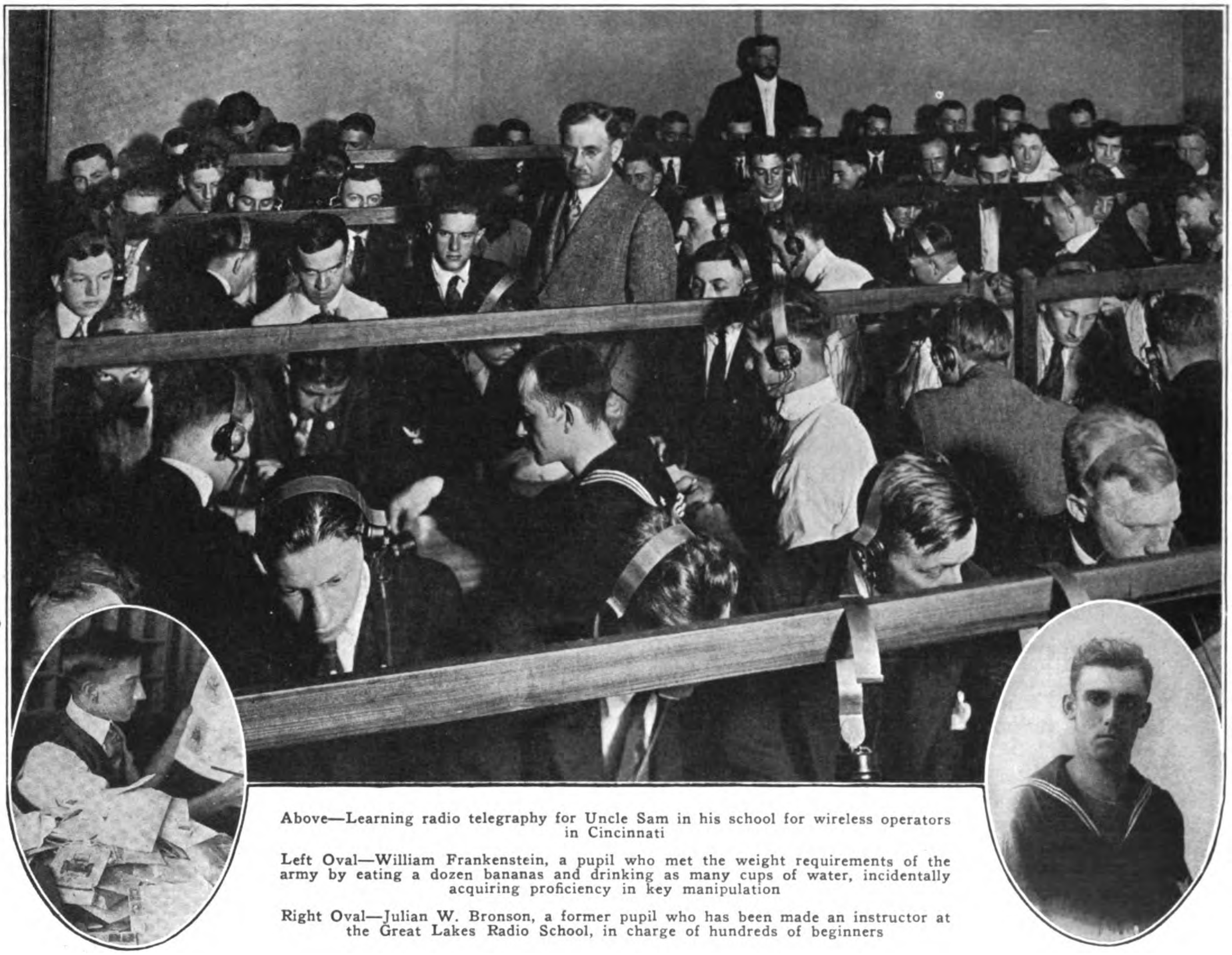
Miss Mary Conway, the principal of the Continuation School, was a woman with wide experience. With years of practical training behind her, Miss Conway plunged into the new work with vim and vigor. She recognized that without practical surroundings for the students, progress would be necessarily slow. So she acquired a full set of equipment, including typewriters, keys and instruments and transformed the room into a real "Western Union" school.

Progress was rapid and many a young man and woman, as well as older men, obtained a position at the key with the great commercial telegraph companies.

It was at this time that the Ohio National Guard was there was not a competent instructor to teach the men what they really should have learned—the Continental Code for radio work. Major Dube cast about for a man. He finally decided upon H. Serkowich, with the Cincinnati Chamber of Commerce, a man with wide experience both as a radio and telegraph operator and a wire chief on steamships and railroads.

Serkowich, however, couldn't leave his work at the Chamber of Commerce, nor could he sacrifice the indirect work he was then doing for the Government. He agreed, however, to give his services if the classes would be conducted at night. Miss Conway and Superintendent Condon consented to the change gladly, and the twilight school was started.

Serkowich immediately shifted to the Continental Code and it was not very long before those sixteen "non-coms"



Above—Learning radio telegraphy for Uncle Sam in his school for wireless operators in Cincinnati

Left Oval—William Frankenstein, a pupil who met the weight requirements of the army by eating a dozen bananas and drinking as many cups of water, incidentally acquiring proficiency in key manipulation

Right Oval—Julian W. Bronson, a former pupil who has been made an instructor at the Great Lakes Radio School, in charge of hundreds of beginners

encamped at Sharonville, Ohio, preparatory to going to Camp Sheridan, Ala. The Signal Corps of the army was in its youth; but the experience of our allies taught us many things which we were not required to have rammed down our throats, and the War Department soon started out in an efficient way to bring the Signal Corps up to a high standard. Major Dube of the Ohio militia, who seemed to have a greater pre-vision than a good many, heard of the good work accomplished at the Continuation School and of the wonderful benefits the telegraph companies were reaping, and brought sixteen of his non-commissioned officers to the school to learn the code.

They were only there a few days when it was seen that and sixteen more had qualified with flying colors, competent to take over the army signalman's job.

In seeking another competent instructor, the Board of Education plucked Frederick W. Dearness, principal of the 12th District School, who was well versed in wireless telegraphy.

Serkowich recently has been commissioned a lieutenant in the navy. He was assigned to the Cincinnati district and is still at the school.

Equipment had been supplied by public-spirited men and women. This equipment, moreover, was complete. The desks, designed by Serkowich to accommodate the maximum number, were installed by the school board carpenters. Buzzer systems and head pieces were given by the telephone company and a local electric company. In the Morse Section, the typewriters were bought by the Board of Education, as was the other equipment.

About this time the draft became active. The National Army, in its process of formation, needed signal men badly. This dearth of men prompted Colonel L. D. Wildman, U. S. A., of the Signal Corps, stationed at Chicago, to write to the Cincinnati school authorities, appealing to them to help the Government in this crisis.

"In the organization of signal troops," he wrote, "a grave difficulty has been discovered in securing the required number of Morse and radio telegraphers for the first increment of troops. Since it has been found difficult to secure the required telegraphers for the first increment, it is an assured fact that unless immediate steps be taken to increase the number of available telegraphers the situation will be even more serious for further increases of the army. It is, therefore, most important that efforts be devoted to educating students in sending and receiving by the Morse and Continental codes with proficiency."

Wide publicity brought many students, most of whom were of the draft age. One room broadened to two, and two to five.

* * * *

One hundred and fifteen men have received certificates of efficiency from the school and have been recommended to the Federal Board for Vocational Education, at Washington, with which the school is affiliated.

Of the one hundred and fifteen, sixty-two are in the navy, twenty-six in the air service, or Aviation Section, Signal Corps, and twenty-seven in the land army. Many joined the service without receiving their certificates and made good. Enrolments have totaled hundreds. Of the navy's sixty-two, many have gone through Harvard University, and are at this moment on the ocean.

Memorizing the Continental Code is the first step at the school. Recruits are taught to make signals on the telegraph key and to transmit sentences. Practice in code sending and receiving comes next. Then they learn to speed up and to combine speed with accuracy. At each step they are moved up in the school. When they are in the fifth "stage," recruiting officers from the army, navy, and air service give them talks, each pointing out the merits of his particular service.

* * * *

The call of wireless penetrated deep. It spread its enticing fingers into all walks of life. Charles H. Elston, assistant Hamilton county prosecutor, was one of those who heard it and answered in the affirmative.

He is now at the Ohio State University at Columbus putting the finishing touches to his course, from which he will soon emerge a pilot in army aviation.

Elston didn't have to go; he had been placed in Class 3 of the draft. However, he went to the radio school, and was recommended for the Signal Corps. According to letters received by his mother, he attributes the major portion of his rapid progress through the training school to the course at the Cincinnati school.

Julian W. Bronson is another who made good. Because of the training he had received at the Cincinnati school, Bronson was made an instructor at the Great Lakes Radio School and placed in charge of hundreds of beginners. He received his certificate of efficiency November 15, 1917, together with Willard B. George, Matthew Schenchoff and Edward J. Corcoran, the first of the civilians to complete the course.

All four served as instructors for some time; then Bronson, with two others, grew restive for active service, and insisted they be sent to Harvard so as to qualify for service by summer. He completed his course at the University and is at this moment at an eastern port ready to take his place beside the key with an invincible fleet or on our fast growing merchant marine.

"The school at Cincinnati has been a wonderful help," he wrote his father, who is attached to the Cincinnati Post Office Inspector's office.

Millionaires were no exceptions when the multitudes of red-blooded youths thronged to the service. Shoulder to shoulder at the school with sons of ice wagon drivers and bakers, for six weeks, was Cornelius J. Hauck, son of Louis Hauck, millionaire Cincinnati brewer. Young Hauck—he is 23—is about to graduate from a field in Tennessee as a bomber in aviation. He writes that the knowledge he received in Cincinnati helped him marvelously.

* * * *

And so the wheels of learning have ground; minds have been moulded and careers shaped with each daily revolution.

The old building has recently been painted. But the paint is only a weak, outward manifestation of the remarkable change on the inside.

The halls still brouse in semi-darkness, a reminder of the days of disuse before the war, but the rooms are a living, quivering example of bustle and life. Here is a tailor, worth $200,000 in his own name, vainly trying to catch the meaning of the whining jerks of the instrument, operated by a $15-a-week shoe clerk. Shoulder to shoulder they are, a room full. Here is Fred. W. Dearness, a school principal in the daytime, instructing Jim Brown, the cobbler's son, and doing his utmost to knead Brown's brain so Uncle Sam will benefit. The boys' faces, for the most part, are stern, and it doesn't take a super-imagination to transplant them to a ship, or a battlefield, or an airplane.

And as one passes from the busy room, the hums, and slurs, and buzzing notes, charge the air with a vibratory message of conquest to come. The sharp notes of the telegraph key are heard, from other rooms, where girls are learning to take the places of the men who go. And the many typewriters with their clatter almost make the place sound like a business college.

Hustle and hurry—and for what? For Uncle Sam; for you and me; for democracy. The old school, the busy students, everything, all are but a remarkable example of the adaptability of the schools of the land of the Stars and Stripes to meet a crisis—and meet it with vigor!

Torpedoed!

(*Continued from page* 18)

of our sailors and firemen who could not withstand temptation broke into the cargo of dried fruit, for which they were put in irons. Our coal supply was about exhausted and the captain decided to change our course and steer for Bermuda, where we could replenish the bunker.

On January 13th we had another alarm! We sighted what appeared to be a submarine ahead of us, rolling about in the sea. Upon drawing nearer we found it to be a submarine chaser flying distress signals and the flag of France. As we drew alongside, S. C. 171 could be distinguished on her bow. The captain ordered a lifeboat lowered and an officer went aboard the chaser.

There were twenty Frenchmen aboard. They were weak from the want of food. Some of them were so near starvation that they were unable to stand.

From what information we could gather from the officer we learned that they had become separated from their escort in a terrific gale. Their engines were disabled and

(*Continued on page* 43)

World Wide Wireless

(Continued from page 9)

A Job For Retailers in Electrical Supplies

THE big guns at the front are mounted on money. Don't forget that! And they will hold the enemy back only so long as their foundations last. Don't forget that!

This war cannot be carried on on loyal sentiment and armchair strategy. It has got to be carried on with big armies, powerful guns and everything guns and armies need for continued action.

War Savings Stamps will furnish the money provided retailers enlist their salesforce at full power to sell the stamps. Some of them have more salespeople at command than a regimental commander has fighting men. Just think a moment of the selling power of a store as big as that. Just think of the stamps it could sell if it worked only 15 minutes a day. And the smaller stores can do as well in proportion.

Ask your local dealers to put in a Thrift Stamp Department today if they haven't already done so. And then push the stamps!

Enrollment in Radio Sergeants School Open

"SCORES of German machine-gun nests hidden in this wood stopped the advance of our troops, but the American artillery opened so hot and accurate a fire that the majority of them were silenced; the infantry then rushed the others," is often the wording of an official communique from the front in France.

There must be accurate observation, correct transmission of information back to the artillery headquarters, calculation of the range and direction at which to set the guns; and the rest is simple.

Observations far behind the enemy lines are made by airplane. The aerial observer has a wireless sending set, and back near headquarters there is a radio sergeant with a wireless receiving set. As soon as a message is received at headquarters it is telephoned to all batteries firing or about to fire on that target.

Telephone lines connect each battery with its headquarters, and each headquarters with the next higher in the chain of command. These telephone lines have been constructed and are maintained under all difficulties encountered in modern warfare by the electrician sergeants. These electrician sergeants also operate the searchlights used in night operations against hostile aircraft and bodies of troops.

Every time a gun is shifted, its location on the map must be accurately determined by survey and triangulation. It takes a specialist to do it and this specialist is an enlisted man trained as a master gunner.

These radio sergeants, electrician sergeants and master gunners are being trained for this service in a twelve weeks' course at the coast artillery school at Fort Monroe, Va. Hundreds of men are being turned out in every class.

Any civilian, whether he be subject to draft or not, or any enlisted man now in the service, is eligible to enroll for this course of training and attend the coast artillery school, provided he has the proper qualifications, physical and mental.

The physical qualifications are those required of all recruits for general service. The mental qualifications are outlined in a bulletin issued by the coast artillery school, which may be had for the asking. Requests for this information may be made of the director, Department of Enlisted Specialists, Coast Artillery School, Fort Monroe, Va.

Daughter of Morgan's Partner an Inspector

AMONG the first of the wealthy women of America to don overalls and accept manual toil was Miss Alice Davison, daughter of H. P. Davison of J. P. Morgan & Co. and the American Red Cross. For $20 a week Miss Davison works every day as radio inspector in a wireless factory in upper New York.

Miss Davison, who is only twenty, explained that her purpose was to release a man for the front. She is one of a group of young women who took a special course of instruction as radio operators.

Wireless Equipment for Lightships

BRENTON'S Reef lightship, off the south end of the island of Rhode Island, has been equipped with wireless apparatus for the first time as the outcome of the German submarine raid. The announcement of the fact calls attention to the stupid neglect of the past. The loss last winter of Cross Rip lightship and the fact that its crew had no means of radio communication emphasized a lack of liberality and progress in the lighthouse establishment, or perhaps in congressional provisions, and warranted the belief that before this time all of the off-shore light stations would be provided with modern means of calling for assistance or rendering aid to mariners in distress.

If it was necessary for the submarine raider to enforce a lesson that even the loss of the Cross Rip vessel and crew failed to teach, then we owe something to the imperial German navy.

Perhaps some allowance must be made for war conditions in explaining the delay in supplying radio equipment for the lightships, but the war makes the improvement more necessary now than in peace.

Marconi Marine Co. Earns Over Two Million

DURING 1917 the business of the Marconi International Marine Communication Company increased by nearly 100 per cent. in gross revenue, according to the directors' report which has just been issued.

The gross revenue for 1917 amounted to £470,657, an increase over the preceding year of £200,476. This increase was derived principally from rentals of additional ships fitted. However, it is pointed out that necessary restrictions in respect of private messages at sea have continued and prevented revenue being received from this source.

The profit for the year amounts to £192,055, and from this figure is deducted £50,000, being a necessary allowance for obsolescence of plant, leaving a net profit of £142,055. During the preceding year the net profit amounted to £96,748. The improvement is about proportionate to the increase of the business. The balance of the debenture reserve account and the balance of share premium account have been transferred to general reserve, which now amounts to £258,009. The losses sustained in consequence of attacks upon the mercantile fleet during the year 1917 have been debited to profit and loss.

The total number of public telegraph stations owned and worked by the company on the high seas increased from 1,472 at the end of December, 1916, to 2,265 at the end of December, 1917. The organization of the company, together with that of its associated companies, with a total of some 4,000 mercantile vessels fitted with Marconi telegraph stations, has continued to render inestimable service, says the report.

The directors recommend a final dividend of 10 per cent., which, with the interim dividend of 5 per cent. paid in February, will make 15 per cent. for the year. The Amalgamated Wireless (Australasia), Ltd., in which the company is interested, has paid a dividend of 5 per cent. in respect of the year ending June 30, 1917.

Crack Austrian Naval Operators Arrested

AGENTS of the Naval Intelligence Service on August 31st picked up two wireless operators who, it is alleged, came to the United States on the steamship Martha Washington of the Austro-American Line, which sailed from Trieste on July 18, 1914, and took them to the New York Port Alien Enemy Bureau, where the men were questioned by Chief Examiner Perry M. Armstrong.

The men are George Fergal, a warrant officer in the Austrian navy, born at Klagenfurt in 1893, and Guido Gassa, born in Vienna in 1886, who enlisted in the Austrian navy when 16 years old, but claims to have received his discharge in 1909.

They were taken into custody when it was discovered, it is alleged, that they are still receiving pay from the Austrian Government and that both are well acquainted with the confidential code of that Government.

Fergal has three brothers now in the Austrian army and one brother has been killed in the present war. He enlisted in the Austrian navy in 1911 and became a wireless operator, serving on various ships of the navy. He was then put on duty handling the confidential code of the Government at a land station.

In July, 1914, after war was declared, he was assigned, it is alleged, to the Martha Washington by the "Funken Telegraf Inspectory." Papers in his possession indicate that he belongs to the "Imperial and Royal Wireless Department of the Austrian Navy."

Gassa, who is said to be the best wireless operator in Austria, speaks six languages—German, Slav, Italian, Bohemian, Spanish and English. He was assigned to various naval vessels. His claim is that he got his discharge from the navy in 1909, but this is doubted by the Federal officials. He, too, it is said, was assigned to the Martha Washington by the Funken Telegraf Inspectory.

The Martha Washington, which reached here on August 2, 1914, was interned. The operators remained aboard the steamer at Staten Island until it was taken over by the United States.

Since April 24, 1917, it is alleged, the Austrian Government has been paying the two wireless operators through the Transatlantic Trust Company, which was taken over by the Alien Property Custodian a few weeks ago. Gassa has been receiving $70 a month and Fergal has been paid $55 a month it is said.

Navy's News a Daily Radio Feature

EACH night the Navy Department sends out from Washington a wireless news service, "The Navy Press," to all ships and coast radio stations. The message ranges from 800 to 1,600 words in length and contains items of general and particular interest to officers and seamen in every branch of the naval service. Each day the budget of news is carefully sorted and the more important events are put into concise English. During the night the words are flashed out by the Government's radio operators, and next morning there appears upon the ship's bulletin boards a résumé of all the previous day's happenings, both abroad and at home.

No cipher is used and the process is known as "broadcasting." It goes out to any and every vessel, battleship or merchantman, whose radio instrument is tuned to receive it.

On small ships one bulletin board is usually enough to contain the news for those aboard. On a large man-of-war there may be ten or even more. One is ordinarily placed in the ward room, one in the junior officers' mess room, one in the warrant officers' mess room, and one in the chief petty officers' mess room. Several bulletin boards for the crew are located in convenient gathering places about the ship. Besides the bulletin boards, a copy of the news letter is given to the ship's commander and, if there chances to be an admiral on board, a special copy is prepared for him also.

The news needs of men aboard a battleship are as various as their tastes and dispositions. All are interested in war developments, but each seaman also has his particular hobby. One is eager to know what is happening in the theatrical world, another is chiefly concerned with the fluctuations of the stock market. The United States Navy Press Service recognizes this divergence of interests and caters to the different wants.

Closely related to the interest in market reports is the desire of the sailors to know about the financial standing of Government bonds. A great many of them own Liberty bonds. Although they feel sure of the security of their investment they like occasionally to be reassured.

Baseball, the national sport, is constantly in the minds of the boys at sea. Although they are unable to play while cruising (for the deck of a ship is a poor place to knock flies and swat out three-baggers), they flock eagerly to the bulletin boards to read notices of the games of the landlubbers. When the big-league season opens, reports of all the important games become a regular feature of the service. When a world's series is on, or a decisive game is to be played near the end of the season by closely matched teams, special wireless messages are sent out for the information of the jack-tars.

Contemporary Editor Taltavall Dies

THOMAS R. TALTAVALL, aged sixty-three years, editor of Telegraph and Telephone Age, New York, died at his home at Mahwah, N. J., on September 2nd of heart disease, after an illness of several months.

Mr. Taltavall learned telegraphy at Wellsville, Ohio, in 1867 and soon developed into one of the most expert telegraphers in the country, being employed in many of the larger offices. He was selected as one of the original operators to man the first wire leased by the Associated Press to carry the newspaper service between New York and Washington in 1875, and was assigned to the Washington, D. C., Bureau. He was soon after transferred to the New York office, with which he remained fourteen years, in the latter eight filling the position of superintendent of the leased wire system of the Associated Press. In 1890 he resigned to become editor of the Electrical Age. In 1894 he became associate editor of the Electrical World, which position he held until 1911, when he accepted the editorship of Telegraph and Telephone Age. Mr. Taltavall was the inventor of many useful electrical devices and was one of the best-known writers of electrical literature in the country.

Chinese To Have Wireless Telephones

THE Chinese Government has made an agreement with the English Marconi Company to purchase wireless telephones at a price of £300,000. The telephones are to be delivered within nine months. The price will be deducted from a loan of £600,000 at 8 per cent.

The Government has received advances which make possible a resumption of the fighting against the South, which recent events had rendered doubtful.

Finding Your Way Across the Sea

The instruction series by Capt. Uttmark which has been running in The Wireless Age has been interrupted by the pressure of work on the author, who is engaged in training men for the Government. The suspension of this feature for an indefinite period is therefore regretfully announced.

The Editor.

Progress In Radio Science

(*Continued from page* 14)

and one anode. Each cathode is connected to the negative terminal of a high voltage source of direct current through a large inductance and a resistance; and the anode, likewise through an inductance to the positive terminal. An oscillatory circuit is shunted between the cathodes.

In figure 1 the arc generator is furnished with direct current, but in figure 2 it performs the combined function of rectification and generation being fed by an alternating current dynamo.

nately carry the main current through the tube, they may be called "arcing cathodes." Inductance 7 and resistance 9 may be conveniently combined into a single coil having proper inductance and resistance. Likewise 8 and 10. Inductances 2, 7 and 8 should preferably be wound so as to have a minimum distributed capacity. An oscillatory circuit, comprising, for example, a condenser 11 and inductance 12, is connected between the cathodes as shown. The tube may be started in a variety of ways. The method

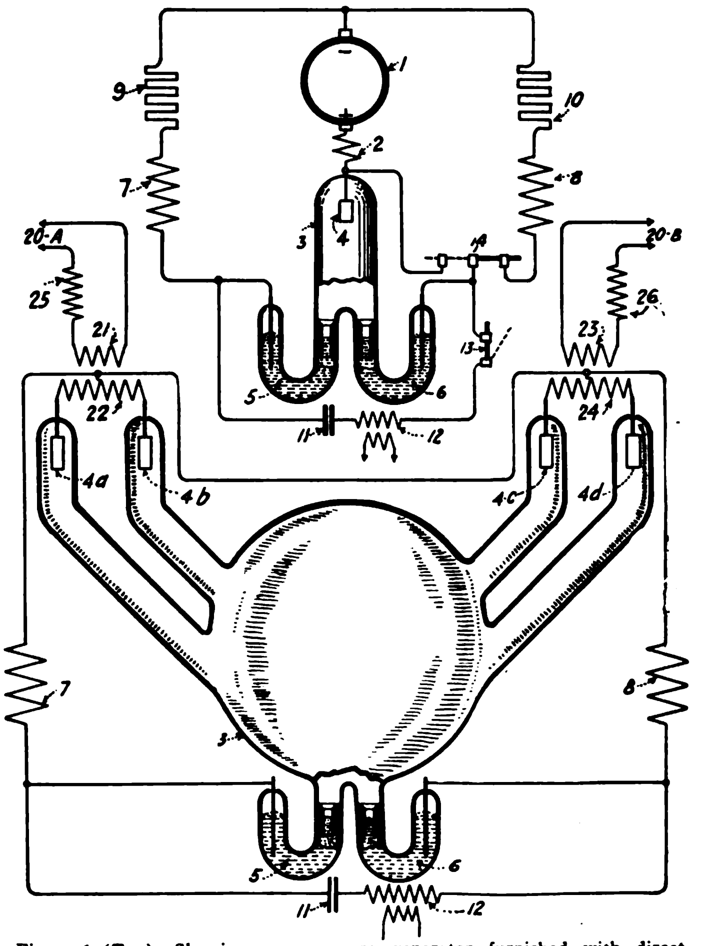


Figure 1 (Top)—Showing mercury arc generator furnished with direct current
Figure 2 (Bottom)—Mercury arc generator fed by an alternating current performing combined function of rectification and generation

Referring to figure 1 a source of high voltage direct current such as a high voltage dynamo, is shown at 1, with plus and minus terminals as indicated. To prevent high frequency energy from getting back into the supply circuits, an inductance is provided such as is shown at 2, although any other suitable means may be employed for this purpose. 3 designates a mercury vapor tube having an anode 4, and two mercury cathodes, 5 and 6. Cathode 5 is connected to the negative terminal of 1 through a large inductance 7 and a resistance 9, and cathode 6 is likewise connected through the inductance 8 and resistance 10. Since these cathodes alter-

shown here is as follows: A switch 13 in the oscillatory circuit is opened, and a double throw switch 14 is thrown to the left. These positions are shown by the dotted lines in the figure. The cathode 6 is thus temporarily made a starting anode, and by tilting the tube in the usual manner, the discharge through cathode 5 is started and will be maintained. Switch 14 is now thrown to the right, the position shown in the drawing by the full lines, and if the tube is again tilted, cathode 6 will be started. Two such parallel discharges are ordinarily highly unstable, but if each cathode is supplied through a suitable inductance, as shown, the parallel discharges are rendered stable and will run indefinitely under suitable conditions.

The stability produced by the inductance in series with each cathode is destroyed if a condenser is shunted across the cathodes and it is owing to this fact that the system can be made to oscillate. One mode of operation is as follows:

Suppose that the parallel discharges are operating steadily, the switch 13 being open. Let this switch now be closed (position shown by the full lines); the stability of the parallel discharges is destroyed, and one of them, say that through 5, will be extinguished. The current through inductance 7, which formerly went through 5, must now take the path from 4 through 6, 13, 12, 11 and 7; that is, the inductance 7 now begins to discharge itself into condenser 11. In a very short time the condenser attains a voltage, say V, sufficient to start a discharge in the tube between 5 and 6, hence the oscillatory circuit begins to execute an oscillatory discharge around the path 11, 12, 13, 6, 5, 11. Discharging under ordinary circumstances the condenser would attain at the end of the first half-swing a voltage (V-v) which is reversed in sign to the original voltage V and smaller in value than V. But as soon as the condenser circuit begins to discharge through the tube, cathode 5 is started again and cathode 6 extinguished. The current through inductance 8 must now pass through cathode 5, hence while the oscillatory circuit is executing its first half-swing, inductance 8 is discharging into condenser 11. At the end, or shortly before or after the end, of the first half-swing, therefore, the condenser voltage will not be —(V-v) but —V, which voltage is sufficient to start the reverse discharge between 5 and 6. The condenser circuit now begins to execute its second half-swing, starting cathode 6 and extinguishing cathode 5 again. The condenser voltage tends toward the maximum value (V-v), but the inductance 7 must now discharge into the condenser, so that the voltage V is reached again, and the process repeats itself.

When the system is operating in the manner described the oscillations produced are undamped and practically sinusoidal. The system may oscillate in other ways, however, giving for example rapid series of slightly damped waves, or other types of waves. The manner in which the system oscillates is determined by the magnitude and character of the various constants which enter into the circuits.

In the drawing the cathodes 5 and 6 are shown constricted where the discharge enters them. The cathodes are preferably in this form because better results have been obtained with them than with mercury pools of the ordinary type.

It is found by experiment that in order to obtain steady oscillations the ratio of inductance to capacity in the oscillatory circuit must be very large. The oscillatory circuit can be connected or coupled to the antenna or other circuits in any desired manner; and, under proper conditions, the antenna itself may be the oscillatory circuit or part thereof.

This system may be adapted for use with alternating current supply. Single phase may be employed, but polyphase currents are preferred. Referring to figure 2 which shows the invention adapted for use on a two-phase system, 20A and 20B indicate the two-phase supply, 21 and 23 are the primaries of a pair of transformers, 22 and 24 are the secondaries of the same. The primaries are supplied through the series reactances 25 and 26. The tube 3 is provided with four anodes, 4a, 4b, 4c and 4d. Special care is necessary to prevent arcing between these anodes. The terminals of 22 are connected to anodes 4a and 4b, those of 24 to 4c and 4d. The mid-points of the secondaries 22 and 24 are connected together, and from these midpoints run the parallel paths 7, 5 and 8, 6. The significance of these and the remaining members is the same as in figure 1. In order not to complicate the figure, starting means are not shown. The tube may be started as shown in and described in connection with figure 1, or in a variety of other ways. It is understood, of course, that means are provided for preventing high frequency energy from getting back into the supply circuits.

It will be observed that the extra resistances 9 and 10 of figure 14 are not shown in figure 2 and that series reactances 25 and 26 are shown in figure 2, through which the primaries are supplied. The reason for this is: In figure 1 the extra resistances are necessary in order to limit the starting current, that is the current drawn by the circuits after the parallel discharges are started and before the oscillations have been set up. In figure 2, however, where alternating current is employed the starting current is limited by the series reactances 25 and 26, hence only small series resistances are necessary; hence the form shown in figure 15 is more efficient than that in figure 1. If the transformers of figure 15 are constructed to have sufficient leakage, then the series reactances are unnecessary. All that is necessary is a loose coupling between the primaries and secondaries of the supply circuits.

Aviation News

(Continued from page 20)

only be obtained by bulk orders permitting a high degree of sub-division of work.

"The problem is complicated by the fact that manufacture and delivery rarely if ever proceed in accordance with anticipation. The output of a particular type may be delayed for weeks or even months owing to some technical difficulty of manufacture. Moreover, as replacement of losses and expansion are proceeding simultaneously in the flying services, and the rate of wastage in different types of engines and of aeroplanes varies considerably according to circumstances, it is impossible to forecast with accuracy what engines will be available for the equipment of new types of aeroplanes after wastage has been made good. Nor is it possible to any great extent to adjust the programme by modifying orders once placed without disorganizing supply. The problem does not end here. Whenever a new type is introduced provision must be made for accumulating a sufficient 'head' of spare engines, spare aeroplanes and spare parts of innumerable kinds, to keep the squadron to be equipped with that type in a condition to make good the day-to-day wastage and carry out the constant repairs required."

Attention was drawn, on more than one occasion, by manufacturers to the importance of maintaining the interest of workers in aircraft factories in the highly important but generally monotonous work on which they are employed. Engaged, as they frequently are, on the production by a repetition process of some small part of an aeroplane, these men and women find it difficult to realize that they are contributing effectively to one of our most valuable instruments of warfare. It was accordingly arranged that Captain Ewart, R. A. F., well known as a writer by the name of "Boyd Cable," should visit various squadrons at the front and gather materials and photographs for lectures concerning the exploits performed with various types of aircraft for delivery to the workpeople engaged on the manufacture of those particular types. Captain Ewart delivered several series of lectures which, judging from the reports received from the factories concerned, proved a very great success.

Electrical Digest

The Production of Nitrogen From the Atmosphere

THERE has been erected at the United States Department of Agriculture's Experiment Farm at Arlington, Va., the largest experimental plant in the United States for the production of nitrogen from air. The nitrogen so produced is combined with hydrogen to form ammonia, which can be used in the manufacture of explosives and fertilizers. Experiments with the view of increasing the efficiency of the process are now being conducted by the Bureau of Soils. The Haber process of manufacturing nitrogen is being employed. This process involves the production of ammonia from hydrogen and nitrogen. The two gases are mixed in the proper proportion, put under high pressure, and subjected to intense heat. They are then passed over a spongy iron, whereupon a portion of the mixture combines to form ammonia.

The Aluminum Production of the United States

THE United States is far in the lead among the Aluminum producing countries of the world. In fact about one-half of the world's output is produced in this country.

A recent compilation by the National City Bank of New York shows that the production of aluminum in the United States has grown from 60,000 lbs. in 1890 to 7,000,000 in 1900, 48,000,000 in 1911, 100,000,000 in 1915, 140,000,000 in 1916, and approximately 180,000,000 in 1917.

It is stated that aluminum is proving an acceptable substitute for tin in the metal industries. Its cost is no greater than that of tin, which is an important matter to the United States, because this country produces no tin and purchases large amounts abroad.

Most of the aluminum produced at present in the United States is employed in aeroplanes, automobiles, helmets, and cartridges.

Pauxite, the mineral from which the aluminum is produced, is found in many parts of the United States, but the bulk of it is furnished by the State of Kansas. The finished product is made in various parts of the United States, the most important plants being located at Niagara Falls, N. Y.

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

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

GUGLIELMO MARCONI, President

J. ANDREW WHITE, Acting President — ALONZO FOGAL, JR., Secretary

THE proposed extension of the draft ages to include men from 18 to 45 years, calls for serious attention on the part of former amateurs in the United States, particularly those who were below age in the first call.

An increased army naturally will require an increased number of radio engineers, operators, mechanics, repairmen, and installers. Amateurs approaching the age of 18 and up to 21 years ought to take full advantage of their spare time, and prepare themselves for an appointment in the radio divisions of either the army or navy. This will mean an immense saving of time and labor to the government. Every means at their disposal should be grasped to gain a practical education in wireless. This can be obtained by joining a local radio school, or by forming a local radio club for the sole purpose of instruction in the theory and in the International Code.

A considerable amount of self education can be carried on. Literature is now available for the study of the art in all its phases. Code practice outfits are inexpensive, and the Marconi-Victor Records can take the place of a special instructor. It is not difficult for the beginner to master the fundamental principles of wireless transmitting and receiving apparatus if he will first make a thorough study of the elements of electricity and magnetism. By close application, he will finally arrive at the point where he requires instruction on actual equipment. A radio school will generally be found within a reasonable distance.

It is safe to say that the new draft will include thousands of wireless operators, therefore, why not start instruction today. Putting it off will never do. Skilled men are the requirement of the hour. The selected man should not wait until he has been assigned to a cantonment. He should go to camp with a complete mastery of the basic principles.

His expertness will come under the observation of some superior officer sooner or later, and before he believes it possible, he will receive a higher appointment.

The amateurs of this country have responded nobly to the government's call for volunteers. It is next to impossible to locate a former well-known experimenter. He is either in the front ranks with Uncle Sam's Army or in the laboratory doing research work in radio. Many have received commissions, rapid promotion being possible because of the experience gained through their home experiments.

A man in charge of a large government school told the writer recently that students who were formerly amateur experimenters, outshine all others from every standpoint, and he expressed the desire that the government would in the future pay particular attention to enrolling first, young men who had operated experimental wireless stations in years gone by. He declared that they possessed a certain keenness in manipulating wireless equipment which the land line telegraphers required several months of close application to acquire.

In preparing themselves for government service several inquiries have been received from various amateurs which in a general way may be stated as follows: "What shall we study to fit ourselves for government radio work?" To this we reply that that aspirant should master first the International Telegraph Code. He should follow this by study of elementary electricity and magnetism; next—the alternating current dynamo and transformer. He should learn how to use measuring instruments, and afterward take up the radio frequency circuits of the wireless transmitter and receiver.

The process of tuning is next in order; then the principles and operation of the vacuum detectors. He should study the fundamentals of undamped wave transmitting and receiving apparatus particularly, the arc transmitter and the beat receiver.

Within a space of three to six months, the beginner should acquire a fair general knowledge of wireless telegraphy, and then by taking a finishing-up course at a properly equipped radio school, he will be a well-balanced radio man. The foregoing deserves serious consideration.

The following is a statement of fact, but for reasons well known to ourselves, the proper names of the gentlemen involved cannot be published:

Bill Jones and John Smith lived on the same block, and both were deeply interested in amateur wireless telegraphy. Jones constructed a haphazard station without giving serious attention to basic principles. He used his apparatus merely as a toy, the major portion of his time being spent in filling the ether with nonsensical conversations. He never studied a book on radio and sidetracked all attempts to study the theory underlying the working of his apparatus. Like many others in the same class, his interest waned until his station was only heard occasionally.

John Smith, on the other hand, read every piece of available wireless literature, and he conducted a series of experiments to determine the how and why of his apparatus. He built his instruments in accordance with well-known principles, and every test he made was for the purpose of making a new determination. He was often laughed at by Jones for taking the art so seriously, but nevertheless he plugged away until his station had a reputation of being the best in that locality.

Both of these gentlemen being within the draft age, they decided to enlist in the Navy as radio operators. Jones enrolled in this particular division because he thought that he was going to take on "something easy," but Smith entered with the sole idea of doing the greatest possible good to the Government. They joined a prominent Naval School at the same time and were placed in the regular routine. Jones held that if he became a fair wireless operator he was doing his part, at least in the eyes of the neighbors in his home town, but Smith had a larger vision, and he did everything possible during his training period to further his knowledge of the art.

To make the story brief, Smith is now a Radio-Gunner in charge of wireless operations on one of the largest vessels in the Navy. Jones is a third-class electrician on a merchant transport, and the chances are that he will continue in this capacity for the duration of the war.

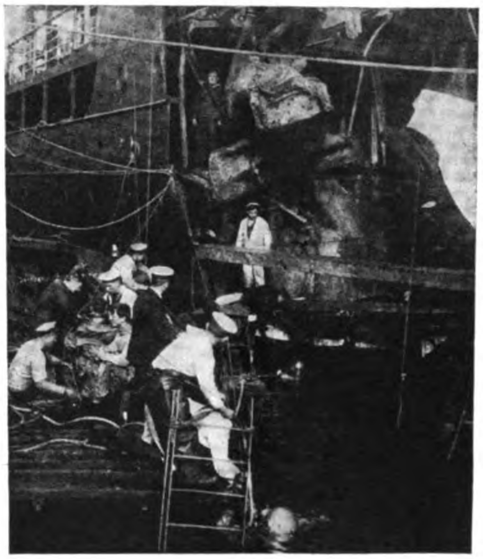
Would you rather be Jones or Smith? If Smith, then go back and read the first article in the bulletin again.

Torpedoed!

(Continued from page 35)

the men were without food for eight days. They had even eaten the cats that were on board. The crew had given up all hope of being rescued, as several ships had sighted the chaser but thought it to be a submarine and changed their course.

A lifeboat filled with food supplies was sent out to her. We then took her in tow and continued on our voyage. This happened by coincidence



Divers at work searching for the bodies of firemen who lost their lives

on my birthday—the 13th, surely for the Frenchmen, a lucky 13th.

Later we learned that there were seventeen of these U-boat chasers built in the United States for France, and only eleven reached port.

We arrived at St. Thomas, Bermuda, two days later with the S. C. 171 safely in tow. She was taken in by a tug and I have heard nothing further concerning her. After coaling, our voyage to New York was resumed without further incidents.

Lack of skill in story-telling has probably made this a pretty poor yarn, but I am hopeful that in it readers will see that submarine attacks are still one of the grim features of the present war. We wireless operators have our trials at sea just as frequently as do those who are fighting "Over There." But the knights of the sea roads are winning their victories and the spirit of '76 assures a certain triumph. America's day on ocean crossroads is coming; soon the Hun must seek shelter. And when we have the upper hand, well—if Sherman thought war was hell, the Kaiser's opinion surely will not look well in print.

Harvard Radio School

Uncle Sam is sending out every week from fifty to one hundred wireless operators from the big Harvard plant at Cambridge, Mass., which was transferred to the Government a year ago as a radio finishing school. It is the only institution of the kind in the country, and the classes have in the aggregate 5,000 ambitious youths.

Memorial Hall, perhaps the most famous of all the Harvard buildings, and wherein generations of undergraduates have dined, is the main eating establishment for the radio army.

But this old hall has its quiet period, for on payday, which comes twice a month, only a handful go there to dine. The radio boys walk with the "ghost" and go him one better by taking an eight minute subway jump to Boston, where they come up for air and a change of scenery.

The radio students notably are orderly. They are scattered over a wide area, many of them lodging in private homes without official restraint, yet police and military records reveal blank blotters so far as they relate to radio students.

This being a finishing school, only those who are able to copy ten words a minute in the Continental code are admitted for the sixteen weeks course. To be sent out for service at sea they must be able to receive twenty-two words a minute, the minimum grading. There are many experts among the teaching force whose speed runs up to thirty-two words a minute, but beyond that a radio message would be hard to get. From three to six operators are assigned to each ship. With the large number of vessels building for the merchant marine and the navy, the radio school is doing its best to turn out experienced operators as fast as possible.

The radio men have come from every State in the Union, many of them under draft age, and generally eager for active service.

Warming the Aviator's Feet

ELECTRICAL means of keeping an aviator's feet warm is the basis of a new apparatus recently devised by a New York inventor. The illustrations show the arrangements.

This shoe-warmer equipment comprises an insole having the general appearance of the commonly used slip insole, except for the two plugs projecting about one-eighth inch from the bottom.

When the insole is placed in position in the shoe, the two small plugs fit in two sockets which are sunk about one-eighth inch in the heel. These sockets are the terminals of two small insulated wires, which are connected to the terminals near the top of the shoe. These terminals may be made invisible if desired.

Electric current is brought to the terminals through small insulated wires attached to the inside seam of the trousers; these wires connect with the source of electric current at the waist so that there are no loose wires to inconvenience the wearer.

The amount of current consumed is very small indeed, two ordinary sized flashlight batteries being sufficient to keep a person warm for a number of hours.

While it was to give aviators a practical means for keeping themselves warm that brought about this invention, its use is not by any means restricted to aviators' needs. Look-outs

Showing method of wiring

on naval patrols, submarine crews, observers in observation balloons, soldiers convalescing, motor car and motor truck drivers, and all others who are subjected to the rigors of outdoor life can use this simple equipment to advantage.

An obvious application would be to our troops operating in the arctic region of Siberia this winter, whether fighting or convalescing. The man using this equipment is not only going to be kept comfortable, he is going to be very much more efficient.

It would seem also that this invention will prove of great value to the man about town this winter. Some of us will not have all the coal we would like to have, so that other means will have to be resorted to. From a coal-saving and economic point of view, this idea can't be beaten, the inventor claims; by using one's electric lighting circuit, the feet (which affect the temperature of the whole body) can be kept warm for about 1 cent a day. Not only can a person be kept comfortably warm in this way, but they may enjoy fresh air at the same time; windows need not be sealed up in or-

Style of insoles with wiring and contact points in place

der to retain the warmth, the stale and injurious air which is the general rule with every other heating means being dispensed with. Thus lungs are kept strong and in a condition to resist the extremely cold air of outdoors. It is well known that more colds, pneumonia and grippe are brought about through people going out into the cold air after sitting for some time in a carefully closed-up office or room than by any other means. The shoe-warmer equipment is expected to do away with this danger.

Queries Answered

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

Positively no Questions Answered by Mail.

F. R. D., Mobile, Ala., inquires:

Ques.—(1) Up to the time of the United States' entrance into the war, what was the most commonly used type of oscillation detector?

Ans.—(1) It may be said that the carborundum rectifier was the most popular up to that period, due mainly to its simplicity, ruggedness and stability. Vessels fitted by the English Marconi Company usually include a magnetic detector with the radio equipment. This is by far the most stable and fool-proof of all oscillation detectors, but it possesses the disadvantage that it is not sensitive on the shorter range of wave lengths. Its reliability in operation, however, offsets its shortcomings in that respect. The two and three-electrode vacuum tubes were favored up to that time, but were expensive to build and operate as compared to the simple crystal.

Ques.—(2) I have noticed that there are a variety of methods of connecting the potentiometer and battery to the carborundum rectifier. Which one is preferable?

Ans.—(2) There are three methods of connection as shown on page 134 of "Practical Wireless Telegraphy." The connection generally favored is that of Fig. 153b. Fig. 153c are the connections used by the English Marconi Company. The connections of Fig. 153a are now practically obsolete.

Ques.—(3) How does the operator obtain the best operating adjustment of the carborundum crystal?

Ans.—(3) If the receiving tuner is fitted with a buzzer tester, the buzzer is set into operation. The operator then tries various points of contact with the crystal with simultaneous adjustment of the potentiometer, until the loudest signals are obtained in the head telephone. It is difficult to give specific instructions in advance. Also remember that the current from the local battery must flow through the crystal in a definite direction. The correct polarity is readily determined by experiment.

Ques.—(4) What is meant by a "standby circuit?"

Ans.—(4) This is the circuit that the receiving operator employs when he desires to receive response from several transmitting stations operating on slightly different wave lengths, without accurate tuning. For "standby" work, the operator employs close coupling between the primary and secondary coils of the receiving transformer.

Ques. (5) In the circuit of the three-electrode vacuum tube, I often notice a resistance connected between the grid and filament. What is the function of this connection?

Ans.—(5) This resistance is employed to prevent an extraordinary negative potential piling up in the grid condenser, or on the grid itself. It can be shown that if the grid of the vacuum tube is charged to a sufficiently high negative potential, the plate circuit will open; that is, the passage of current from the plate to the filament will be obstructed. Hence, when a cascade amplifier is employed, it becomes necessary to connect a resistance between the grid and the filament of the vacuum tube, in order that the fluctuations of the grid potential in the second or third tube will not become so great as to render the vacuum tube inoperative.

* * *

A. B. L., Clarksburg, W. Va.:

We cannot publish details concerning the scope of instruction given at Naval Radio Schools. The Navy has both general schools and "finishing up" schools. The appointments which Naval students obtain depends primarily upon their rate of advancement. This is a matter on which we cannot give you much information.

* * *

G. R. L., Washington, D. C., inquires:

Ques.—(1) Assuming a short-wave condenser to be connected in series with a wireless telegraph receiving set; will the antenna system respond to the longer waves in the position of maximum capacity of the condenser or in the position of minimum capacity?

Ans.—(1) The shorter wave length adjustment will be obtained when the capacity of the condenser is near to zero. Moreover, this condenser will be a greater determining factor in changing the wave length when its capacity is equal to or less than that of the wireless telegraph aerial.

Ques.—(2) When the statement is made that the decrement of a wireless transmitter is 0.2, what does this expression indicate?

Ans.—(2) The decrements of damping indicates the rate at which oscillations die away in a circuit producing damped oscillations. It is in reality an expression which shows the energy losses in a given circuit. A decrement of 0.2 signifies that each spark discharge in the closed circuit of the wireless transmitter sets up approximately 25 complete oscillations in the antenna circuit before the amplitude of the last cycle is .01 of the amplitude of the initial cycle. The logarithmic decrement of damping is the logarithm of the ratio of the amplitude of two successive oscillations in a wave train in the same direction; that is, it is the decrement per complete cycle.

Ques.—(3) Can you give me a simple explanation of what is meant by a quenched spark?

Ans.—(3) The phenomena of quenching is obtained to a greater or lesser degree with all types of spark gaps. A proper quenched spark gap is one that permits little or no retransference of energy from the aerial circuit back to the closed circuit. In other words a quenched spark gap permits the closed circuit to oscillate through 2½ or 3 cycles, after which the insulating qualities of the gap are restored and the oscillations are suddenly cut off. This permits the aerial circuit to oscillate at its own frequency and damping, and generally results in oscillations of feebler decrement than are obtained with spark discharges, in which the quenching feature is not so pronounced.

Quenching, in a sense, means rapid cooling of the gases around the spark discharge electrodes. If the gases cool so rapidly that the gap's insulating qualities are restored after two or three cycles of current, then the most effective quenching is secured. The most effective way of obtaining rapid cooling is to cause the spark to discharge between large copper plates, the sparking surfaces of which are separated by, say, 1/100 of an inch. Other means, however, may be used for cooling the gap.

Ques.—(4) How can the transmission range of a radio transmitter be predetermined?

Ans.—(4) Formulae has been presented for this calculation, but they are only approximations. The better way to determine the range of transmission is to conduct actual experiments to this end. Of course, engineers have made observations through years of experience, and they are enabled to predetermine with a fair degree of accuracy the probable range of transmission. In fact radio engineering has been reduced to a scientific basis, enabling practically all calculations to be made in advance. Local conditions, however, may upset the calculations, particularly in a region where there is considerable atmospheric electricity. The approved method is to construct a transmitter of more power than is required to cover a given distance. This permits communication to be carried on under adverse circumstances.

* * *

P. R. A., U. S. A.:

Ques.—(1) In the operation of our transmitting apparatus the aerial ammeter fluctuates badly, that is, if we depress the key, the pointer will jump from 6 to 10 amperes, and irrespective of how we adjust the apparatus this will continue. Have you any advice to offer?

Ans.—(1) This may be due to a variety of causes. The ammeter itself may be defective, that is, there may be leakage in the insulation, or the antenna wires may swing to contact with guy wires on the vessel. If a multiple quenched spark discharge is employed the insulating gaskets may leak air, and some of the plates are possiby short-circuited. If the brushes on the motor generator are making good contact, and the transformer is apparently in first-class condition, it would be well to take the quenched spark discharger apart, clean the plates, and install a new set of insulating gaskets. The plates should then be clamped in their rack with good pressure. The spark should then be allowed to discharge through the gap for a period of at least a half an hour. After this the set can be readjusted for resonance, until the maximum reading of the ammeter is secured. If this does not remedy the trouble, look for leakage in the insulation elsewhere.

Ques.—(2) In the advent that a frequency meter is not supplied with a radio set, how can the frequency of the generator be obtained?

Ans.—(2) A small speed indicator should be applied to the shaft noting the revolution per minute. Divide this by 60 to obtain the number of revolutions per second. Assume that the generator made 33⅓ revolutions per second, and it had 30 field poles. Then the frequency equals

$$\frac{33\frac{1}{3} \times 30}{2} = 500 \text{ cycles per second}$$

In other words, the speed of the armature per second multiplied by the number of field poles and divided by 2 will give the frequency of the generator.

Ques.—(3) How can we remedy sparking at the brushes of the motor?

Ans.—(3) Clean the brushes of the commutator thoroughly. If the commutator is grooved, remove the armature from the machine and have it turned down in a lathe. Be sure when replacing it that the brushes are placed in the neutral field. If the armature coils are not defective, this should remedy your trouble.

Ques.—(4) Can a carborundum crystal be used as an oscillation detector for undamped waves?

Ans.—(4) Not unless a local radio frequency oscillation generator is supplied. If, for example, a three-electrode vacuum tube is connected up for the production of radio frequency currents, and it is placed in inductive relation to the aerial circuit, beats will be generated in the receiver circuits, and they may be detected in the circuits of the carborundum rectifier.

Ques.—(5) Can a carborundum crystal be employed to take down wireless telephone conversations?

Ans.—(5) Any type of oscillation detector responsive to damped waves will be suitable for this purpose.

* * *

A. P. R., Student at a Naval Radio School, inquires:

Ques.—(1) I have often heard the expression "feedback" employed in connection with receiving apparatus in wireless telegraphy. Just what does the term mean?

Ans.—(1) This term is applied in connection with the regenerative circuits used with the vacuum tubes. In a feedback circuit, the plate circuit is coupled to the grid circuit either inductively, conductively or electrostatically, such a circuit is essentially the regenerative circuit first shown by Armstrong.