November, 1918

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The WIRELESS AGE

Volume 6

Number 2

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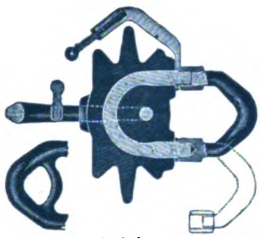
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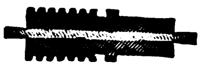
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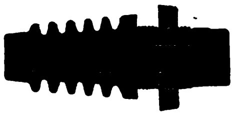
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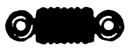
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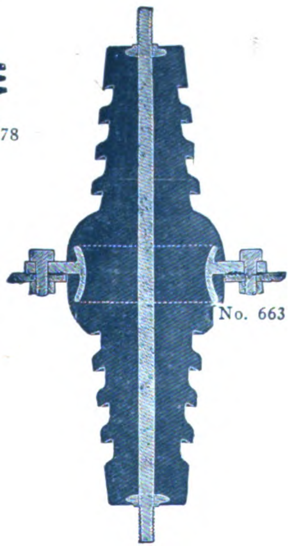
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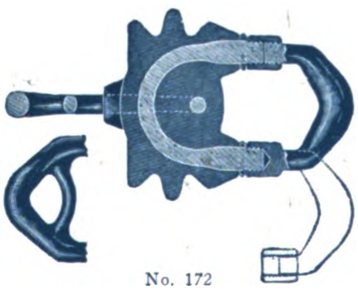
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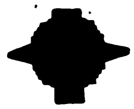
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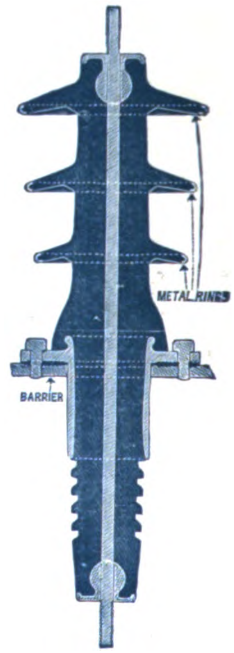

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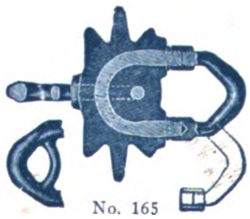
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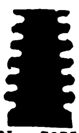
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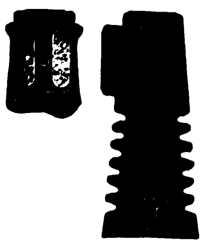
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The Wireless Age

Edited by J. ANDREW WHITE

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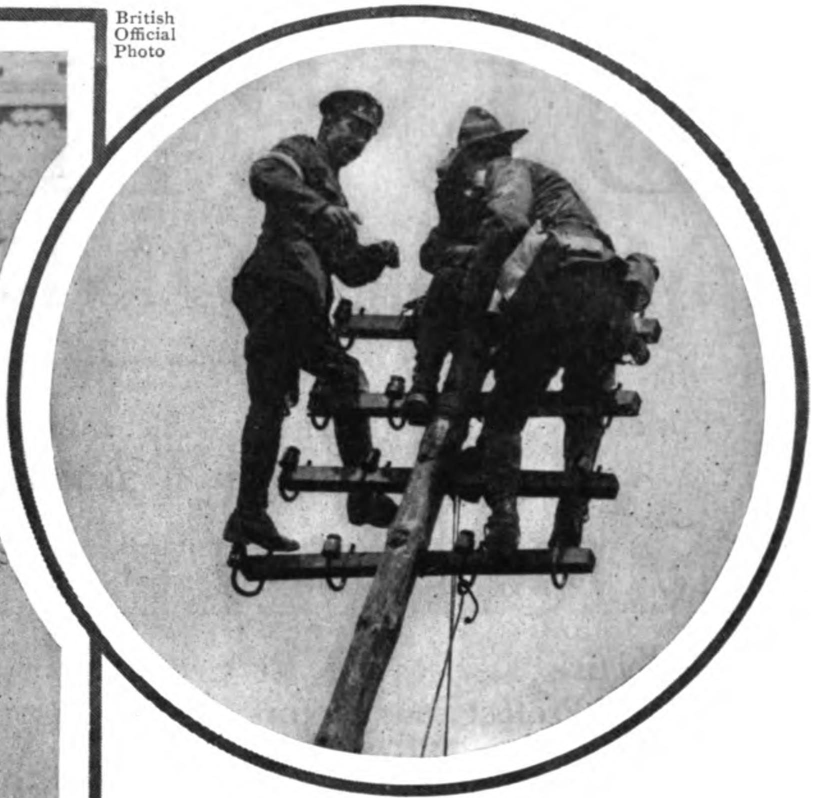

Above, in circle, the union of the allied armies visualized in members of both British and American Signal Corps working side by side in the construction of a telegraph line on the western front

To the left, protective armor for shock troops. The bullet-proof vest shown will stop revolver bullets at any range and resists shrapnel at 1200 feet velocity per second. It is flexible and scientifically made to protect the sides and abdomen and all vital organs of the body

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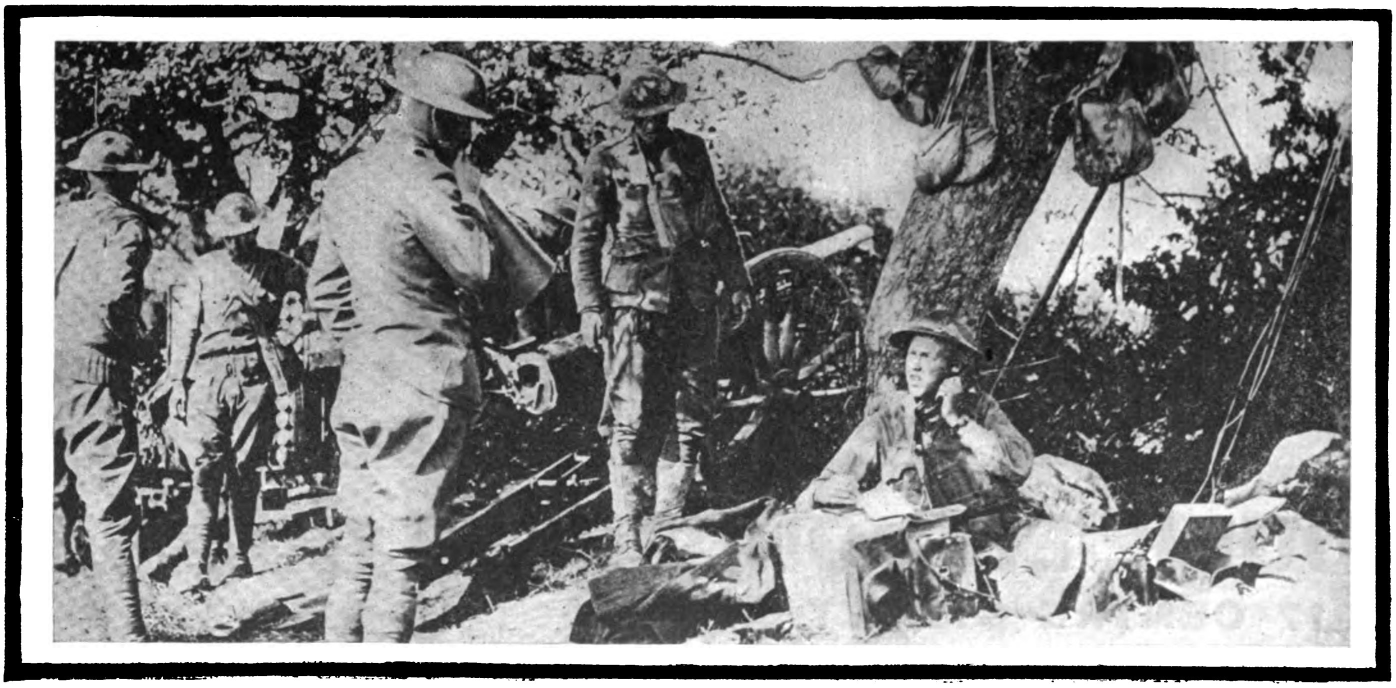


This photograph, an official one taken by the Signal Corps in France and released by the Committee on Public Information, shows how closely allied is electrical communication with artillery ranging in modern warfare. The battery captain, with the megaphone, is withholding fire of his field pieces until full data is received by the signalman at the foot of the tree

VOL. 6. NO. 2. NOVEMBER, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Is Greatest Aid to Alaskan Education

A SCHOOL teacher's job in Alaska is anything but a bed of roses. Seventy native schools maintained by the government throughout the territory are in charge of men as resourceful as Charles N. Replogle, the government teacher at Norvik, who is required to make a study of the reindeer industry in addition to his hundred and one other duties.

The Eskimo is not as isolated as the geography would indicate, for at some of the schools wireless stations have been established and news of the world is flashed to them. Concerning his enterprise Mr. Replogle says:

"The greatest difficulty experienced in teaching the Eskimos is not in teaching them regarding the facts of life, but in getting those facts applied to their everyday living. Instruction has, therefore, been of the most practical kind. The morning exercises are largely taken up with singing and telling the wireless news from all over the world, as received at our wireless station. So eager are the people to get in touch with the world that it is common to have the schoolroom full of adults to hear the news. In order to understand it they must become acquainted with geography and history. These studies have given them a comprehensive viewpoint such as was never possible to obtain through the abstract textbook method of teaching. This has had much to do with the change of the customs of the people themselves. To them the United States and its government is no longer a matter of a man or two, but is a big tangible reality.

"The wireless has done more in one winter to awaken the slumbering intellect of the native than years of abstract bookwork. His education has come to him imperceptibly and has fastened itself upon the consciousness without definite effort on his part. There is no longer any balancing of the 'native custom' against the new knowledge. In room No. 1 a class was organized for the study of electricity and the "radio" code. With the very limited general knowledge of the pupils, the progress was necessarily slow and very tedious."

British Take German Wireless in Spitzbergen

SEIZURE by a British expedition of German mining property and other development plants in Spitzbergen, including a big wireless installation, is reported by the London Express. The coal and iron deposits will be of the greatest importance to Great Britain and the allies. The expedition sailed a few months ago under the protection of the British navy. Sir Ernest Shackleton, the Antarctic explorer, was the commander, but he was subsequently obliged to leave to take up other duties. His successor, F. W. S Jones, took a large number of miners, an enormous quantity of mining material and supplies sufficient for three years. Work is now going on on a large scale. Capt. Wild, who was with Shackleton in the Antarctic, is in charge of operations. Mr. Jones says the expedition met with considerable difficulties, including encounters with eight German submarines.

Believe Austria Has Secret Wireless Station

A Vienna message to the Frankfurter Zeitung states that the existence of a secret wireless installation is suspected at Prague, and the Austrian authorities are displaying considerable anxiety regarding it. Close search having failed to discover it, the installation is thought to be of a movable character.

Balloon Cable a Cross-Continent Aerial

THE wireless station at Arcadia, Cal., by using for aerial the cable of a balloon, put aloft from the training field, has intercepted messages sent by the Brooklyn Navy Yard wireless stations, according to an announcement by the War Department. This balloon cable probably makes the highest aerial in the world.

This announcement was made by the Division of Military Aeronautics, indicating increasing efficiency in both the work of students and the equipment of the War Department's various balloon training fields. The balloon school at Arcadia has 106 miles of wire in use in teaching military communication. For the purpose of demonstration it has a complete system of wiring strung as it would be in the front line trenches on the battlefield. Communication posts and stations for all kinds of messages are used by the students the same as soldiers use them at the front.

A good part of the country southeast and southwest of Arcadia is laid out with lines of communication to this balloon school, similar to part of a sector at the front. All of the balloons, when aloft, are so wired that they can be lined together with any trench, doubled up for any work together, or they can be cut off from the trenches and talk only with their own chart room and winch or operating crew on the ground below.

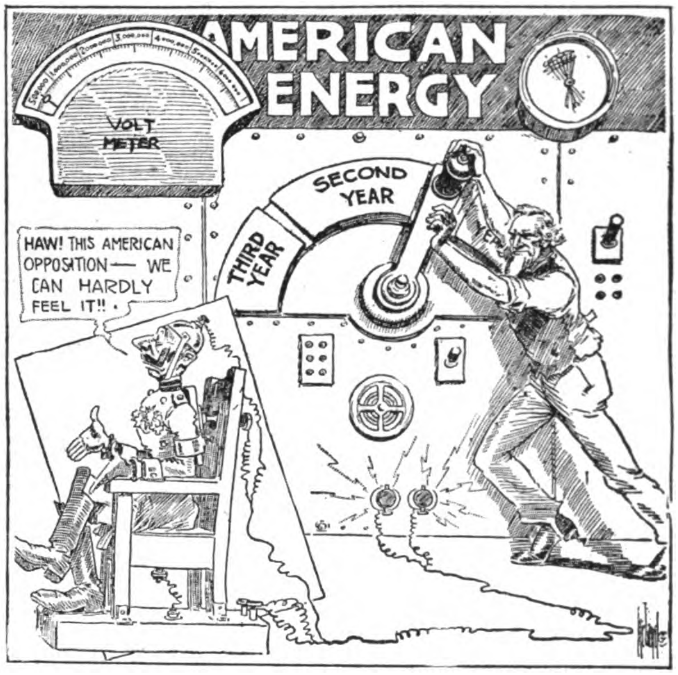
Isle of Pines Radio Resumed

THE Department of Commerce has received from the American Consul at Isle of Pines, Cuba, information that that island once more is in telegraphic communication with the world at large. A new wireless station has been constructed to replace the one destroyed by a hurricane at Nueva Gerona last September.

The new station is claimed to be far superior to the one destroyed and it is said to be the second largest in Cuba and to have a radius of 500 to 600 miles in the daytime and about 1,000 miles at night. The tower is 250 feet high and the cost of construction of the station is estimated at $20,000. Messages can be sent direct to the United States at night, via Arlington, Va., but may have to be sent via Havana, Cuba, in the daytime.

A Wireless Message Around the World

A FEW years ago the news that a wireless message had enveloped the globe would have been astonishing, would have been the news of the day, notes the N. Y. Times. News values have altered since August 1, 1914, and on October 2 the report of this event was printed briefly. News value is an expression which, being translated, means "what people are interested in," and in these days proportions are altered.



Ireland in the Columbus "Dispatch"
"Don't be impatient, Bill, you're going to feel it"

The short report printed was that direct communication between England and Australia, a distance of 12,000 miles, had been established. Twelve thousand miles is half way around the globe. But since the electromagnetic waves move equally in all directions, this message moved also in the opposite direction to that in which it was aimed and covered the other 12,000 miles. It did more than that, it enveloped the entire globe in every direction. Puck offered to spread a girdle around the world; this scientific Puck changes the girdle into a mantle.

That, however, is a feature of the report which only tickles the love of the marvelous. The practical side of it is not the encirclement of the globe, but the sending of the message to the intended receiver of it halfway around the circle. "The messages were received with perfect clearness." They went from the Marconi station at Carnarvon, Wales, to the Amalgamated Wireless Company of Australia at Sydney. The abounding achievements of science during the war, many of them directly caused by the war, are getting little attention compared to the bloody drama itself, but after the war they will come into their own.

American Marconi on Preferred List of Peace Stocks

STOCK of the Marconi Wireless Telegraph Company of America has recently shown marked activity in the New York Curb market. A leading specialist brokerage house is bidding 4⅛ for the holdings of its customers, stating that "among the so-called Peace Stocks, Marconi Wireless is on the preferred list." The statement issued adds that this is due to the general admission in commercial circles that the business of the company will expand enormously all over the world. The opinion continues that, when the war is over, Marconi Wireless of America must be regarded as one of the best and most profitable investments in the industrial group, and the steady accumulation of this stock, at a little below par ($5) a share, is for some of the best-posted authorities in Wall Street, who recognize that the outlook for Marconi is very bright.

It is intimated that the strength of the issue has partial foundation on the action of the company on August 1, when a dividend of 5 per cent. was paid, the belief being general that this dividend is the forerunner of regular annual or semi-annual dividend payments.

Naval Radio Men Score 100 Per Cent. on Loan

THE Eleventh Battalion at the Naval Radio School at Boston subscribed 100 per cent. to the Fourth Loan. The average subscription of each man was $61.22. As we go to press, $125,000 has been obtained at the school, the Eighth Company ranking second with 46 per cent. subscribed. Lieutenant W. D. Fleming, assistant paymaster, was in charge of the station's campaign.

France Completes Radio Chain With Giant Station

THE American Army will soon be sharing with the French in the operation of the highest and most powerful wireless sending station in the world. This is now nearing completion on the French coast—the point cannot be stated—and its giant towers can be seen rising 810 feet, or 300 feet higher than the Eiffel Tower. Soon it will be in direct touch with America, with far more power than ever before, supplementing the cable for transatlantic service and perhaps with its new power rivaling the cable for quick communication.

All along the front small wireless stations have been set up to intercept enemy radio exchanges and locate enemy stations. Messages are picked up from all the capitals of Europe, and especially from the larger German cities. This practice of intercepting messages seems to be universally accepted as a war necessity, and the crop daily gathered includes those from friends as well as foe. The enemy has many small radio stations along the front which are in constant communication with Berlin and Hanover, the two central enemy stations.

The American Army controls a quadruple cable line across the English Channel, which connects the French telegraph and telephone system directly with the English lines. Thus American officials are brought together for direct immediate exchange between Paris, London and American headquarters at the front.

The Signal Corps has undertaken a huge work with some 3 to 4 per cent. of the entire Army—or about 35,000 officers and men in a force of 1,000.000 men—maintaining the steady flow of communication throughout this nerve system of the American Army.

Periscopes and Wireless on Army Tanks

YANKEE ingenuity provided many surprises for the Germans in the St. Mihiel drive. Some of our tanks were equipped with periscopes, enabling the crews to look over the high ground in front of them.

The tanks attached to the American corps were constructed in France in accordance with American plans. All are manned by American crews. The machines are small, fast and powerful two-seaters, equipped with strong offensive armament.

Each carried a wireless outfit, and many a message was flashed from tanks to airplanes, which, in turn, were sent back to headquarters in the rear.

The heavier armor makes our tanks nearly proof against the German anti-tank rifles except for certain direct hits.

One American chauffeur showed the greatest skill in conducting his monster, stamping out the German machine-gun nests by reversing one caterpillar and putting full speed on the others, thus turning round and round till the enemy strongholds were crushed.

New Galena Discovery Cuts Price From $112 to 7 Cents Per Pound

THAT the unusual type of galena ore, used by the government in wireless receiving apparatus and formerly purchased from abroad at a cost of $7 per ounce, is found to some extent in two mines of Utah—the Tintic Standard and the Scranton, both of Tintic—is a fact that is leading to still further search for larger deposits of the much sought for metal.

Only a short time ago the government had the burden of the $7 per ounce price lifted by the discovery, made by S. M. Soupcoff, of Salt Lake, of a quantity of the ore in Smuggler mine, Aspen, Colo., which was purchased at the price of 7 cents per pound. The ore, about ten tons in volume, occurred in a big pocket and the government bought all there was. This will last probably a year, but not much longer, owing to the rapid growth of the wireless industry, and the search for another deposit equally as good is consequently kept up.

Captain E. J. Raddatz states that the desired ore, in small quantities, had been found in the Tintic Standard mine, but never in a quantity sufficient to make handling it worthy of consideration from a commercial standpoint. A similar ore has also been found in the Scranton, a shipping property of the Tintic district. This, too was only in small quantities.

The ore required in the making of detectors for wireless is the purest galena that can be found, 86 per cent lead.

Enemy Aliens Barred From Jersey Coast

UNDER a Presidential order issued October 2, practically the entire territory from Rockaway to Point Pleasant, N. J., along the ocean front and for a distance averaging three miles or more back is made a zone barred to German aliens except under permit.

Rockaway Point, all of Staten Island and all of the New Jersey shore resorts come within the restrictions of the order, which was issued as a means of shutting off all possible communication between the shore and submarines operating at sea.

It is estimated by the Federal authorities that approximately 15,000 Germans are affected.

The order provides that "no German alien enemy shall reside in or continue to reside in, remain in or enter any of the areas so prescribed, except by permit of the President and under such limitations or restrictions as the President may prescribe."

Where it is deemed advisable permits will be issued by United States Marshals of the affected zones, with the approval of the United States Attorneys or the Alien Enemy Bureau of the Port of New York.

Since submarines first made their appearance on this side of the Atlantic, reports have come persistently to the officials of the Army and Navy Intelligence of lights flashing from the shore and the operation of secret wireless stations. The Highlands of Navesink and the high points on Staten Island have been repeatedly subjected to investigation, as have other points further south on the Jersey Coast.

In one case a small dismantled wireless apparatus was found in the possession of a German. While proof has never been obtained of actual communications sent to sea, it was decided that the only safe way was to bar Germans from all points of vantage.

German Wireless Officer Arrested in Rochester

THE Intelligence Department of the Army made a great catch when its agents landed Lieut. Ernest Adolph Buderus von Carlhausen in Rochester, N. Y., on February 16 last, after trailing him from New York. Some of the facts concerning this man's activities have been given out by the Rochester office of the Department of Justice.

Fitzpatrick in St. Louis Post-Dispatch

"This paper says Hindenburg is dead"
"Which one of the marines got him?"

The marines in France have lived up to the best traditions of valor in the service. The boys in Fitz's cartoon naturally conclude that their mates, if anybody, would have "got him"

The German, it appears, is a wireless expert, and while in Rochester attempted to purchase a tract of land on Irondequoit Bay, in a secluded location, with the intention of erecting thereon a powerful wireless plant from which messages might have been sent direct to Germany.

Carlhausen was employed at the Ritter Dental Manufacturing Company while in Rochester, and lived with a woman not his wife, according to information in the hands of the authorities. His wife was arrested shortly after Carlhausen himself was captured, the woman being found on Long Island. She is said to have made a record before the war as a diplomatic spy, and is believed to have succeeded in getting valuable papers into the hands of German agents. The theft of a code book of an American battleship was one of her most important coups. A naval officer was court-martialed for this.

Carlhausen was also receiving mail as Ernest A. Buderus. He is a graduuate of the naval college at Kiel, and is an electrical expert.

The German is now interned at Fort Oglethorpe, Ga.

Radio Frequency Changers

Reported Progress in Their Application to Wireless Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

STUDENTS of radio telegraphy are familiar with use of frequency-multiplying transformers for increasing the frequency of a normally low-speed radio frequency alternator to a value suitable for transmission at commercial wave lengths. This system has not been widely adopted, in fact, prior to the war it had been employed in but one instance in the United State, viz., at the Telefunken Station, Sayville, L. I.

It is claimed by the inventors that this method of multiplying frequencies possesses certain inherent advantages over the radio frequency alternators of either the Alexanderson or the Goldschmidt reflector types, chief among them being the reduced initial expense of construction. In order to secure large power outputs from either of these machines a very expensive design is required. The high peripheral velocity of the rotor is another factor difficult to get around except at the lower frequencies.

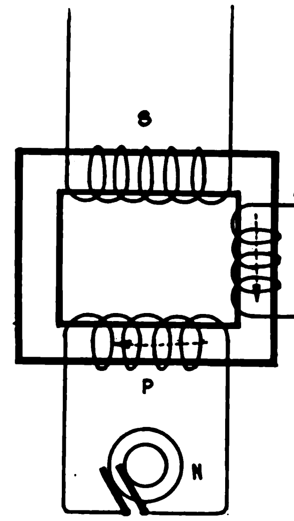


Figure 1—Diagram showing the fundamental principle of the frequency changer

In the frequency transforming system the alternator frequency lies between 5,000 and 15,000 cycles per second, which partially reduces the mechanical and electrical problems, particularly at frequencies exceeding, say, 75,000 cycles. Secondly, the length of the wave motion radiated by a radio frequency alternator is not readily changed, for it requires a change of armature speed and a consequent readjustment of the tuning circuits for electrical resonance with the aerial, the readjustments being more complicated with the Goldschmidt machine than with the Alexanderson alternator. Furthermore, the maximum output of the radio frequency dynamo is secured at some constant speed, which if changed to another speed to give another frequency, results in uneconomical operation. Other difficulties arise in the control of the antenna currents from such alternators for radio telegraphic and telephonic signaling. On the other hand, the frequency of the antenna currents in the frequency transformer system can be quite readily changed by the aid of special circuits here to be described. The iron and eddy current losses in the frequency transformer system, however, must be considerable, as is evidenced by the fact that oil and water cooling facilities are provided. Just what commercial application these frequency changers will have in the future is difficult to state, for we are required to rely on the statements of the inventors, solely, as regards their efficiency.

The fundamental principle of the multiplying frequency transformer system may be partially explained by aid of the diagram, figure 1, where P and S are the primary and secondary coils, respectively, of a radio frequency iron-core transformer, fed by, say, 10,000 cycles from an alternator N. A DC excitation winding A, fed by a battery or dynamo B brings the magnetism of the core to the "knee" of the characteristic saturation curve or to the point where an increase of current results in practically no increase in the magnetism.

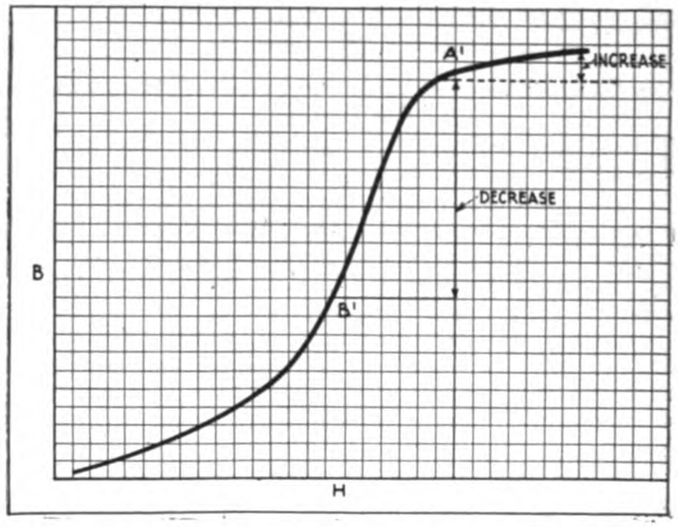


Figure 2—Characteristic B-H curve

Such a curve is shown in figure 2. This is commonly called the B-H curve where H represents the ampere turns of winding A and B the resulting magnetic flux through the core. Point A′ is the "knee" of the curve.

Now in the circuit of figure 1 there is superposed on the flux set up by winding A, the flux induced in the coil by winding P (fed by the alternator) and when P sends its flux in the same general direction of that set up by winding A, it is evident from the curve that the total flux is but slightly increased. The resulting wave of magnetization is flat-topped and it, therefore, has practically no effect on the secondary winding S.

On the other hand, the reverse cycle from N opposes the flux from A, resulting in a considerable decrease, say to the point B′ (on the curve) and the wave of magnetization becomes peaked, that is, there is a large decrease in magnetism through the core, which on the termination of the half cycle of current from P, returns to the normal value of magnetization.

This decrease and subsequent increase of the magnetism through the core induces two pulses of current in opposite directions through S; in other words, a **complete cycle of alternating current**. In summary, the first half-cycle from P has no effect on S and the second half cycle induces a complete cycle of current in S.

A transformer of the type described would have

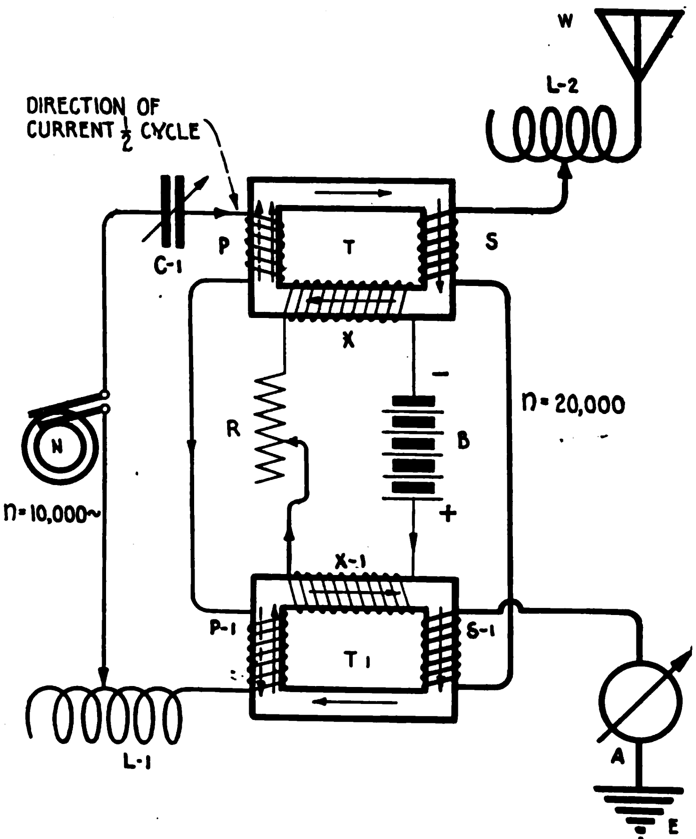


Figure 3—Circuit employing two transformers to produce current of double frequency

no practical value for only ½ cycle of the alternating current is employed, in other words, a DC pulsating current through P in the proper direction would have the same effect. However, if two transformers are employed, as in figure 3, both alternations of the complete cycle from the radio frequency alternator are utilized so that current of double frequency flows in the complete circuit of S.

In the system shown in figure 3 the frequency of the 10,000 cycle alternator N is increased to 20,000 cycles in the antenna circuit corresponding to a wave length of 15,000 meters. T and T-1 are closed core transformers suitably designed for radio frequency currents. Primaries P and P-1 are wound in relative opposition. Secondaries S and S-1 are wound in the same direction. The transformers are saturated to the knee of the characteristic curve by windings X and X-1, which are also in relative opposition. B is a source of direct current, either a storage battery or DC dynamo, and R a regulating resistance. Choke coils (not shown) are connected in series with the DC leads to prevent the induction of radio frequency currents in the exciting circuit. One terminal of the winding S and one terminal of the winding S-1 are connected to the aerial and earth, respectively.

The circuit of the radio frequency alternator N is completed through the variable condenser C-1, primary windings P and P-1, through coil L-1. C-1 and L-1 tune the complete primary circuit to the frequency of the alternator.

Assume that the fluxes in the cores have the direction shown by the full line arrows, and moreover, for a half-cycle from the alternator the direction of the current is as indicated: the flux generated by winding P then has the same direction as the flux in the core of transformer T, and as a consequence, no induction takes place in S; but on the other hand, the flux generated in P-1 opposes the flux in the core of T-1, causing a complete reduction of flux and a subsequent rise to normal saturation. The result is the induction of a complete cycle of current in the winding S-1 for ½ cycle through P-1. For the next half cycle the process mentioned takes place in secondary coil of transformer T. Therefore, there will flow in the antenna circuit two cycles of current for each cycle through P and P-1; in other words, the frequency is doubled. Resonance as usual is established by the aerial tuning inductance L-2, and maximum antenna current is observed by the aerial ammeter A.

It is obvious that by an additional set of transformers connected to the terminals of S and S-1, the current of double frequency may again be doubled, but the efficiency of the apparatus decreases as the steps of transformation increase. A complete system for increasing the frequency by three steps is shown in figure 4.

The phenomena involved in the induction of currents in the circuit of figure 3 can be explained graphically by the series of curves in figure 3-A where graph O-1 represents the alternating current supplied by the radio frequency alternator N. In graph O-2, the dotted line represents the normal flux through the iron-cores set up by the DC excitation windings. The flat-topped portion of the curve B indicates the state of magnetism when the fluxes of the primary and excitation windings add up. On the other hand, the peaked portion of the graph shows the change of flux when the two fluxes in the core are in opposition.

The graph C shows the change of magnetization in the second transformer; it is to be noted that the peaks of B and C are separated by ½ cycle. The in-

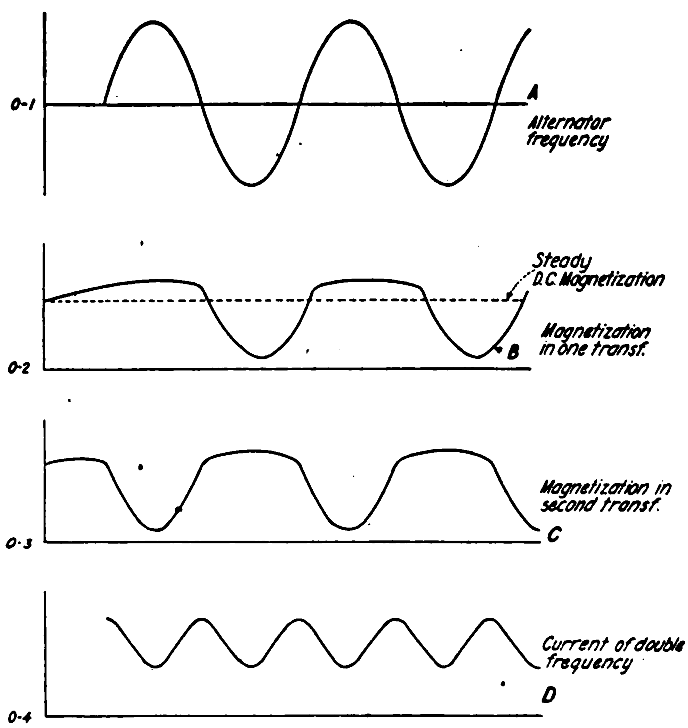


Figure 3A—Series of curves showing graphically the phenomena involved in the induction of currents by circuit in figure 3

duction due to these peaks of magnetization is shown in graph D which is seen to be of double frequency.

Regarding the Design of the Frequency Transformers

Each transformer in a frequency changing group comprises an annular or rectangular closed arm yoke composed of thin laminated iron sheets so constructed that each sheet is seamless and has the form of the complete yoke. The thickness of the sheet decreases with increase of frequency.

The variation of flux generated by the alternator has a tendency to induce high voltages in the excitation windings fed by the DC dynamo, and in order to reduce these E. M. F.s to a safe value, it is of advantage in high power sets to divide the excitation coils into groups A, B, C, connected in parallel as shown in figure 5. A low voltage DC generator is then employed. If several frequency changers are used a single DC generator may be employed to excite all the windings.

It is found that the greatest efficiency is secured from these frequency changers when the effective number of ampere turns for the radio frequency winding is approximately equal to the ampere turns of the DC winding. The former should not exceed the latter by more than 20%. It tends toward increase of efficiency also to keep the magnetic leakage of the transformers at a minimum. The iron and copper

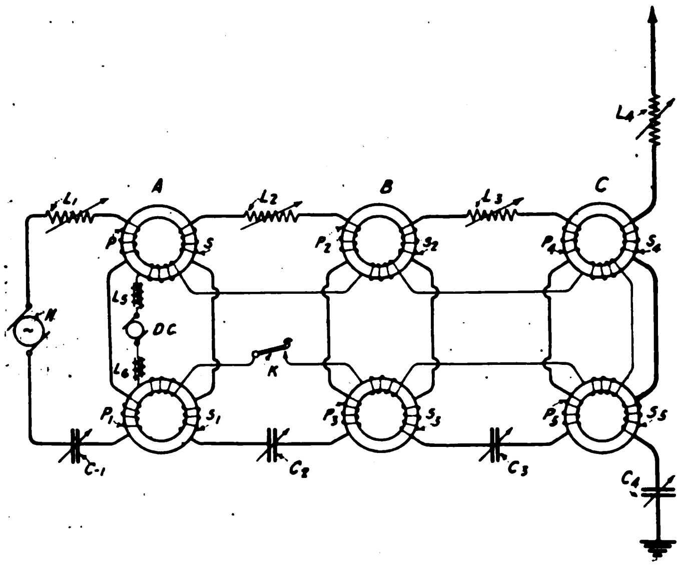


Figure 4—System for tripling the frequency of a radio frequency alternator

losses must be reduced to the lowest possible value. The windings must be uniformly placed over the length of the yokes. In case very large power outputs are required the closed iron yokes should be constructed of individual insulated packs of sheet metal with intervening air spaces. The windings should also be arranged to give air space between the individual layers. The entire apparatus should then be submerged in oil circulated between the windings and the packs of sheet metals.

Three Step Multiplier

In the diagram of figure 4 the frequency of the alternator N is doubled by group A, doubled again by the group B and doubled once more by the group C; therefore if the frequency of N = 10,000 cycles per second, the frequency of the current in the antenna circuit will be 80,000 cycles, corresponding to the wave length of 3,750 meters Resonance in the antenna circuit is then established by the aerial inductances L-4 and variable condenser C-4. It is to be observed that a single DC generator excites the cores of groups A, B and C, and that signaling is accomplished by opening and closing the key K. The circuit between groups A and B is tuned by inductance L-2 and condenser C-2; and the circuit between groups B and C by the inductance L-3 and the condenser C-3. Careful adjustments must be made in this circuit for maximum efficiency.

Redoubling Transformer System

Von Arco and Meissner have recently shown modifications of figure 3, the objects of their design being to still further multiply the frequency, to modulate the antenna circuits at speech frequency for telephony,

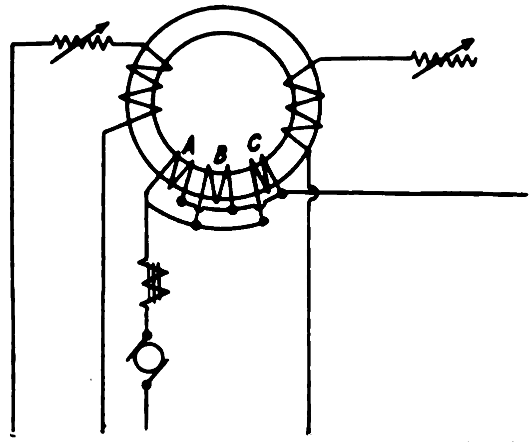


Figure 5—Showing method of reducing the production of high voltages in the excitation coils

or to permit telegraphic signaling Special designs are offered to eliminate the induction of excessive high voltages in the various circuits. In fact, the inventors have encountered problems in the frequency transformer system equally as severe as other investigators have in respect to the high-speed radio frequency alternator, but step by step they have described various means for eliminating undesirable phenomena in the operation of the system.

A modified circuit in which the increase in frequency is obtained by superimposing the current from the secondary coils of a subsequent step upon the coils on a preceding step, is shown in figure 6. Through group A and group B there is induced in the coils S-4 and S-5 a frequency of four times the initial frequency, which is fed back through the conductor D, variable condenser C-1 and the inductance L-1 to the primary coils P and P-1 of the first step. This current is again doubled to eight times the initial frequency by group A and to sixteen times the initial frequency by the group B, the latter current flowing in the antenna cir-

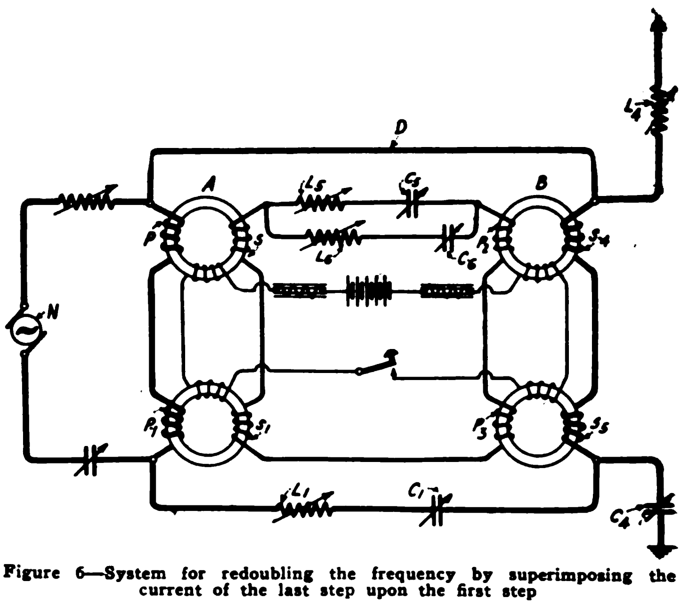


Figure 6—System for redoubling the frequency by superimposing the current of the last step upon the first step

cuit which has been carefully tuned to this frequency by the inductance L-4 and the condenser C-4. If the frequency of the alternator N is 10,000 cycles per second, the frequency of the antenna oscillation will

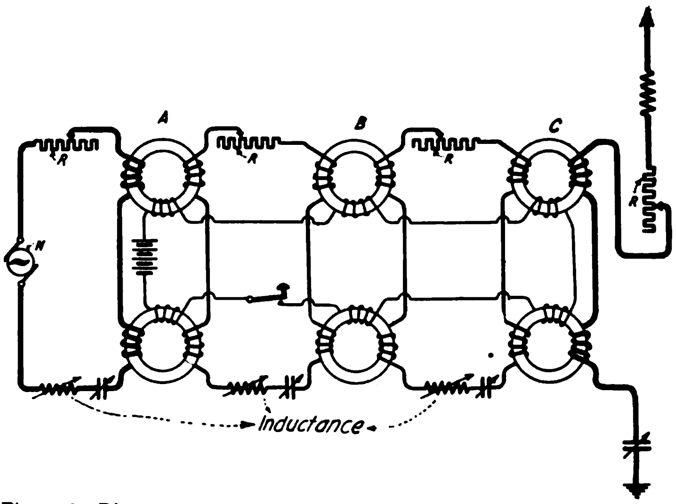


Figure 7—Diagram showing simple method of tuning the radio frequency changers

be 160,000 cycles per second, corresponding to the wave length of 1,875 meters. This brings the radiated wave down to a value suitable for transmission on the larger classes of vessels where large aerials can be erected.

It is evident that several paths must be provided for the currents induced in S and S-1 and that they must be carefully tuned to the various frequencies. Thus, inductance L-5 and condenser C-5 provide a path and act as tuning elements for the current of twice the fundamental frequency, and L-6, C-6 a path for the current of eight times the fundamental frequency. In all other respects the circuit is identical with figure 4.

Aperiodic Frequency Multipliers

Von Arco and Meissner have found through practical experience that the procedure of tuning the several circuits of cascade frequency multiplying systems such as shown in figures 4 and 5 becomes exceedingly tedious, for these circuits must be tuned to the impressed frequency of the alternator and any slight change in the frequency of the alternator will require a total readjustment of the circuits. The range of resonance is small and due to the extremely tight coupling between the various transformers, inductive disturbances arise which make it difficult to locate the resonance adjustment quickly. Again it is desirable in many stations to provide apparatus permitting the wave length to be quickly changed, but obviously if the transformer system has a multiplicity of tuning elements, it offers too many complications to permit this to be done quickly.

Two solutions of the problem have been given by the inventors whereby the problem of tuning becomes relatively simple. The circuits are shown diagrammatically in figure 7 and figure 8. In figure 7 adjustable resistances R have been placed in the generator, intermediate and antenna circuits to increase the damping. During the first adjustments to resonance, they are thrown in the circuit at full value and as the inductance and capacity are changed for resonance (as will be observed from the reading of the aerial ammeter), the resistances are gradually reduced until the maximum efficiency of conversion is secured. The foregoing process greatly assists the preliminary adjustments of the apparatus at any particular wave length, the circuit being first tuned roughly and finally more sharply.

In the system shown in figure 8 the tuning of all steps is eliminated except that of the antenna circuit, the intermediate circuit being adjusted for very high damping not by the insertion of resistance coils as in figure 7 but by giving the various windings a greater number of ampere turns so as to increase the damping. In the diagram A and B are two frequency transformers with the usual intermediate circuit, S-1, P-2, S-2 and P-3 and the excitation or magnetizing windings L. The antenna circuit is connected to the last set through the transformer M-1 with the adjustable secondary.

Owing to the high damping provided by these windings they act like ordinary transformers in which the phenomenon of resonance is not so evident. The resistance of the windings is comparatively large as is the self-inductance. The capacity of the condensers C, C-1 and C-2 is also very large to assist materially the damping factor.

Transformer M-2 is wound with a large number of turns to make the circuit of the generator nearly at aperiodic. The adjustable secondary of the transformer M-1 permits the E. M. F. in the antenna circuit to be adjusted to a safe value. If the frequency changer secondaries were supplied with variable secondary windings, the same results would be secured.

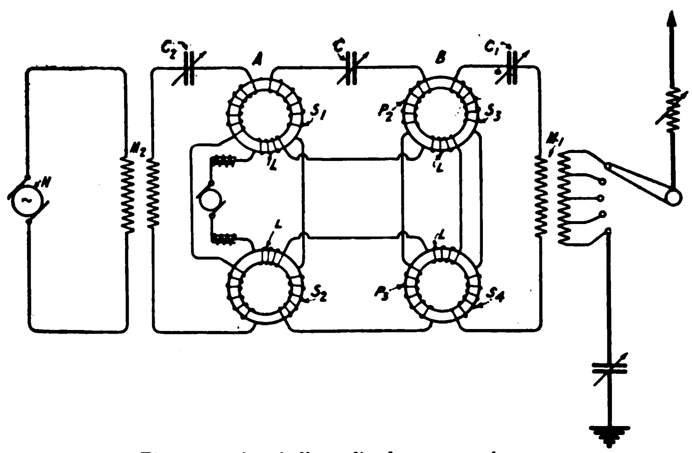


Figure 8—Aperiodic radio frequency changers

The inventors remark that the efficiency of conversion of this type of apparatus is comparatively good and at high powers the loss of energy due to the lack of resonance is negligible considered from a commercial view-point.

(To be continued)

December Wireless Age

Unique methods of controlling the antenna current for radio telegraphic and telephonic signaling are among the most recent developments in the art of wireless. The second instalment of "Radio Frequency Changers" in the December "Wireless Age" will therefore, be very timely.

When "Bunty Pulls the Strings" in a position back of the British lines a highly destructive shell screams over No Man's Land to return the Hate of Fritz. The photo on the left shows Bunty, a favored high calibered cannon of our Allied artillery

Above, in circle, are the chiefs of the headquarters Aviation Section with the American forces in Great Britain. Seated, Col. C. R. Day; standing, left to right, Lt. Col. W. H. Harms, Major W. A. Larned, Major W. H. Shutan

At the left, members of the Women's Signal Corps, composed of prominent Englishwomen, training in field buzzer and telephone communication

Mobility of equipment is equally as important as troop transport, so the caterpillar tractor goes forward on a speedier motor truck

Press Ill. Svce.

An actual scene on the first line with the battle raging across No-Man's Land. This is the view that the Signal Corps man gets as he maintains the lines of communication in the trenches

Under Fire With the Signal Corps

WHEN the average man hears the Signal Corps mentioned he has a somewhat hazy idea of its work and of how it is connected with the vast organization of the modern war machine. Even to the man in the army the Signal Corps is more or less an unknown quantity.

The activities of the Signal Corps are so wide in scope and their development of so recent a date that this vagueness is not to be wondered at. Until the time of the Civil War, armies and their units had been small enough to permit the commander to keep sufficiently in touch with his forces by runners and mounted messengers. During the Civil War, however, armies grew so large and unwieldy that their efficiency began to be impaired through lack of a perfect system of communication. It was seen that no matter how perfectly trained an army might be in its various activities, if it was unable to know the proper time to perform, its efficiency was imperilled. In fact, it was already realized that a perfect army is nothing more than a perfect soldier on a vast scale and, like that soldier, in order to be of any service or accomplish its aims, it must have a nerve and control system just as perfect as his.

The first step in improving the signal service was the use of the telegraph which, at the time of the Civil War, had been commercially perfected. While some progress was made at that time in its use, it was not until the time of the Spanish-American War that the signal service of the army was employed on anything like the scale of today. During that war the Signal Corps was an entirely mounted organization and was required not only to be as mobile as the cavalry but was even required to anticipate the needs of the cavalry and immediately have stations, where all officers could transmit messages, open and working as soon as the cavalry came to a halt. Our Signal Corps had developed a system of communication for open warfare that was practically perfect; in fact one which would have given any number of pointers to even the perfect German war machines.

At the opening of the present world war it was seen that the signal service as organized for open warfare would not be applicable to the different conditions required in trench warfare. As our entry into the war seemed so remote there was nothing done actually to change our methods, but at the same time the Signal Corps was making a study of the various means of communication in use by the different armies in Europe.

As soon as war was declared it was known at once just what the duties of the Signal Corps would be during the several months before the actual entry of our troops upon the firing line. It was known that the moment our force set foot on foreign soil to study and determine the method of warfare to be adopted it would be necessary to keep this force in constant communication with the authorities at Washington. As soon as it was decided that our operations would be in France the material and the personnel for laying trunk telephone and telegraph lines from the various seaports through the heart of France over to the theatre of operations were at once assembled, and this personnel was among the first actual troops to be sent over. Today there is scarcely a city in the principal part of France through which an American telephone line does not pass.

As soon as it was decided that we were to adopt the French methods of warfare we began to make a study of the French system of signaling. While we speak of having adopted the French system of warfare, this is

The Marines, too, have their signal units; here they are shown grouped above a telephone switchboard used at division headquarters

only approximately true as concerns the work of the Signal Corps. The main problems were to see what different kinds of messages had to be transmitted, the various ways the French had of doing it, whether any of the English methods were an improvement, and, lastly, whether we could not work out a system combining all the merits of the others, at the same time omitting their defects. This has been done so far as possible, and the United States Signal Corps now has a system of signaling as applied to trench and semi-open warfare which represents the most modern ideas of all the armies now at war, including even the German.

The success of this system is attested not only by the way in which it works in trench warfare but even more forcibly by the manner in which it has enabled perfect communication to be maintained in the first big offensive of the Americans.

In the dugout the quick-witted signalman is a valuable aid to the guns which are firing overhead

The lines of information from the various army headquarters are continued practically in the same manner as the main trunk lines that run through France in the service of supplies. Radio begins to play an important part in the game. However, it is within the division itself that the development of all means of communication takes place. Here every method of signaling that has ever stood up under the ordeal of battle plays its part. The whole area within ten miles of the front line is a maze of "lines of information." For convenience these lines may be divided into four great net works, any one of which may be depended upon as a complete and independent means of transmitting information.

The first and most complicated is the wire net. This begins at division headquarters and reaches its tentacles out toward the front in all directions. Its large central telephone exchanges located at intervals over the entire front, sometimes in half-demolished dwellings, sometimes in dugouts 40 to 50 feet deep, are the busiest spots on the battlefield. Its lines must furnish communication for the artillery, machine guns, the infantry, the trench mortars, the balloons, the engineers, the field hospitals, and all the other units that go to make up the war machine. In fact, the telephone system is much more elaborate and more complicated than in a young American city.

The problem of laying the wires under shellfire and keeping them in repair at all times is enormous. While the Field Signal Battalion of the Signal Corps is directly in charge of all systems of communication within the division it is assisted by telephone men from all the other units who work under it and carry out its ideas. The wires are often in the form of large buried lead cables, for whose installation it is necessary to employ highly specialized cable splicers, who carry on their work often with shrapnel raining around them. Lines radiate from these cables in smaller trunk lines, all of which have to be buried, but as these lines approach the front they are laid along the sides of the trenches the soldiers use.

It would be necessary to bury cables or wires fifteen to twenty feet to make them at all immune from shellfire, and as it is almost impossible to accomplish this, it can be seen how great are the troubles which the signal men encounter in trying to locate and repair breaks, especially in rain and snow or on dark nights, when the mere lighting of a match would be a welcome target for the enemy. All the wires have to be so carefully tagged and labeled that the telephone men can creep along a wire and merely by feeling these labels know exactly from what point the wire starts and where it terminates.

Another system which works independently of the wire system and which will interest the man who is inclined to wireless rather than wire work, is the radio net, which in itself furnishes complete lines of information throughout the area. In this net are employed radio instruments such as the average American radio man never dreamed of. Beginning at the front line are little radio sets with antennae so small that they can easily be concealed in a dugout. A little further back are trench radio sets whose transmitting range is larger than those in the dugouts, but whose antennae are so small that they can be placed just off the ground and not be seen by the enemy, or can even be placed in an unused communication trench.

The radio serves a great mission in the artillery, where it is relied upon as the fundamental means of communication between the artillery and the airplanes which see and control the fire of its guns. Each shot is observed by one or more airplanes, which at once send with their radio sending sets the exact information of the result of the shot to the radio receiving set back by the guns. In this way it is possible accurately to adjust the fire of the guns on a target, which without the use of the radio

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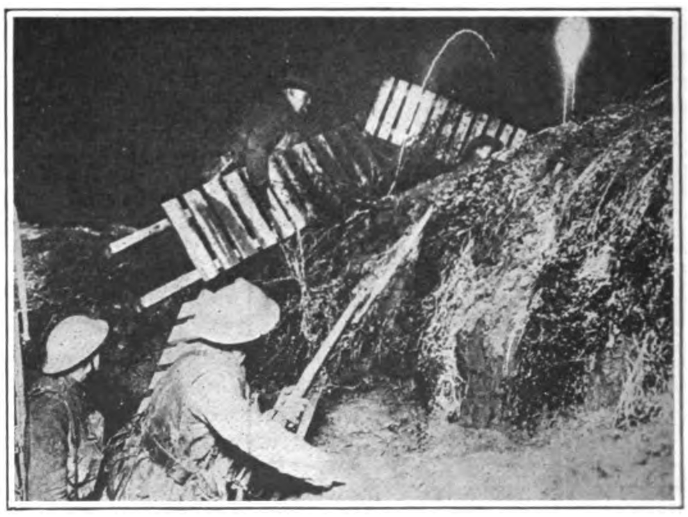


When an advance is made the signalman goes over the top, too, for laying wires under shellfire is a routine part of his job

Code Practice for Receiving

The Principle, the Four Stages, and the Basic Law

By Gordon Lathrop

Of the Marconi Institute

IN last month's article the writer specified four stages of code sending, through which the code student must pass before he becomes expert in transmitting messages.

Phrased a little differently, though fundamentally identical, four stages may be defined through which the receiver must pass.

The first stage in sending finds the aspirant learning to construct each letter, numeral and punctuation mark in proper form.

The first stage in receiving is when the beginner is learning to **detect**, and write down, each letter, numeral, and the punctuation marks of common usage—to detect each, moreover, as a sound, an individual cadence.

The second stage in receiving is like the second stage in sending. This stage in sending has already been described as: "Learning to make a succession of letters to compose a dictionary word, code word or cipher combination in rhythmic steadiness." Applied to receiving, the second stage would be: Learning to detect and write down, accurately, and with **comprehension** of the word in its entirety, a succession of letters to compose a dictionary word, code word or cipher combination.

It is not enough to write down the letters blindly. Connection of the letters in word form should be made. That part of the brain which has to do with the registration of the cadence of each letter should be co-ordinating with those faculties which consciously recognize the word in its entirety.

Short, commonly used words, arranged in alphabetical relation, should be sent the beginner of this stage. Greater speed of transmission of words of increasing length may be gradually applied. Code words and cipher combinations may be included as part of the practice during this stage.

Building Up Endurance

The third stage in receiving, as is the third stage in sending, is that period during which the student is building up telegraphic endurance, so that he can last throughout the sustained periods which practical telegraphy calls for. Sentence practice should be added to word practice in this stage. Practice, practice, practice, aiming for accuracy and "clean" copy, rather than for speed, is the prescription for this stage.

The fourth stage in sending is when the aspirant puts on his sending the final touches which produce style and speed. In receiving, this stage finds the code man learning, in general, the tricks of the speedy telegrapher. Specifically, his aim should be to learn the forms of telegraphic communication which prevail in the particular branch of the art in which he desires to become a worker. Knowledge of the methods and forms, and of the phraseology employed in each of the branches of the telegraph field is essential to become an "all-round" expert telegrapher. Press, broker, commercial, railroad; radio in its increasingly numerous military and civil sub-divisions—each of these has its bag of tricks to be learned. Not until these become familiar can the telegrapher work at high speed in any particular branch.

Roughly, then, the four stages, in both receiving and sending, may be defined as (1)—The "A.B.C." stage; (2)—The word stage; (3)—The stage which makes for endurance, and (4)—The finishing-touches stage.

It should be noted that these four stages run into one another and are of indefinite lengths. What one student may acquire in telegraphic facility in one month may take another three months. Every telegrapher, however, must go through these four stages. Every one does, in fact, whether consciously or unconsciously; whether in proper sequence or haphazardly.

The Basic Law of Progress

A single principle rules throughout the four stages noted in the foregoing. The principle applies to receiving as well as sending, though perhaps not so obviously. It is self evident to even the novice in the code that the correct principle of sending is to keep the members which have to do with the process—the hand, wrist and forearm—in constant balance.

Even in such a physical process as sending, however, the hand, wrist and forearm will not keep in balance if the mind is not in harmony with telegraphic laws of progress.

"Progress in the order indicated by Stages 1, 2, 3 and 4," is the writer's conception of the basic law of correct progress in the code. "Do not pass from one stage to another until each has been thoroughly mastered in proper sequence," is its inevitably corollary. If an over-zealous student tries to whip an untrained hand and wrist into a speed which his desire wills, his sending will reflect the mental fault. He is out of balance, telegraphically.

The earnest endeavor of the student should be to resist the temptation to leap from one stage to another before he has thoroughly mastered each one in proper sequence. The practice of the code is peculiar in that one may experiment—after a fashion—and one is continually tempted to do it. The last stages of the art beckon invitingly to the novice immediately after he has learned the alphabet. But the student who tries for speed in sending before he has learned steadiness, is endangering materially his chances of ever becoming either a steady or a speedy sender. And he is not progressing. Time spent in trying to receive press matter, for instance, before he has learned to copy a succession of five-letter dictionary words with comprehension, is wasted.

The Acquisition of Balance

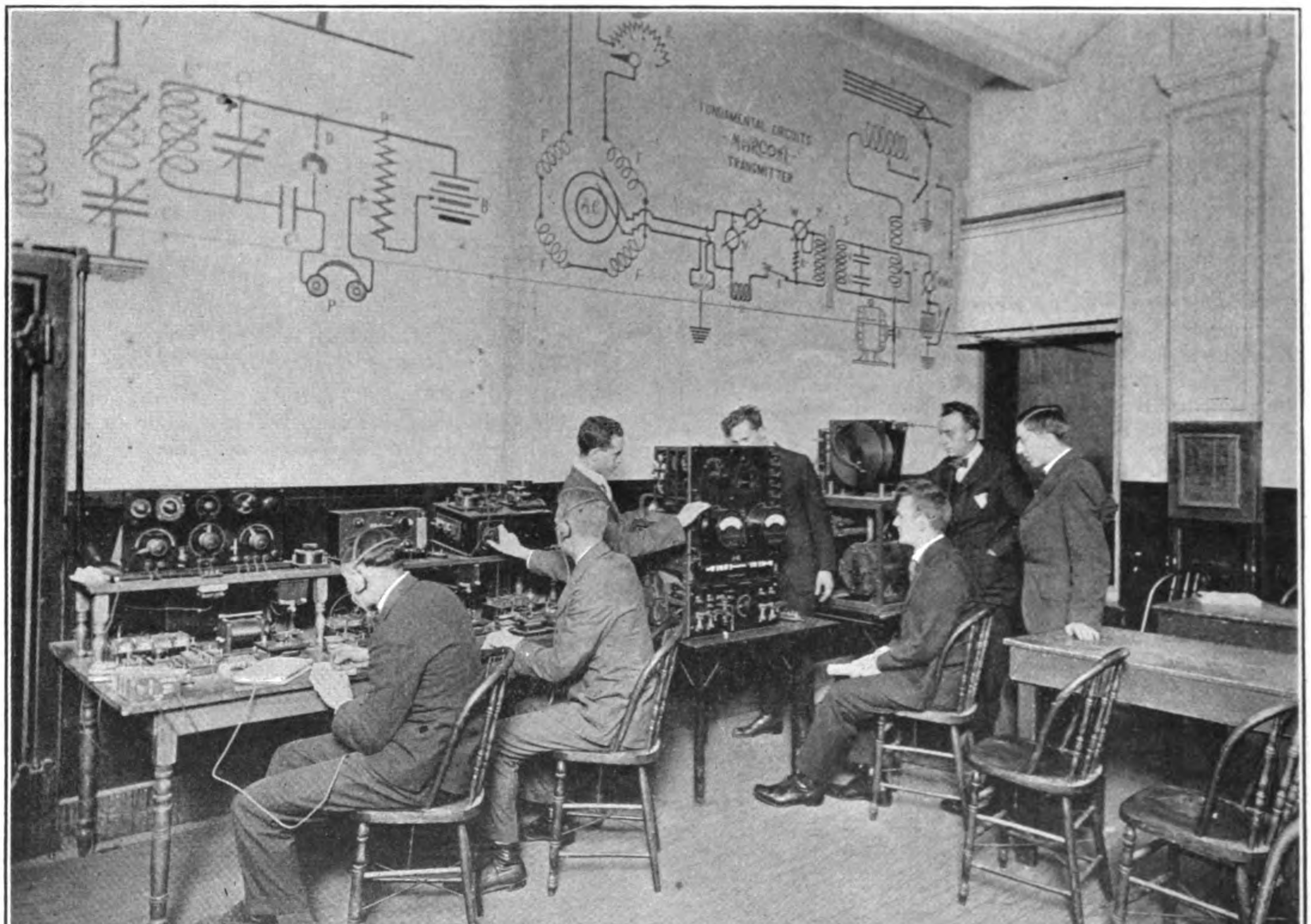
In applying to the receiving process the principle which is expressed in the one word "balance," the writer conceives the working of the mental apparatus in the same manner he would of a system of telegraphic machinery in proper relation and coordination. As a matter of fact, "in balance" is the term applied by technical men to such frictionless interworking of the telegraphic system. The whole will not balance if a part has been neglected. Moreover, the assembling of the apparatus must be done systematically.

The sequence of instruction given the beginner in telegraph receiving should likewise be systematic. Receiving is a process of taking on one conception after another; then of tucking them away—through the effort made by practice—in that part of the mind where are stored the things one knows so well they function without conscious effort. Not until the ideas of any particular stage function without conscious effort is the receiver "in balance" at that particular stage. The test of the student's right to progress from one stage to another should be whether he has learned to fulfill the requirements of each stage with a minimum of conscious effort.

In the first stage, there must be the correct conception of the letters "A" to "Z," for instance. Throughout all the intermediate stages, to the point where the radio man can detect cipher combinations through heavy interference, or to the point where the speedy press telegrapher, working with Phillips Code, will associate, for example, the letters "az," as sent, with the word "applause," the process of receiving is one of taking on and tucking away a sequence of correct conceptions.

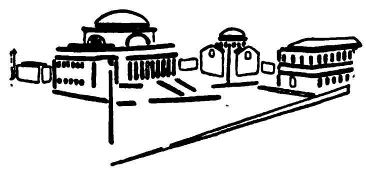
The duty of the code instructor, as the writer sees it, is to render the student's progress as free as possible of needless handicaps. Further, the instructor should lay out a system of practice material. It is the writer's opinion, based upon experience and demonstration, that this system should be built around the principle laid down in the foregoing; governed by the law of the code as stated, and its corollary, and arranged in recognition of the four stages of progress which have been specified.

In next month's article the writer will present an arrangement of exercises which he believes will help the beginning telegrapher as much as any prepared system can help. Primarily, in code as in everything else, the burden of achievement rests upon the individual.



Instruction in the adjustment of wireless receiving apparatus is given in the Marconi Institute during the period in which the students are perfecting their skill in receiving the code messages. In the photograph above members of an advanced group are shown operating various types of receiving apparatus, the nature of war service in which they will soon engage requiring familiarity with marine sets of varying powers from battleship equipment to submarine and Signal Corps apparatus for land and airplane use.

Progress In Radio Science



Marconi's Improved Radio Transmitter

READERS of THE WIRELESS AGE are already familiar with the apparatus developed by G. Marconi for the production of continuous oscillations by over-lapping wave trains. This system has proved most effective for long distance communication at high power. It has done away with many of the intricate mechanical and electrical problems encountered in the construction of radio frequency alternators or arc transmitter system. Moreover it makes an apparatus capable of generating damped oscillation at any spark frequency desired.

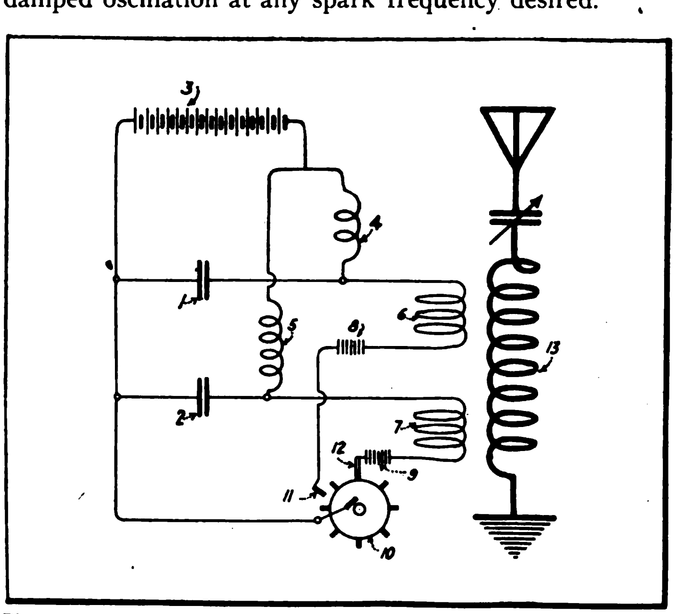


Figure 1—Circuit showing improved method of producing continuous oscillations by overlapping wave trains

In this system a number of spark discharges are made to occur successively in such a way, that the resulting trains of oscillations induced in the antenna circuit, overlap in synchronism. This results in the flow in the aerial circuit of oscillations of constant amplitude.

Numerous circuits have been devised by Marconi to carry out this fundamental idea, among which those shown in figures 1, 2 and 3 stand out prominently. The apparatus shown in figures 2 and 3 are modifications of figure 1.

In these diagrams, 1 and 2 are two high voltage condensers which are charged from the same source of current 3 (usually a direct current dynamo or a large storage battery), to inductance 4 and 5 respectively. These condensers discharge through primary coils 6, 7, the quenching spark discharges 8 and 9 and a disc discharger 10.

The electrodes 11 and 12 belonging to the condenser circuits 1, 6, 8 and 2, 7, 9 respectively are so arranged that discharges take place from 11 and 12 to the disc studs alternately at regular intervals and the interval between the commencement of the discharge of one condenser and the commencement of the discharge of the next condenser should be equal to or an exact multiple of the period of the aerial and intermediate closed circuit assuming that 6 and 7 are wound in the same way; if, however, they are wound in the opposite way, the interval should be equal to or an odd multiple of the half period. The primary coils 6 and 7 are coupled to a common secondary 13 which forms part of an aerial circuit.

The inductances 4, 5 should be large compared with inductances of the other parts of the circuits, but should, of course, not be so large as to prevent the condensers being sufficiently charged in the time available.

Figure 2 shows a modification in which a single inductance 14 through which both condensers discharge is employed, instead of the two separate inductances 6 and 7. This inductance is not coupled directly to the aerial but to an intermediate oscillating circuit 141 which is itself coupled to the aerial.

Figure 3 shows a modification in which each discharge circuit includes a spark gap which is of such nature that the normal working potential will not spark but which is capable of being ionized by a second or trigger spark, which by reason of the shortness of its wave length and also because its circuit has little interaction with other circuits gives more accurate timing than is possible with the dischargers in the main circuits.

The main condensers 1 and 2, which are charged from

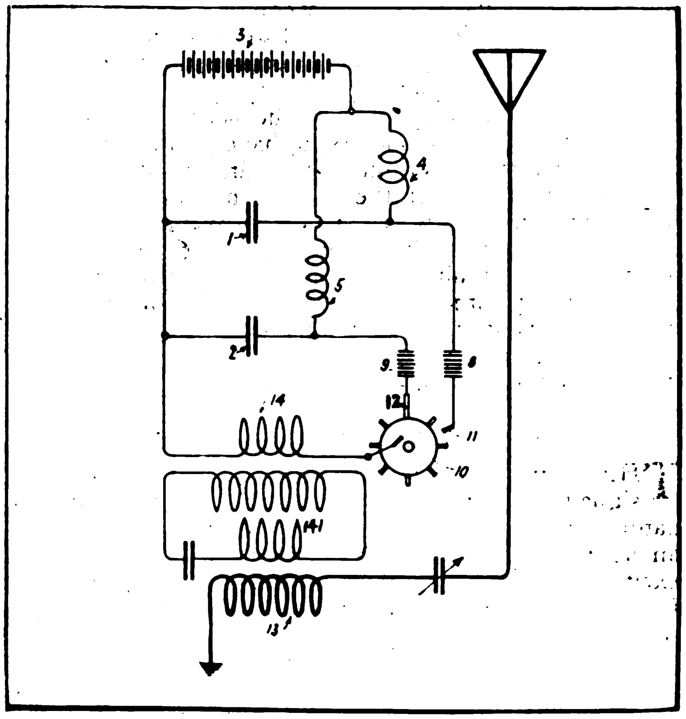


Figure 2—Modified circuit of figure 1

the high tension battery 3 or other source of supply through inductances 4 and 5, discharge through primary coils 6 and 7, quenching arrangements 8 and 9, the secondaries 15 and 16 of two small oscillation transformers and electrodes 11 and 12, respectively, to the main disc 10.

Auxiliary or trigger condensers 17 and 18, which are small in comparison with 1 and 2, are charged through suitable inductances 19 and 20 from a high tension battery 21 or other source of supply. These condensers discharge through the primaries 22 and 23 of the small oscillation transformers, and electrodes 24 and 25, respectively, to a trigger disc 26.

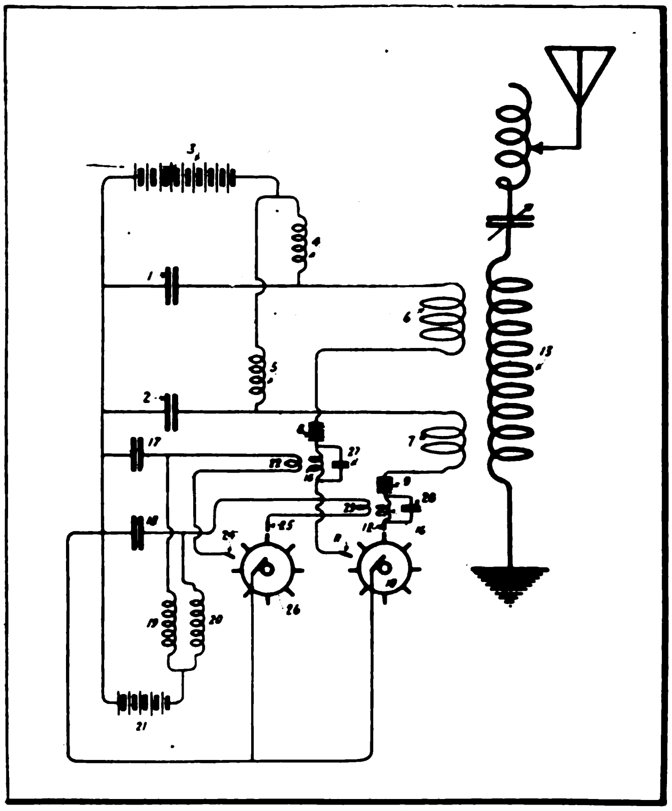


Figure 3—Showing the use of a trigger spark

This trigger disc is preferably coupled to the main disc 10 and the electrodes are arranged so that when a stud on 10 is opposite 11 or 12 a stud on 26 is opposite 24 or 25, respectively. The main circuits 1, 6, 15 and 2, 7, 16 are both coupled and tuned to the aerial circuit. The trigger circuits 17, 22 and 18, 23 have preferably a very much higher frequency than the main circuits; the secondaries 15 and 16 of the oscillation transformers are preferably shunted by small condensers 27, 28 placed across them and the circuits 15, 27 and 16, 28 are tuned to the trigger circuits 17, 22 and 18, 23, respectively.

Immediately either condenser 17 or 18 discharges, a high potential is induced in the oscillation transformer secondary 15 or 16 causing a spark at 11 or 12 thus allowing the main condenser 1 or 2 to discharge.

A Novel Radio Telegraph Aerial

THE ordinary receiving aerial responds best to radio signals, the frequency of which coincides with its natural frequency. It has also been observed that such an aerial system will oscillate at its own period when excited by electro-magnetic waves having a widely different period. This is particularly true when such electro-magnetic waves emanate from nearby powerful transmitters or are the result of atmospheric electricity.

Roy A. Weagant, chief engineer of the American Marconi Company, has made an exhaustive investigation of this phenomenon and he believes it to be due to the distributed capacity, inductance, and resistance of the aerial. He has found that by placing a series of coils in the antenna from the earth to the free end, the aerial takes on a characteristic which permits it to respond only to radio signals of the frequency to which the complete antenna system is tuned.

By adopting this construction he was enabled to eliminate the interference of transmitting stations operating on short wave lengths located in proximity to the large receiving aerial employed by the Marconi Company in transoceanic communication.

The fundamental construction is illustrated in figure 1, and a modification in figure 2. In figure 1 a series of inductance coils i, preferably of equal dimensions, and placed at substantially equal distances apart, are inserted in the antenna system. The usual receiving transformer is indicated by the primary coil 10 and the secondary coil 11. The presence of the coils i in the receiving antenna impart to it a fundamental oscillating characteristic, which blocks out oscillations of higher frequency than those which it is intended to receive.

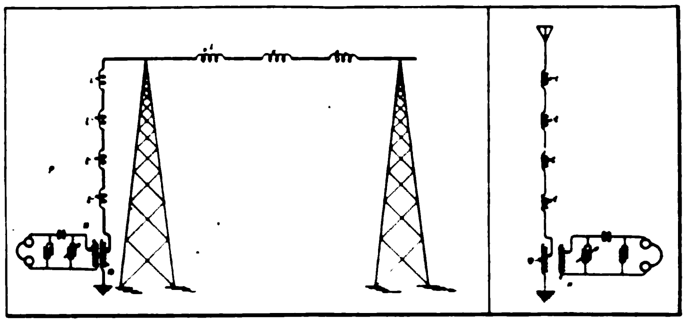


Figure 1 (right)—Showing new type of aerial with series of coils inserted
Figure 2 (left)—A modification of figure 1

In the ordinary aerial system, the antenna can be set into oscillation at its own natural period, either by the repeated application of minute impulses at the frequency of the antenna, or by shock excitation such as might be caused by one or more uni-directional impulses or oscillatory impulses of relatively great strength, but at a frequency differing from that of the natural frequency of the antenna.

Mr. Weagant declares the construction as in figure 1 to be so effective in this respect, that it became possible at the Marconi factory in Aldene, N. J., to receive signals transmitted direct from Nauen, Germany, with the ordinary factory antenna while the operation of testing transmitters in the factory building was going on. The inventor mentions that this aerial is most effective in the reception of continuous oscillations.

Method for Exhausting Vacuum Tubes

AS mentioned in previous articles it is highly desirable that the anode of a three-electrode vacuum tube be heated during the exhaustion process to free it of all occluded gases.

In the construction of vacuum tubes in which it is desired to maintain a high vacuum, it has been found that unless the electrodes and walls of the vessel have been subjected to a vigorous preliminary treatment, the gases retained by them will slowly leak out with the result that the vacuum is soon decreased and ionization by collision with the gas molecules can then take place.

This preliminary treatment is usually carried out by heating the walls of the vessel externally, and by directing a stream of electrons towards the anode or plate. These electrons upon striking the anode liberate all ionizable matter which may be removed in the pumping process.

To do this effectively it is essential that the energy of the striking electrons shall exceed their velocity during normal operation of the vacuum tubes.

An apparatus has recently been devised by Ellsworth Buckley, which provides for heating the anode by vigorous bombardment of electrons without endangering the cathode (or filament), this being the method by which gases are driven from the plate.

It has been found that in preparing vacuum tubes it is not allowable to draw from the cathode a much larger current than is used in normal operation, for the effect of that treatment is to disintegrate the cathode. The present invention insures that the electrons striking the anode shall do so under the influence of a large voltage and consequently with large kinetic energy, while at the same time this large voltage is not able to draw more than normal current from the cathode.

In a thermionic device of the type described, if the potential of the auxiliary electrode is made negative with respect to the cathode a larger voltage between anode and

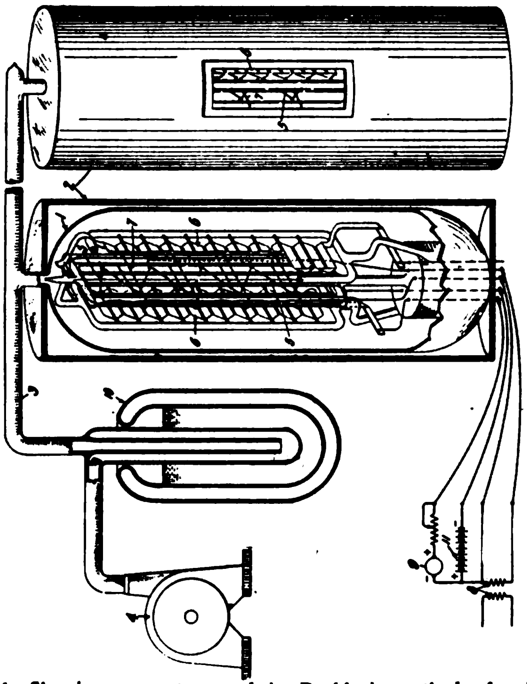


Figure 1—Showing apparatus used in Buckley's method of exhausting vacuum tubes

cathode is necessary to produce the same current from the cathode as would appear in the absence of such a voltage applied to the auxiliary electrode. But the kinetic energy of the electrons striking the anode increases with increased voltage, and it is therefore possible by applying a negative potential to the auxiliary electrode, to increase the voltage effective in driving electrons to the anode very much above the normal value, while maintaining the current at its normal value. By this process vigorous bombardment of the anode is possible without drawing more than normal current from the cathode.

Buckley's process will be more completely understood in connection with the drawing figure 1, in which 1 represents a vacuum tube of the usual type consisting of an evacuated vessel containing cathode 5, anode 6 and an auxiliary electrode 7. This vessel is inclosed in an oven 2 which may be heated externally. The glass tubing 3 serves to connect the tube with a molecular pump 4 or other suitable means for exhausting it. The liquid air-trap 10 is included in this line of tubing for the usual purpose. The filament 5 is heated by means of alternating current furnished to it through the medium of the transformer 8, whose primary winding is energized by means of the source of alternating current, not shown in the drawing. The voltage between anode and cathode is supplied by means of the direct current generator 9, while the electromotive force required to maintain the auxiliary electrode negative with respect to the cathode is obtained from the battery 11, whose negative pole is connected to the auxiliary electrode.

During the process of evacuation the pump is operated, the filament heated and a discharge started between anode and cathode. The battery 11 is then applied and the voltage of the generator 9 increased. The current through the tube is adjusted to approximately normal value and the bombardment of the anode at the increased voltage is continued until no evidence of gaseous ionization in the tube can be detected.

As an example of the voltages employed in one type of tube, it has been found that in the early part of the process a maximum of about 200 volts can be maintained between the cathode and the anode. By applying 110 volts between the cathode and the auxiliary electrode making the latter negative, a maximum of 500 volts or more may be obtained with consequent more rapid release of gas from the anode. In the later stages of exhaust a potential difference of 750 volts or more may be maintained by the use of the negative auxiliary electrode, while if that electrode were disconnected it would not be more than 550 volts.

A Combination Circuit for Tube and Crystal

THE English Marconi Company has developed a novel circuit for the combined or individual use of the vacuum tube and the crystal rectifier. The scheme of connections is shown in figure 1. C is short wave condenser, L is the antenna inductance, L-1 a coil which acts as a primary winding of a receiver tuner for use with the crystal detector D, or as a regenerative coupler for amplification by the vacuum tube. L-2 is the secondary of the tuning transformer for use with the crystal or a tuning element of the plate circuit for regenerative coupling in connection with the vacuum tube. C-1 is the plate circuit tuning condenser. D is a carborundum rectifier, P-1 a potentiometer, B-2 the plate battery, T a telephone transformer and P-2 a pair of low resistance telephones.

It will be clear, from close observation of the diagram, that if the filament F of the vacuum tube is cold, the crystal detector D alone may be employed to detect spark signals. L-1 is then the primary of the tuning transformer and L-2 the secondary. If, on the other hand, amplification of the incoming signal is desired, the filament F is brought into play. The grid

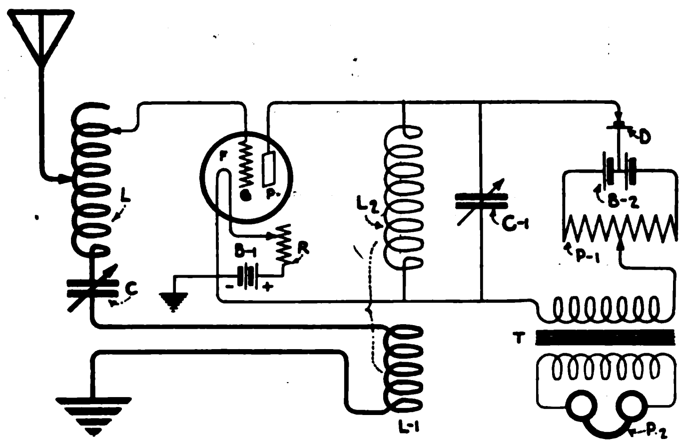
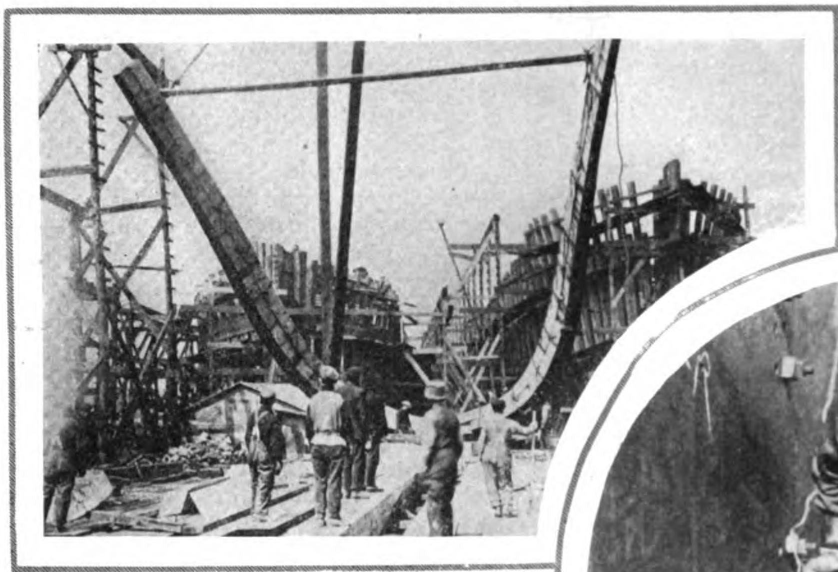


Figure 1—Circuit for the combined or individual use of vacuum tube and crystal rectifier

element G is then connected to the antenna inductance L and by suitable adjustment of the reaction L-1, L-2 and of the grid circuit potentiometer P-3 the circuits of the tube will be set into self-oscillation. The apparatus then receives by the phenomenon of beats or by careful adjustment of L-1 and L-2. Amplification of the incoming signal can be secured without the beat phenomenon.

There is thus provided a receiving apparatus which is independent of the vacuum tube, for should it become inoperative, such as by burning out of the filament, signals can still be received by the crystal detector alone. For longer distances, the vacuum tube circuits are brought into action for amplification. The apparatus clearly is responsive to undamped waves as well as damped waves.



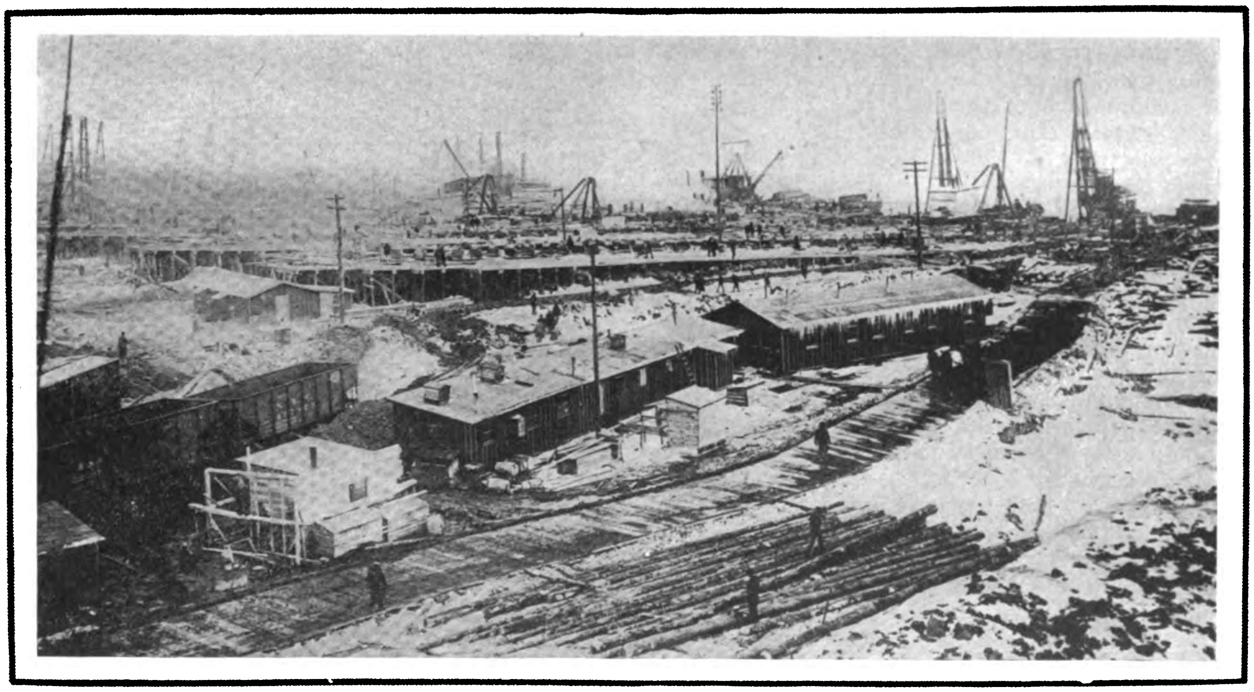
Photos: Underwood & Underwood

Building Ships for Uncle Sam

To the left, a shipyard scene as the first frame or rib of one of the standardized wooden vessels is raised in view of two partially completed sister ships

Above, in circle, one of the riveters with his electric machine endeavoring to maintain the high speed of his crew, record breaking which has astonished the world being a daily occurrence with these loyal workers

To the left, an underneath view of the belly of a wooden ship showing the calking of her seams in progress. So well are these wooden vessels constructed that Lloyds' give them an insurance rating as high as steel craft



A glimpse of the famed Hog Island shipyard, the largest in the world, though but 9 months old

Wartime Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE I

EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic.*

CONTINUOUS WAVE GENERATORS
DECREMENT AND TUNING

(1) The apparatus heretofore described in this series of lessons dealt with the transmission and reception of radio telegraph signals by means of damped oscillations. In the systems under consideration, these oscillations were produced principally by the **periodic discharge of a condenser through an inductance across a spark gap.**

(2) To insure selectivity, that is, discrimination between stations operating on nearly the same wave lengths, it is desirable that the **oscillations** in a wave train be **slowly damped out,** that is, the rate of decay must be reduced to a minimum.

(3) The United States Laws decree that the minimum damping of two successive oscillations must be .2 or less; that is, **the logarithm of the ratio of the amplitude of one oscillation to the next oscillation in a wave train must be .2 or less.**

(4) It has been shown that if the damping decrement of a wave train is known, the number of oscillations per wave train (assuming they have died out when amplitude of the last one is .01 of the first one) can be obtained from the following formula:

$$M = \frac{4.605 + \delta}{\delta}$$

where δ = the logarithmic decrement.

Thus a decrement of .2 corresponds to approximately 24 complete cycles in the antenna current for each spark discharge and similarly a decrement of .01 to 46 complete cycles.

(5) Modern wireless telegraph transmitters radiate wave trains the decrement of which is often as low as .03 per cycle corresponding to 150 or more oscillations in the aerial circuit for each spark discharge in the closed circuit.

(6) **When the decrement of a transmitter is low a slight change of inductance or capacity at the receiving station will eliminate the signals.** The factor of selectivity is accordingly high. On the other hand, **if the decrement is high, a relatively large change of inductance or capacity is required at the receiver to eliminate the signals.** The factor of selectivity is accordingly small.

(7) The desired low damping of the aerial currents in a radio transmitter is secured by the employment of a spark gap giving good **quenching** effects. The reaction of the aerial circuit on the spark gap circuit during the building up of the aerial oscillations is thereby prevented, permitting the aerial currents to decay at the natural damping of the antenna circuit. The insertion of loading coils at the base of the aerial aids in lowering the decrement.

(8) The sharpness of tuning or the adjustment for resonance in two coupled circuits is limited by the sum of two decrements, that of the impressed E.M.F. and that of the circuit being driven. The same applies to a radio transmitter and receiver. Hence it is obvious that a **transmitter employing undamped or continuous oscillations gives greater selectivity** than the damped system, for it is evident that the undamped or continuous oscillations possess no decrement. (Slight inequalities of amplitude exist in most continuous wave generators.)

(9) One of the great advantages of the continuous wave generator in radio telegraphy is the **syntonic** or **resonance** effects secured at the receiver, and, moreover, owing to the new principles of reception which such transmitters bring into play, the range of transmission has been remarkably increased.

(10) It should be known here that previous to the advent of the **vacuum tube generator** for continuous waves, a reliable short wave continuous oscillation generator was not available. The most commonly used undamped oscillation generator heretofore was the **arc generator**, which will not function uniformly at wave lengths below 1000 meters, the best results being obtained at frequencies corresponding to wave lengths above 3000 meters. The vacuum tube generators, on the other hand, will function at frequencies from **a cycle per second up to several millions.**

PROBLEMS INVOLVED IN THE RECEPTION OF CONTINUOUS AND DISCONTINUOUS WAVES

(1) It is frequently of advantage to make a comparison of the continuous and discontinuous wave system in respect to the methods of reception.

(2) Since the **telephone** is almost universally used to record radio telegraph signals, it is convenient to consider the problems of reception from the standpoint of this piece of apparatus. It has been established that a **current which impulses the diaphragm of the telephone receiver from 100 to 1000 times per second gives the maximum response, with a given current.**

(3) In the discontinuous wave transmitter the currents induced in the receiving apparatus are already modulated at an **audio frequency** by the charging current at the transmitter, but it is plainly evident the energy radiated by a continuous wave generator will produce no effect on the receiving telephone because, for example, if a rectifier is connected in the receiving circuits the telephone diaphragm will be impulsed by direct current pulses occurring at radio frequencies.

(4) **Radio frequency currents in excess of 20,000 per second will not give audible response in a telephone, but a rectified radio frequency current if broken into groups of say 200 to 1000 per second will give audible response with a minimum of current.**

(5) In the case of the reception of undamped oscillation, we are compelled to break up the incoming currents at the receiving station into audio frequency groups either by **mechanical** or other means.

(6) The **tikker** and the **slipping contact detector** are simple circuit interrupters arranged to vary the incoming currents at the receiving station at audio frequencies. The **tone wheel** is a form of tikker which is in reality a partial rectifier producing audio frequency telephone currents. The **beat receiver** produces audio frequencies by the interference of two radio frequency currents, one of which is generated locally and the other, the incoming signal.

When this method of reception is combined with the amplifying properties of the vacuum tube enormous distances of transmission are possible

TYPES OF CONTINUOUS WAVE GENERATORS

(1) The most commonly used type of continuous wave makers are:

1—The Poulsen Arc generator.
2—The Vacuum Tube generator (sometimes called the bulb transmitter).

The other types are:

1—Alexanderson Radio Frequency Alternator.
2—Goldschmidt's Radio Frequency Alternator.
3—The Multiple Frequency Transformer system.
4—The Over-lapping Wave Train system (Marconi System.)

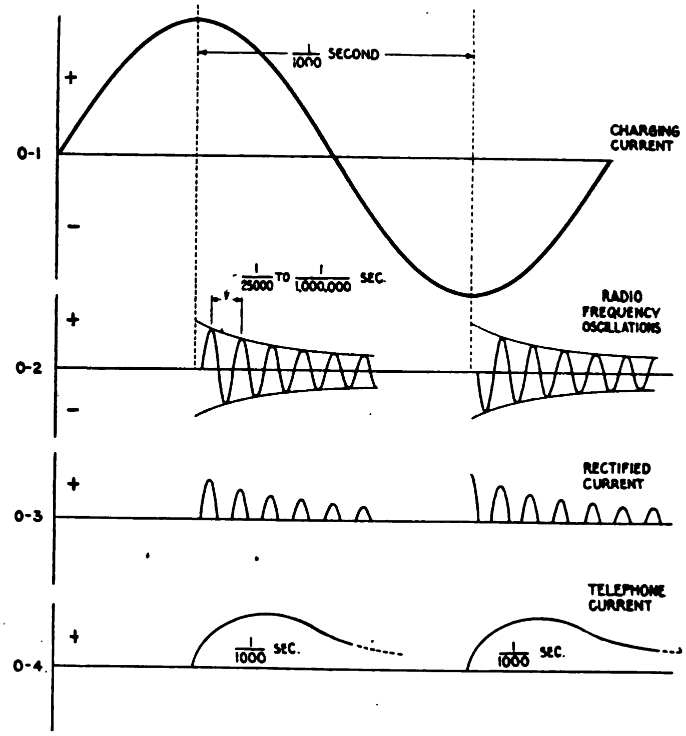


Figure 181

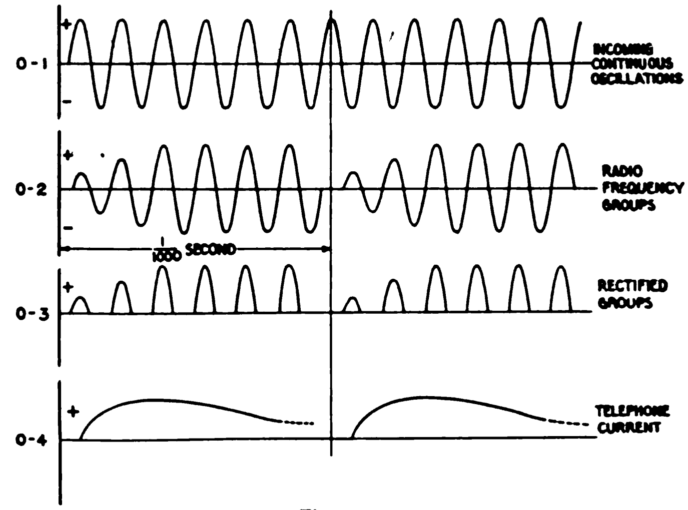


Figure 182

OBJECT OF THE DIAGRAM

To show graphically the fundamental principles involved in the transmission and reception of wireless telegraph signals by means of apparatus for the production of damped oscillations.

DESCRIPTION OF THE GRAPHS

Graph O-1 shows the audio frequency charging current applied to the high voltage condenser in the closed oscillation circuit of the transmitter; graph O-2 the resulting radio frequency currents induced into the antenna circuit of the transmitter which also may be taken to indicate the currents impressed across the oscillation detector (crystal rectifier) at the receiver; graph O-3 the rectified currents in the receiving circuits, and graph O-4 the approximate telephone current.

OPERATION

The frequency of the condenser charging current at the transmitter is assumed to be 500 cycles per second, and since in a **synchronous gap transmitter the condenser is charged and discharged once for each alternation of the charging current**, the spark frequency will be 1000 per second.

Each discharge at the spark gap will induce in the antenna circuit a **group of radio frequency currents,** such as shown in graph O-2. It should be noted that the time period of one alternation of the charging current is 1/1000 of a second, whereas the time period of a complete cycle of the resulting radio frequency currents may vary in commercial practice from 1/25000 to 1/1000000 of a second, depending inversely upon the square root of the product of the inductance and the capacity of the circuit.

Currents of the same frequency will be impressed across the oscillation detector at the receiver, where they are rectified, giving (assuming perfect rectification) the uni-directional pulses shown in the graph O-3. **These pulses occur at rates above audibility** (for it must be remembered that the telephone will not give audible response to radio frequency currents), but since they have the same general direction the telephone diaphragm responds to an average effect as shown in the graph O-4.

SPECIAL REMARKS

(1) It is evident from the foregoing that a 500 cycle synchronous transmitter will give 1000 spark discharges, per second and **each spark discharge will induce in the transmitting**

(Continued at bottom of second column)

OBJECT OF THE DIAGRAM

To show the problems involved in the reception of continuous oscillations such as may be generated, for example, by a radio frequency alternator, and to offer a comparison of the continuous wave system with the discontinuous wave system.

PRINCIPLE

Because the wave motion radiated by a continuous or undamped wave transmitter is not broken into groups, as in the discontinuous or damped wave wireless system, it becomes necessary to interrupt the incoming currents at the receiving station at audio frequencies in order to secure the maximum of response from a telephone diaphragm with a minimum of current.

DESCRIPTION OF THE DRAWING

Graph O-1 shows a **train of incoming continuous oscillations** such as flow through the receiving circuits of an undamped wave receiver. Graph O-2 indicates the **resulting groups of radio frequency currents** when the incoming currents are interrupted mechanically, such as by use of the well-known tikker. Graph O-3 shows the **rectified groups of radio frequency currents** resulting if a rectifier is employed in connection with the tikker, and **graph O-4 the resulting telephone current.**

SPECIAL REMARKS

(1) The graphs indicate only the results secured by the combined use of the tikker and crystal rectifier, but somewhat similar effects are obtained from the beat receiver (heterodyne or beat system, as it is sometimes called), to be described further on.

(2) It is to be noted that the telephone current is approximately the same in the graphs in Figures 181 and 182.

(Continued from first column)

aerial a group of radio frequency currents. Each group will radiate a **train of waves.** A 500 cycle transmitter will, therefore, radiate into space 1000 of wave trains.

(2) Following the actions to the receiver, it is seen that each spark discharge at the transmitter eventually sends a **pulse of direct current through the receiver.** Therefore, 1000 sparks at the transmitter will deflect the diaphragm of the receiver telephone 1000 times and **the pitch of the note emitted by the telephone diaphragm** will be substantially the same as that of the spark discharge at the transmitter.

(3) This accounts for the use of 500 cycle currents in spark radio telegraphy, for they impulse the telephone diaphragm at such rates as to cause it to emit musical sounds.

Two advantages are derived in the use of high spark frequencies:

(a) The telephone gives maximum response when it is impulsed at rates near to 1000 per second.

(b) It is less difficult for the operator to distinguish between wireless telegraph signals and the interfering discharges of atmospheric electricity.

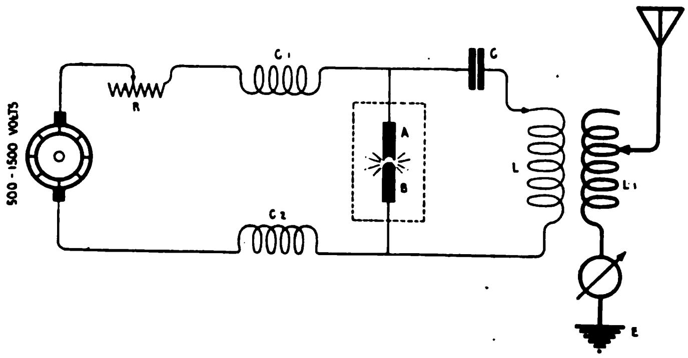


Figure 183

OBJECT OF THE DIAGRAM

To show the **fundamental circuits** of the **Poulsen arc generator.**

PRINCIPLE

Because of the "falling characteristic" of the D.C. arc, in other words, its instability, an inductance-capacity circuit may be shunted across the arc for the production of continuous oscillations.

DESCRIPTION OF THE DRAWING

The arc gap is represented by the **copper** and **carbon electrodes** A and B. The gap is energized by the D.C. generator at voltages from 500 to 1500 volts. R is a ballast or **regulating resistance.** C-1 and C-2 are **iron-core choke coils** to prevent the radio frequency currents flowing in the circuit L, C, AB, from discharging back into the generator. C is the **condenser** and L the **primary inductance** of the oscillation transformer. L-1 is the **secondary inductance** connected in series with the antenna as usual.

OPERATION

The functioning of the arc generator for the production of continuous oscillations can be explained in the following way, but it must be understood that the mode of operation under some adjustments are very complex and require classification, in other words the arc is capable of **generating several types of oscillations,** certain of which are desirable and others distinctly undesirable.

It is to be understood that the **gaseous section** of the arc **does not possess constant resistance,** and it, therefore, does not obey Ohm's law, that is:

> **(a) If the potential difference across the arc is high, its resistance is large and the flow of current is relatively small.**
>
> **(b) If the potential difference across the arc is low, its resistance is low and accordingly the flow of current is relatively large.**

In the region of current flow corresponding to the conditions in (b) the arc is unstable and unless a balancing resistance be inserted in the supply leads from the D.C. generator, the arc will become a short circuit.

It is clear from (a) **that a small increase in potential difference across the arc results in a small decrease in the arc current.** Since this phenomenon is the reverse to that encountered in ordinary circuits whose resistance is constant, the arc is often spoken of as a **negative resistance.**

In the case of the Poulsen arc generator, the operation of the closed circuit in practice is assumed to be as follows, but it should be added that it is doubtful whether this sequence of events remains strictly constant throughout an operating period.

(1) Assuming the arc to be in operation and the condenser connected in shunt: The condenser accumulates a charge, thereby robbing the arc of some of its current.

(2) The decrease of current through the arc in accordance with (a) above corresponds to increased potential difference across the arc.

(3) The condenser therefore continues the charge until the arc voltage becomes stationary.

(4) The condenser then discharges through the arc, increasing the arc current.

(5) In accordance with (b) above, the arc voltage therefore decreases and it thereby assists the discharge of the condenser.

(6) The discharge current from the condenser through the circuit L, C, AB, operates, as in any oscillation circuit, to recharge the condenser in the opposite way.

(7) When the condenser now discharges, its current flows against the current of the arc, and if the condenser current is equal to the arc current the arc goes out.

(8) The condenser cannot therefore complete its discharge, but the supply current is now diverted from the arc and hence it acts to oppose the residual charge in the condenser reducing it to zero.

(9) The supply current then acts to recharge the condenser in the way mentioned at the beginning, that is, it charges the condenser to the voltage necessary to re-ignite the arc discharge, whereupon the cycle of operations is repeated.

(10) The frequency of the resulting oscillations will only approximate that to be expected from the values of L and C. This is due to the fact that the time between the reduction of the arc current to zero and the commencement of the next discharge depends upon the rapidity with which the supply current can recharge the condenser. The arc is therefore apt to oscillate at a fundamental and several harmonic frequencies.

SPECIAL REMARKS

(1) As mentioned previously, several types of oscillations may be generated by the arc system. It is usual to classify them as types I, II, III. Type I represents the case where the **oscillation current is always less than the arc current;** type II, where the **condenser current is the same as the arc current;** type III, where the **condenser current is greater than the arc current.**

Type I oscillations are generally of little importance as the efficiency of conversion is low. Type II oscillations are assumed to be those encountered in the practical operation of the Poulsen arc. The resulting oscillating current is partly a sine wave alternating current and partly a D.C. current. Type III oscillations (due to the lag in the cooling of the arc gap) causes an actual reversal of current across the arc, and the condenser is therefore not recharged by the supply dynamo until the oscillating current has gone through a few swings; in other words, in a circuit where type III oscillations exist, there results groups of damped oscillations much similar to those obtained in spark radio telegraphy.

(2) It is found that the best results are obtained when the **direct current voltage is from 500 to 1500 volts** and the **positive arc electrode is rapidly cooled.** Water is generally circulated through the positive electrode, which is hollow and of copper. The rapid cooling of the arc assists in producing energetic oscillations because it allows the arc to die out rapidly and shortens the time of the condenser charging period.

(3) Increased efficiency is secured, that is, more energetic oscillations are obtained by surrounding the arc with **hydrogen gas.** The gas assists in cooling the ionized vapor between the arc electrodes. **Illuminating gas, alcohol, ether** or **steam** can be used in place of hydrogen.

(4) The oscillations are made still more vigorous by the application of a **magnetic field at right-angles to the arc.** The action of this field is to **deflect the arc to one side,** thereby **increasing its length and consequently the potential difference.** The magnetic field also assists in **blowing out** the conducting ions formed in the gas, thereby increasing the potential difference between the electrodes. This has the effect of giving the condenser an increased charge.

(5) Satisfactory operation is secured only by establishing the correct relation between the **strength of the magnetic field,** the **arc current** and the **length of the arc.** These adjustments are obtained by experiment.

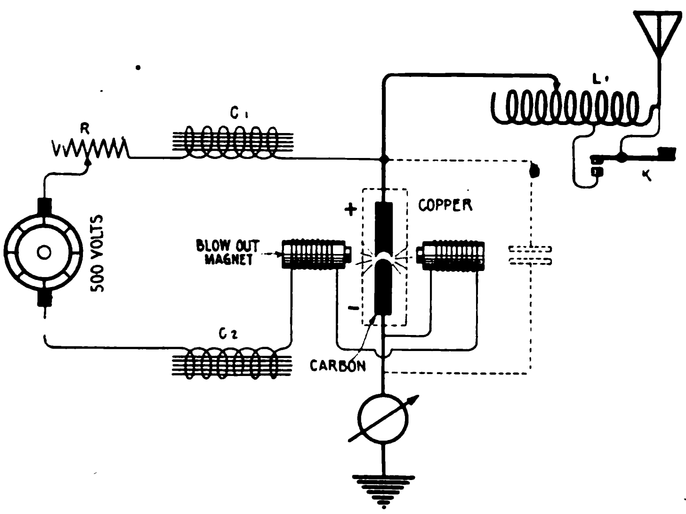


Figure 184

OBJECT OF THE DIAGRAM

To show the fundamental circuits of a modern arc transmitter.

DESCRIPTION OF THE DRAWING

A 500 cycle D.C. dynamo supplies current to an arc gap consisting of a **positive electrode of copper** and a **negative electrode of carbon** enclosed in a **containing vessel** to which is supplied **hydrogen** or **illuminating gas.** In series with the supply mains are placed **powerful electromagnets** which are mounted at right-angles to the arc gap. The supply mains also include the **iron coke choke coils** C-1 and C-2, and a **ballast resistance** R, which prevents the arc from effecting a short circuit. The coils C-1 and C-2 help to maintain the supply current at a constant E.M.F. (there is some argument on this point, for it is believed that these coils act in some circuits to cause a potential difference across the condenser that greatly exceeds the voltage of the supply generator).

The important feature of figure 184 is that the arc gap is connected directly in series with the aerial circuit.

The length of the radiated wave is varied by the aerial inductance L-1.

Signaling is accomplished by means of the key K, which shunts a portion of the aerial tuning inductance; thus when the key is up the antenna radiates a short wave, and when the key is down it radiates a longer wave. If the receiver is tuned to the wave length emitted when the key is down, the signals that are radiated when the key is up will not be received; in other words, signaling is effected by changing the wave length of the radiated wave.

The function of the condenser (in dotted lines) shunted around the arc is to act as a bypass for the radio frequency currents of the aerial circuit, thereby avoiding the necessity of passing the entire antenna current through the arc.

SPECIAL REMARKS

(1) It is through the features shown in figure 184 that the arc transmitter has been brought to the degree of perfection required for commercial application.

These features are:

(a) Placing the arc in an atmosphere of hydrogen.

(b) Using a carbon electrode for the negative side and a water cooled copper electrode for the positive side.

(c) The employment of a transverse magnetic field.

(d) Slowly rotating the carbon electrode by a small motor (not shown in the drawing).

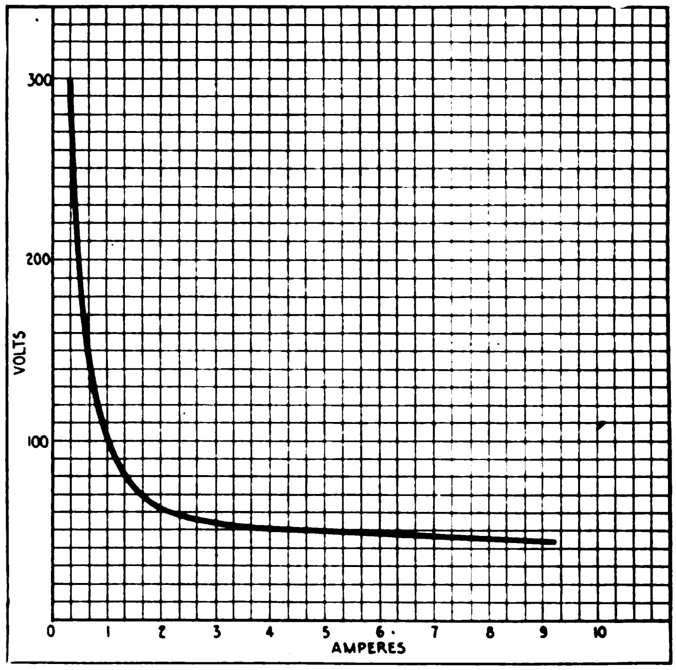


Figure 185—Showing the so-called static characteristic of the arc, that is, the relation between potential difference and arc current when D.C. current is applied to the arc gap. The important point to be observed is that large arc currents correspond to a small potential difference whereas small currents correspond to a high potential difference. This phenomenon is accounted for by the fact that if an increase of arc current is produced by increasing the E.M.F. from the source of supply, greater heat is produced at the negative electrode and therefore greater ionization. The increased number of electrons thus made available for conduction, results in increased conductivity or lower resistance. The supply E.M.F. is therefore enabled to cause an increased flow of current which continues and the voltage required to maintain the arc decreases towards a definite minimum.

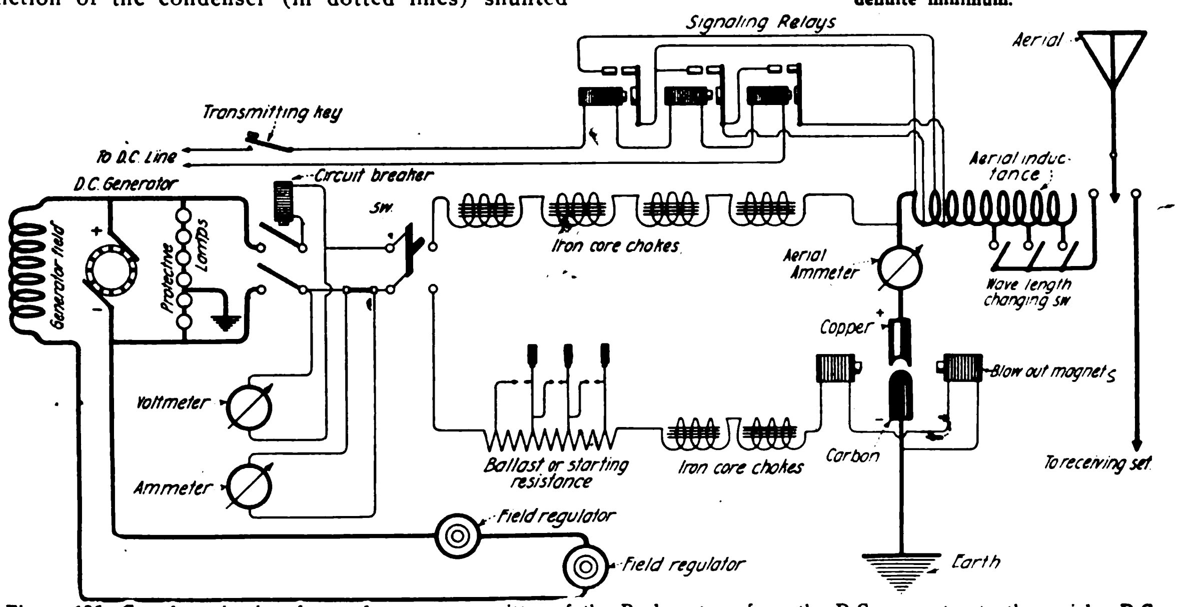


Figure 186—Complete circuits of a modern arc transmitter of the Poulsen type from the D.C. generator to the aerial. D.C. current at 500 to 1500 volts is fed to the arc gap by a generator with variable field resistance. The starting resistances permit regulation of the arc current for maximum efficiency and prevent short circuit of the generator during the preliminary adjustments. The iron core choke coils serve to protect the generator from the radio frequency current flowing in the antenna circuit. Protective lamps are connected across the generator and earthed as shown, four lamps in series on the positive side and two lamps in series on the negative side. Powerful blow out magnets are placed at right-angles to the arc gap. The arc discharge takes place in an atmosphere of hydrogen or illuminating gas. The wave length of the transmitter is varied by cutting in and out turns at the aerial tuning inductance. Maximum aerial current is observed by the aerial ammeter. Signaling is effected by magnetic relay keys which short circuit a portion of the aerial tuning inductance thereby changing the length of the radiated wave.

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

Eighteenth Article—Coast Defense Information in War

IN general it appears evident that the service of security and information in coast defense, as in the field, implies, first, the collection of military information or intelligence; second, its transmission; and, third, its correlation and use. In regard to the first of these elements it may be said that the **collection of information** is primarily the duty of the coast patrol, but in war becomes the duty of the mobile army, the fixed defenses, and of every man of the government service, both civil and military, and, indeed, of all people of the country. But although important information may thus come from many sources and, no matter what the source, should be transmitted to proper authority, yet incidental information, like incidental soldiering, is merely auxiliary to the organized service of information. The continued value of this service depends upon a properly organized corps of men who will transmit the reports of trained observers from the aircraft, signal, and observation stations, from lighthouses and other government establishments, from the floating auxiliaries and ships as well as from chance sources of information, and from the thousand watchers of the coast, upon all of whom reliance must be placed in war to collect that information upon which will depend the attitude of the defense.

But both judgment and experience in regard to the weight to be given this information will be needed by officers and men in charge of this service, and of its transmission, if a constant condition of unrest and excitement is to be avoided at inshore terminals. Who can doubt, for example, that information received at the centers of control will determine the attitude of the army of the defense in threatened areas, and perhaps its ability to prevent surprise or repel attack; that the news or no news, often equally important, from the coast will govern the preparedness and vigilance of the mobile troops and supports and keep the artillerymen at the guns or give them release; that, in short, a well-organized service provided with trained men skilled in the use and maintenance of lines of information will relieve the defense of the greater part of its strain in the absence of the enemy, multiply many times its efficiency in his presence, and permit the smaller force to do the work of the larger. While, on the other hand, an insufficient service of information, handicapped by slow, inaccurate, or faulty transmission, will plague and worry the defense with useless anxieties and alarms, if it does not even lead on to disaster.

British Off. Photo

Coast artillery fire control utilizes the searchlight for code flashing

The **transmission of information,** which is the second element of the service of security, is a duty of vital importance, which should be intrusted only to trained men under military control, supplied with the best known appliances for this service, and should never be left to the chance efforts of any irresponsible person who can use a telegraph key or a radio instrument. In other words, that the section of the coast guard to which **the duty of transmission of information is intrusted should be composed of men trained in naval and military signaling and familiar with the methods of the Signal Corps of the army.**

With the use that will be made of the information when received, which is the third element of the service of security, the patrol has no concern, since this will depend upon commanding generals, and the reception and correlation of reports upon staff officers at headquarters, presumably signal officers, whose duty it should be to formulate and weigh the information transmitted.

It appears that the coast patrol will become in the future one of the strongest arms of that service of security and information upon which so much dependence is necessarily placed in modern war. It follows, and it cannot be doubted, that this patrol or guard when organized should be thoroughly efficient in numbers, personnel, organization, and equipment, and that its men, who are frequently placed at lonely stations and required to act upon their own initiative, should be not only steady, well-disciplined soldiers, but in addition must be carefully selected, intelligent, and keen men, skilled as observers and trained in the use of the telegraph and of mechanical appliances. Besides all this they should possess that judgment which seldom blunders in its work. Fortunately for the country, men of this character are many in civil life and will be found in abundance when called, but these men must be trained as soldiers.

The work of installing the fire control was formerly performed by the Signal Corps of the army, and many of the types of instruments used have been designed

*This article is abstracted from General Scriven's tactical observations, contained in the complete volume, "Military Signal Corps Manual," by Major White.

or adapted by the corps. But in addition to the fire-control systems there must exist both within and without artillery districts the fifth factor of the coast defense, that is lines of information, whether electrical or visual, by means of which artillery headquarters are kept in touch with the interior of the country and with centers of control; the factors and elements of the defense are brought into co-ordination; fixed positions connected; and the district bound into a whole under control of its commander, as an army in the field is linked together and maneuvered by its general.

These units are, as a rule, separated from each other by considerable distances. Each headquarters, however, is kept in touch with the others electrically, mainly through the commercial systems of the country; but the commercial systems are, of necessity, frequently supplemented by military lines, which extend them to artillery headquarters.

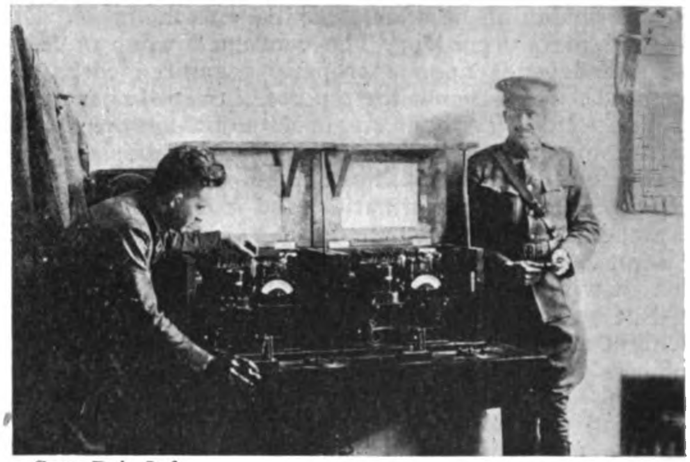
Press Illus. Svce.

For coast defense, means must be at hand for providing temporary lines of communication

In general, artillery lines of fire control and of information (except the field lines necessary in maneuvers) are, in peace, permanent in type; but in war to permanent lines are added a network of temporary systems as flexible and extensive as need be, and in character resembling those of an army in campaign. These may be more limited in extent, perhaps, but based on more stable conditions they are consequently easier to install and maintain against interruption by an enemy, except in the case of the radio. If interrupted, repairs are easier made, since the material should always be at hand at the fixed positions. But as with lines of information in the field, those of the coast defense, both permanent and temporary, must be certain and speedy. They will be more complicated and varied than is possible with the former, since they imply, in addition to land lines, systems of information extending both under and over the sea, and include in their scope every known method of transmitting intelligence from the wink of the ardois, the flash of the searchlight, the tick of the telegraph key, or call of the buzzer to the message of the long-distance radio and of the airplane or dirigible.

With the permanently laid lines of the coast defense transmission should, of course, be as efficient and satisfactory as in civil life if the systems are properly installed and skillfully operated in practice; but in order to secure these results it is evident that the ponderous permanent systems of the fixed defenses, both fire control and information, cannot be thrown out in an hour like the wires of a marching army, but must be carefully planned and constructed in advance as the defenses themselves are planned, must progress to completion with them, and when in place must be proof against reasonable probability of interruption.

Temporary lines will, of course, be installed only when demanded by the exercises and maneuvers or by the exigencies of war. Nevertheless, the means of providing them should be at hand within each artillery district, so that when needed field telegraph and buzzer lines may be laid easily, quickly, and without confusion from district headquarters to the supports, mobile troops, to headquarters and observation stations of the coast patrol. The telegraph and telephone, radio sets and visual appliances should be in readiness for use in the exchange of signals between the fixed positions and coast-defense ships, patrols, picket boats, and scout ships, as well as torpedo planters and the cable ship when necessary, and with the navy. The field telephone should be ready to tell its story from observation stations and the airplane and dirigible should be at hand to send by radio or visual signals their messages from land or sea. Thus the temporary lines of artillery districts will include many aerial systems, and even the permanent communications will not be electrical alone. Both will depend largely upon the auxiliary, but still very important, class of visual and oral signals, which before the introduction of the radio telegraph were the only means known of exchanging ideas without material connection. Visual signaling is probably more important in coast defense than with the army in the field and is vital when communication is needed between ships and shore and the radio is silent. Whether all the signal apparatus outlined will be used by the defense is another matter; still the possibility exists, and the fact remains that opportunity should be given those who have control to employ every method of transmitting information that may prove reasonably valuable. To do this it is necessary that signal appliances of all useful kinds be stored in depots within artillery areas, in addition to the material required for the emergency repair of permanent systems.



Com. Pub. Inf.

A duplex set for long distance communication such as is required in war to supplement existing commercial systems

In war the headquarters of each artillery position, even more than coast patrol stations, becomes a nucleus of intelligence regarding events at sea, and therefore the service of information in and from these districts should be as perfect as it can be made.

Signal Corps News

Officers' Training Centralized at Yale

Men seeking commissions in the Signal Corps of the army will receive their training at Yale University, it is announced. This centralizes training in this branch and makes possible full use of the university's faculty, which will be further augmented. The instruction personnel will be civilian and not military, although students enrolled will be in uniform, and officers, some of them coming from the front, will keep in close touch with the university.

Men detailed from the Government Radio School for Signal Corps officers are already arriving at Yale. About 100 have been transferred from College Park, Md., and others are coming from all parts of the country. These men are graduates of electrical engineering courses or are especially qualified for the work. Eventually there will be 300 men under training in this course, which will cover three months.

* * *

Rank of Ensign in Army Urged

According to the American Army Gazette, a bill is being prepared to recreate the rank of ensign in the army for men who will be non-commissioned officers appointed by the Secretary of War and will rank below a second lieutenant, but above a first sergeant and a sergeant-major.

The need for a rank of this kind cannot be gainsaid. The pay of the non-commissioned officers of the army at the present time, while commensurate perhaps in some cases with their duties, does not begin to compare with the pay of the petty officers of the navy who are doing practically the same character of work. At the present time, outside of master engineer, master signal electrician and master electrician, there is no rank in the army corresponding to the ranks of boatswain, carpenter and gunner in the navy.

The proposed bill will allow the Secretary of War, upon recommendation of commanding officers, to issue warrants conferring the rank of ensign upon sergeants and corporals who have had more than six months' service, who will receive pay at the rate of $110 a month; not only in the line, but in specialized branches of the service, such as the signal, electrical, engineer, artillery and coast artillery corps.

The details of the proposed act will closely follow the lines of the law for warrant officers in the navy.

The fact that at present men of highly specialized ability are daily being inducted into the army and immediately given duty for which in civilian life they received hundreds of dollars a month, and for which in the army they receive but $30 a month, does not make for a high morale in the enlisted personnel.

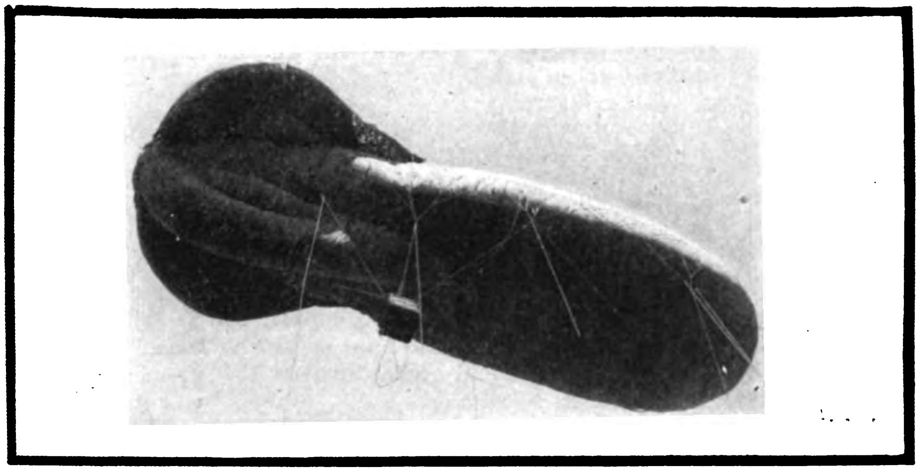
British Off. Photo

Apparatus captured by the British from the Hun who used it to generate electricity for their wireless stations

Instances without number might be cited of men in the army who are to-day working side by side with civilians doing the same character of work, and for which they are receiving one-fifth to one-tenth as much pay, because the civilian is perhaps incapacitated for service either by physical disability or by age limit.

The principal reason, however, for the need of a measure such as is proposed is to take care of the line soldier. Many men in the army who have risen step by step to the grades of corporal and sergeant, and have shown their peculiar adaptability for army life, are still hardly qualified for a commission. It is ridiculous to pay some of these men the paltry sum of from $44 to $60 a month in these days of high wages.

Scenes at the Army Balloon School

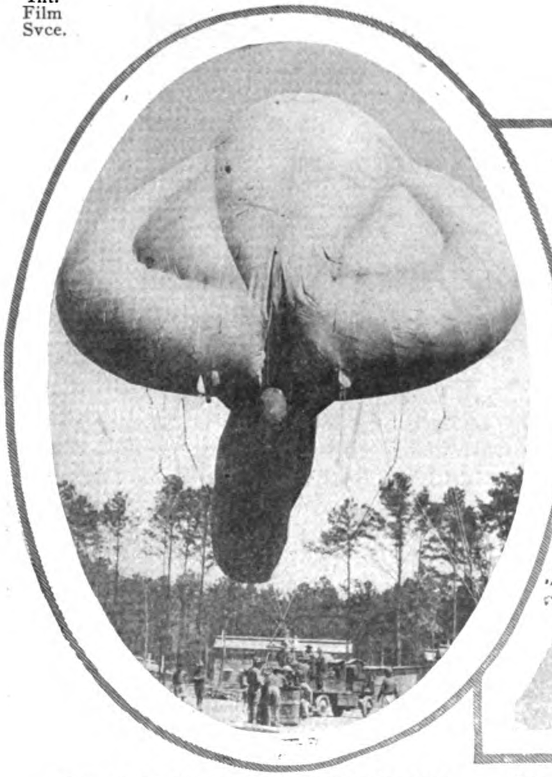


From observation balloons like the one illustrated above the skilled army observers spot the hits of artillery shells and make general tactical reconnaissance notes for the commanding general. These captive craft are ordinarily placed several miles back of the scene of combat and are protected by a patrol of combat airplanes. Reports are made by wire telegraph and telephone and by radio

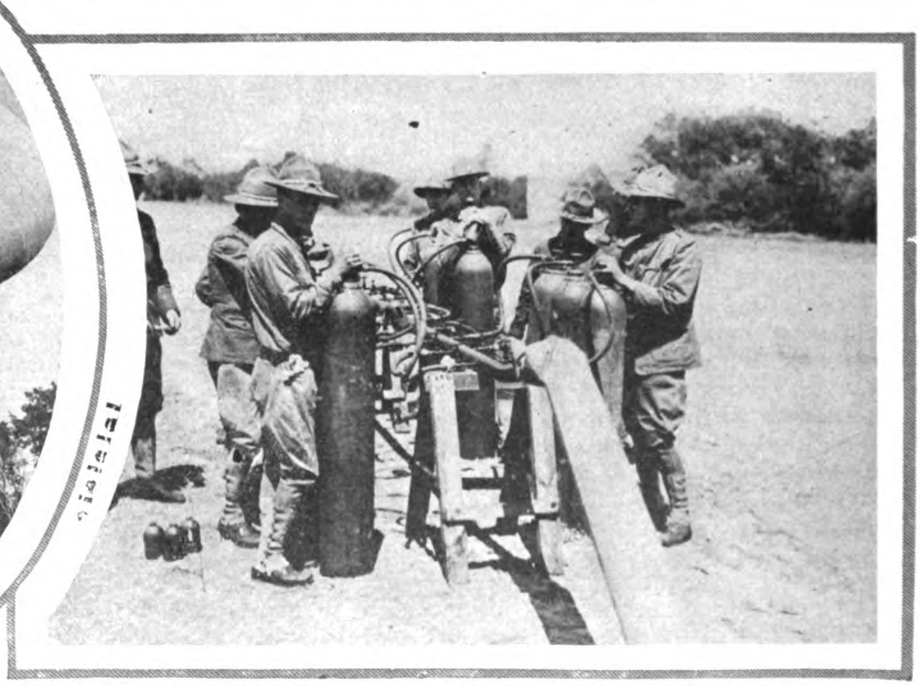
To, the left, Major General W. L. Kenly, Chief of the Bureau of Military Aeronautics in conference with Major Burwell

When the observation balloon is to be lowered the engine installed on the bed of this truck operates a winch around which the steel anchor cable is wound

Photos Int. Film Svce.



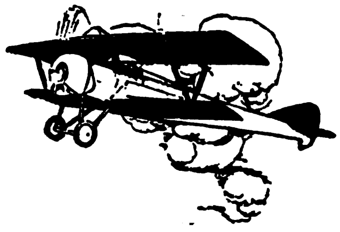
One of the big gas bags in mid-air; rear view, showing the ballonet and rudder inflated



The ground crew with the steel bottles which fill the balloons with gas. This gas is hydrogen, supplied by electrolytic generators, or made from ferro silicon and caustic soda

How To Become An Aviator

The Sixteenth 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

Preparations for Cross-Country Flight

QUALIFYING tests for Junior Military Aviator prescribe two cross-country flights, one of approximately 60 miles and the other 90 miles. When these flights are undertaken the student aviator is expected to know all the fundamental technique of flying, turning and landing, and have reached the stage where the operation of controls is no longer a task but a matter of instruction routine, so to speak; in flying cross-country, therefore, he is enabled to give a large share of attention to following the course and selecting proper places should an emergency landing be required. Prior to the flight a few matters of importance require attention:

EQUIPMENT

The usual flying clothing is worn, the only caution being to provide for sufficient warmth. Leather suit and helmet are worn, supplemented in winter by sweaters and mufflers. Hands and feet are most sensitive to cold and should be well protected; provision of large boots with woolen socks or stockings will repay the aviator in comfort. On a long flight it is well to take two pair of goggles, in case one pair should be lost or broken, and a handkerchief to clean them is necessary. An identification card and money should be carried for emergencies; the telephone number of the airdrome should also be noted and a complete set of tools and covers for propeller and cockpit should be carried.

STANDARD EQUIPMENT—AIRPLANE TOOL CHEST

(Cover.)

1 Saw, hand, 26".
1 Hammer, riveting, 8 oz.
1 Combination square, bevel and level, 12".
1 Rule, folding.
1 Hacksaw, frame.
1 Dividers, pair, 6".

(Top.)

1 Wrench, Stillson, 14".
1 Screwdriver, 8".
1 Screwdriver, 7".
1 Screwdriver, 5".
1 Nailpuller.
1 Knife, draw 8".
1 Hammer, tinsmith's, 1 pound.
1 Hammer, claw.
1 Tape, steel, 100 feet.
1 Brace, 10".
1 Iron, soldering, 1½ lbs., 1 iron, soldering, jeweler's.
2 Center punches.
24 Blades, Hacksaw, coarse; 12 blades, Hacksaw, fine; 1 Chisel, cold, ¼"; 1 Chisel, cold, ½".
1 Calipers, 6".
1 Wrench, monkey, 6".

(Upper Drawer.)

1 Bit, expansive, ⅞ to 3".
1 Pliers, round nose, 6".
1 Pliers, snipe nose, 4".
1 Pliers, adjustable, 8".
1 Pliers, side-cutting, 8".
1 Pliers, adjustable, 6".
2 Pliers, auto, combination cutting, 6 and 8".
1 Nipper-cut, 7".
2 Pliers, diagonal, 6".
1 Pliers, compound, side-cutting, 8".
1 File holder.
1 Spoke shave, 3".
1 File cleaner.
10 Files, assorted, with canvas roll.
1 Screwdriver, 4".
1 Palm, sewing; 8 needles, assorted; 1 ball flax and 1 ball wax.

(Lower Drawer.)

1 Stone, carborundum, 5".
1 Torch, gasoline, flat.
1 Set thin open-end wrenches with canvas roll.
1 Set drills, Morse, straight shank, with canvas roll.
1 Plane, block, 1⅝".
1 Drill, hand.
1 Wrench, 7".
3 Reamers, taper, bit stock, 1¼, 1 5-16, and 1 ⅜".
1 Hatchet, half (small).
1 Snips, tinners.

The machine should be carefully inspected, from tires to instrument board, before the start. Wires, controls, engine and gasoline and oil reservoirs are matters to be looked into by the aviator, who must not accept the word of mechanicians that everything is ready. The instruments required are a compass, wrist watch, altimeter, tachometer, inclinometer and a map board or case. The map case is highly preferable as maps pinned to a board often blow off or are torn in long fast flights.

The map is a most important part of the aviator's equipment for a cross-country flight. It should be placed in a position of easy visibility, such as on the instrument board, or, in any event, as nearly as practicable straight ahead in the line of vision. The course should be carefully mapped out and notations made, as discussed in succeeding pages. On a long journey a weather report obtained by telephone from the point of destination may save trouble should fogs or storms be prevalent there.

PHYSICAL FITNESS

The aviator should have no hesitation in informing his instructor or flight commander of any indisposition; if he does not feel well a cross country flight should not be attempted, as the correct functioning of all his faculties will be required. A long flight on an empty stomach is bad, as dizziness often results. At least a hot drink should be secured, and a good meal if possible. Food in tablet form, chocolate or biscuits may be taken along, but should be placed in a position of easy access.

MAP READING

The aviator must know how to read a map before cross-country flights can be made. An understanding of the meaning of conventional symbols and application of the scale are the main essentials, extensive knowledge not being necessary.

A typical military map is shown in Figure 100.

DEFINITIONS OF TERMS

In mapping, many terms are used, a number of which such as basin, crest, gorge, knoll, plateau, and watershed are universally familiar. A few special terms are defined here, however, for the simplification of the subject.

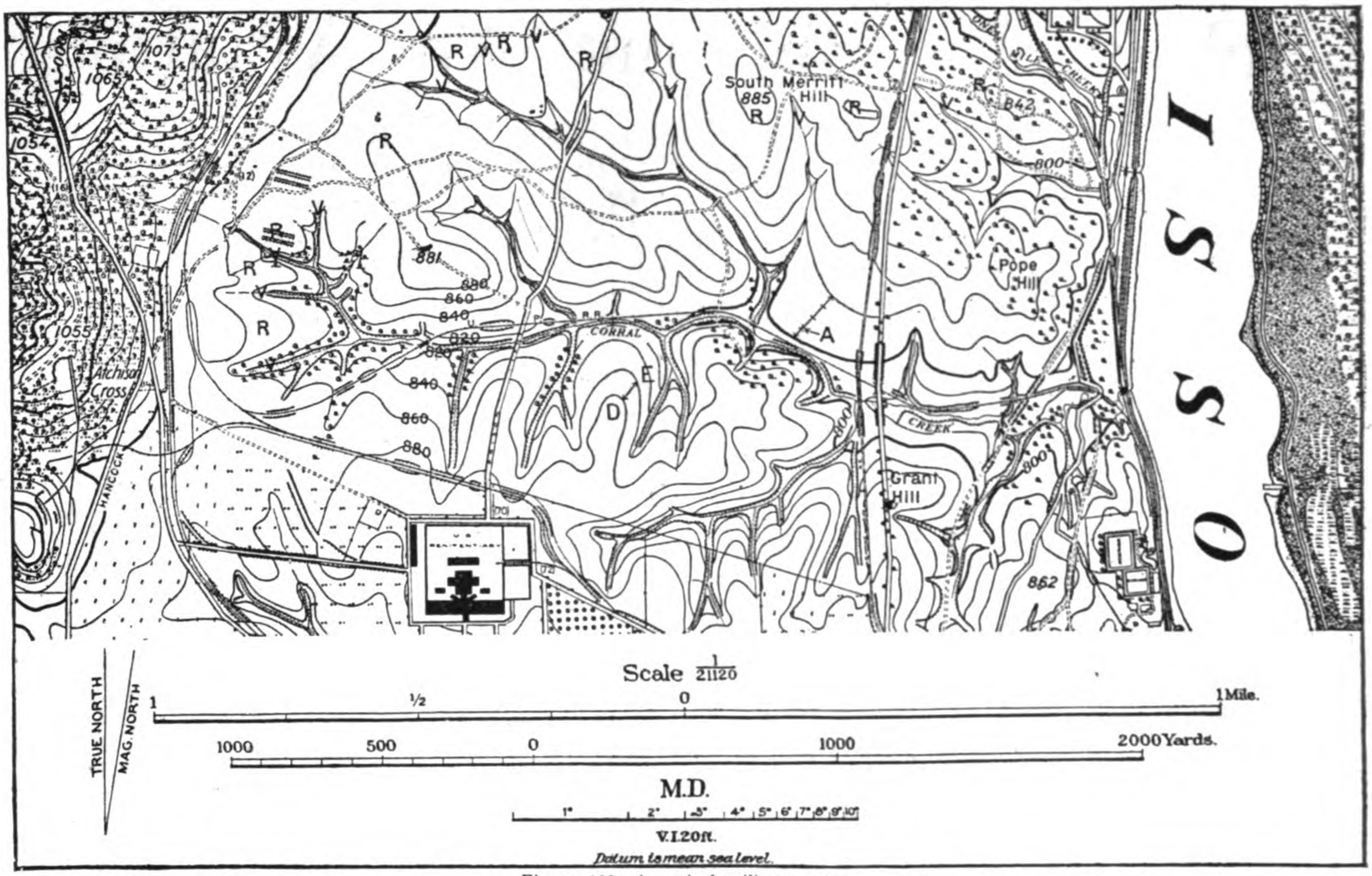


Figure 100—A typical military map

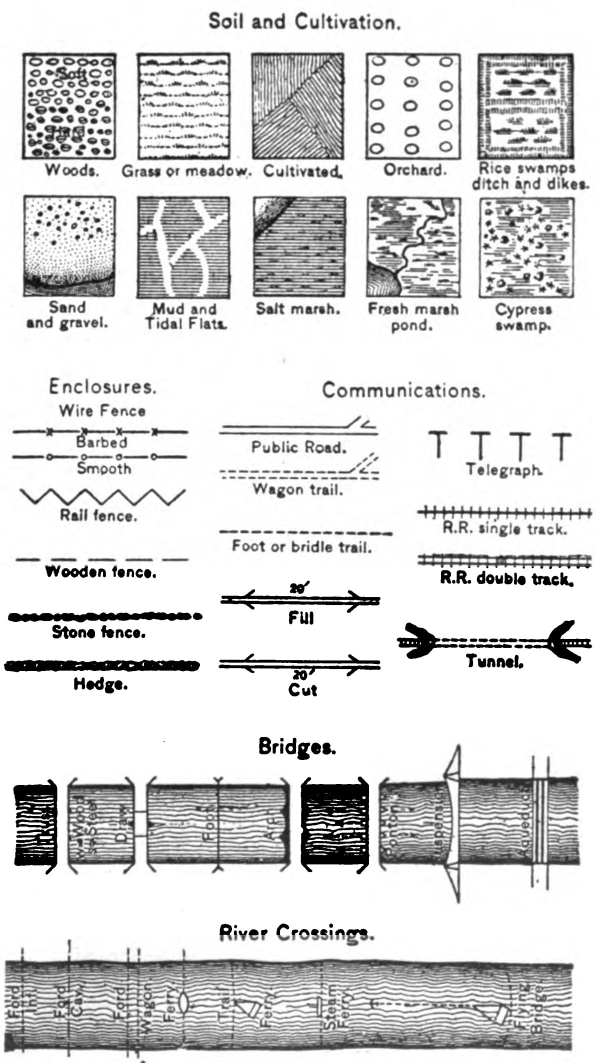


Figure 101—Conventional signs for maps

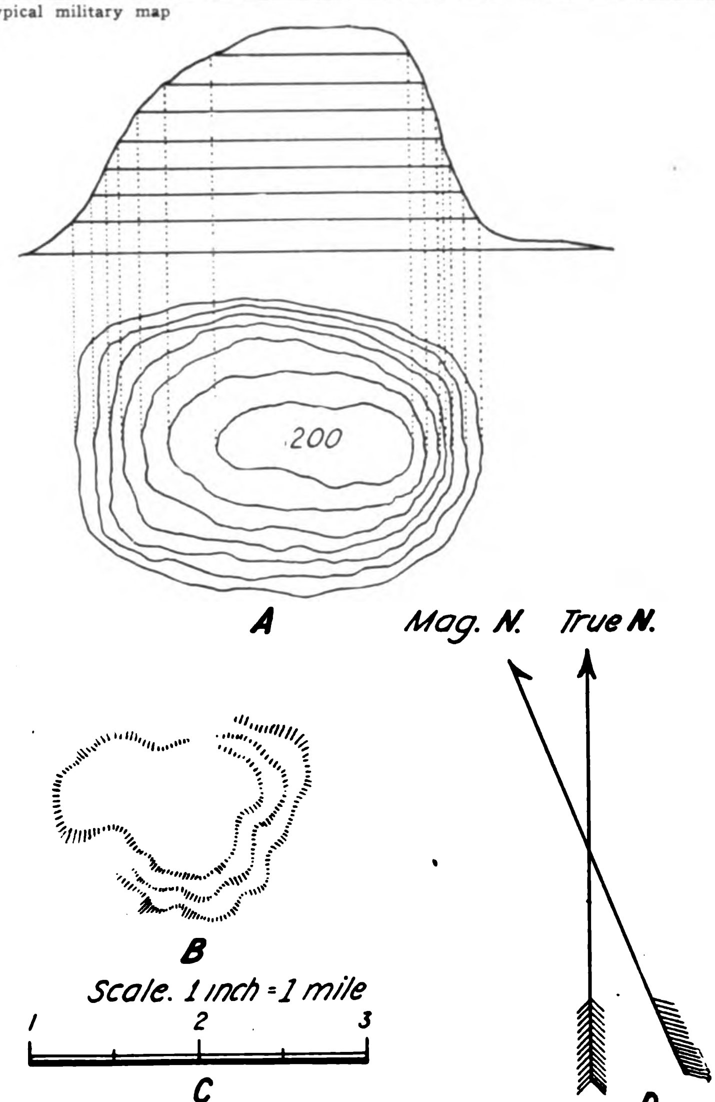


Figure 102—Height, distance and direction symbols

Bearing—The relative position or directions with the north, or true meridian; ***magnetic bearing***, the relative position or direction with the magnetic north.

Contour—A line designating the shape, outline or boundary at a fixed height of a section of ground; contours are used to indicate elevations, each contour representing a rise or fall in feet from those surrounding it. Illustrated by *A*, Figure 102.

Gradient—This indicates a slope expressed as a fraction, a gradient of 1-50 designating a rise of 1 foot in 50.

Datum—A fixed level (generally sea level) from which all heights are measured.

Hachures—A shading method of representing hills, short strokes being drawn directly down the slopes. Illustrated by *B*, Figure 102.

Meridian—A true north and South line.

ORIENTING

The first thing to be determined is: Where is the north? On a map this is usually indicated by an arrow placed in one of the corners. Some maps do not have an arrow, in which case it is a generally safe assumption that the top of the map is the north. When two arrows appear, as in *D*, Figure 102, one points the true north, the other the magnetic north. Usually they are so marked, but if not lettered, the incomplete or less elaborate arrow represents the magnetic north. The magnetic north is the north of the compass; its deviation from the true north has already been explained. When the map has been turned to its proper position, i. e., the magnetic north arrow corresponding with the compass, it is said to be oriented. This is the first step tor the aviator about to lay out a cross-country flight.

THE SCALE

Having located his position on the map, the next features for the aviator to study are the distances between points. These are shown by the scale, which appears usually on the lower end of the map; for example, two points are measured by ruler on the map and the distance is 1 inch; the scale reads: 1″=1 mi. (as in Figure 102), then the actual distance between these points over the ground will be found to be 1 mile. Some maps state: (so many) miles to the inch; the measuring procedure is the same, allowance being made for 2 miles to the inch, or whatever the scale states. What is known as a representative fraction is sometimes used. On the map, Figure 100, this appears as $\frac{1}{21120}$. If the R.F. is $\frac{1}{100}$ it means that an inch on the map is equal to 100 inches on the ground; the fractions are usually large, such as $\frac{1}{63,360}$, which would indictate an inch to a mile, since there are 63,360 inches to a mile. On foreign maps $\frac{1}{100,000}$ is a familiar fraction, and may indicate either inches or millimetres; in all forms the principle is the same and the scale is reckoned in the same way, afterwards being calculated in inches by the aviator. Another method of showing the scale is illustrated on the map, Figure 100, where it is only necessary to copy the scale on a strip of paper and apply the slip directly to the map, reading off the distances between any designated points.

CONTOURS

Contours on a map show the elevations, depressions, slope and shape of the ground.

Hachures (see *B*, Figure 102) sometimes used on European maps, show elevations only and are of little value. The method of indicating features by contour lines is clearly shown in the illustration *A*, Figure 102. The irregular, curving lines which appear on the map represent the outlines of the hill at equally spaced vertical intervals. If, for example, by use of a surveying instrument a line of stakes was placed around a hill, each one exactly the same height above sea level, a line drawn on the map through all the stake positions would be a contour. Study of the diagram *A*, Figure 102, will make it clear how the steepness of hillsides is determined from the map, contour lines close together indicating a steep slope, and far apart, a gentler slope.

On some maps contours are numbered in elevation in feet above the datum place, generally sea level. Thus, at a glance, the elevations are clearly determined.

CONVENTIONAL SIGNS

Interpretation of the symbols used on maps means for the aviator a quick reading of the natural and artificial features of the country. The principal conventional signs used by the U. S. Army are given in Figure 101, and should be memorized. Conventional signs are not drawn to scale on maps, but ordinarily indicate only the position of the feature.

MAP PREPARATION

The squadron headquarters prepares route and area maps in advance, so that proper maps are on hand when flight orders are issued. The work is so regulated that blank orders to pilots and observers can immediately be filled in and all papers and instructions made ready in a few minutes. Usually the headquarters personnel marks off the course for the pilot, indicates the 5 or 10 mile intervals and the "legs" of the journey. A margin for entering the various data is always left on one side of the map.

USE OF COMPASS AND ITS ADJUSTMENT

The compass is an instrument for indicating the magnetic north by a magnetized needle on a pivoted card. While cross-country flight is possible with the aid of a map and identifying landmarks, at times when these are obscured the compass is a necessity to the aviator.

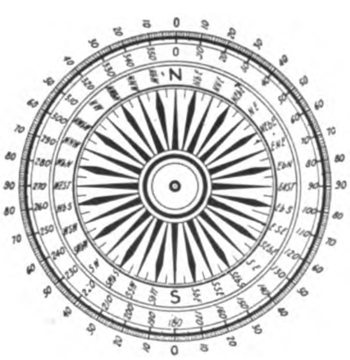


Figure 103—Compass card

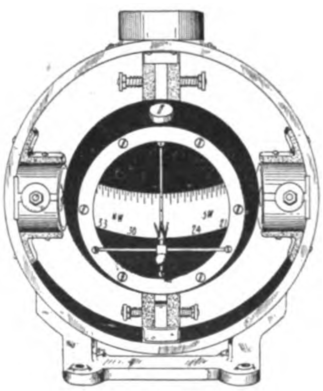


Figure 104—Vertical compass

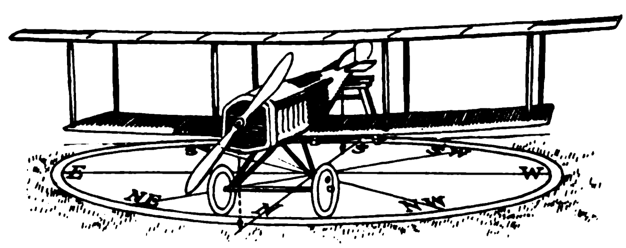


Figure 105—Adjusting the compass

Steering by compass accurately, reference to the map is not required in flight, providing preliminary calculations are accurately made as outlined further on.

THE COMPASS CARD

The card is illustrated in Figure 103. Marking in degrees is clockwise, the circle beginning at N (north) as zero, and comprising 360 degrees. The card is also marked in the old form of the merchant marine; north, east, south and west being represented by 90 degrees, bearings being read, for example, 20° W. of N. An aviation compass of the vertical type is illustrated in Figure 104.

COMPASS ERROR

Variation—The compass indicates the magnetic north from any given place; i. e., the compass magnet points to the north magnetic pole, situated on a northern island of Canada. This is not the "true" north, and it is therefore necessary on maps of the various parts of the earth to make the correction known as variation. This is the angle between the true and magnetic meridian at the point mapped.

Deviation—Since the compass needle is magnetic and the airplane contains much metal of magnetic attraction an error known as deviation is caused which deflects the needle some degrees to the east or west.

Adjusting the Compass—To correct the deviation error is a task seldom assigned to the aviator, but some idea of how it is accomplished will be found of value. (The process which we term adjusting, is known in England as "swinging" the compass.) The airplane is placed with its fore and aft axis exactly north and south, either by aligning it with a tripod "land" compass placed nearby, or by placing the airplane on a cement slab provided for the purpose in many flying fields. The airplane is trued up, in the latter case, by spirit level and plumb line, as illustrated in Figure 105. The compass has what is known as the "lubber's line," which is then fitted to the fore and aft line of the airplane. The compass reading is then taken, and by inserting small field magnets in slots provided for the purpose, the east or west deviation of the needle is corrected until it points north with the cement slab. When the best correction possible has been made a deviation card is generally made out and placed near the compass, for in long flights to a definite objective an error as small as 2 or 3 degrees will throw out the aviator's calculations. A specimen of these cards follows:

For Magnetic Course		*Steer by Compass*	*For Magnetic Course*		*Steer by Compass*
N.	0 degrees	357 degrees	S.	180 degrees	183 degrees
N. E.	45 "	47 "	S. W.	225 "	223 "
E.	90 "	90 "	W.	270 "	270 "
S. E.	135 "	137 "	N. W.	315 "	317 "

PLACING THE COMPASS

The proper location of this instrument is an important matter. It should be placed in clear view and directly in front of the pilot, preferably in the center fore and aft axis of the airplane, as far as possible from moving metal parts such as those of the engine. Metal parts such as control levers and rods, if within 2 feet of the compass, should be non-magnetic, and movable equipment such as machine guns, should be in normal flying position when the compass is adjusted. After any required change in parts is made the compass deviation should be checked and any necessary readjustment made.

A New Protective Condenser

A NOVEL condenser suitable for protection of electrical transmission lines has been designed by E. F. W. Alexanderson of radio frequency alternator fame.

The use of capacity in series with resistance between a transmission line and ground or between the conductors has been proposed for protecting the system from the effect of high frequency disturbances. With such an arrangement the protective path offers a high impedance to current of normal frequency, but a much lower impedance to any high frequency disturbances which may occur in the system. As a result, there will be a flow of high frequency energy through the resistance and a large part of this energy will be dissipated in the resistance. The power factor of a leakage circuit of this kind, however, varies widely with the frequency and with ordinary condensers is normally low. As a means of absorbing high frequency energy such a circuit is most efficient at some particular frequency which depends upon the relation between the capacity and resistance and is less efficient for frequencies higher or lower than this particular frequency.

As indicated in figure 1, Alexanderson's condenser comprises an outer electrode 1 of conductive material and an inner electrode 2 which may also be of any desired conductive material, the space between the two electrodes being filled with an insulating material 3 having a high dielectric hysteresis, such, for example, as asbestos or a compound consisting largely of asbestos. The electrodes are provided with eyes 4 and 5 for convenience in connecting the device to a transmission line. A skirt 6, of porcelain or other suitable insulating material, may be provided to prevent arcing over between the electrodes. A condenser of this type may be connected between a transmission line conductor and ground or between conductors in different phases. If desired, it may be connected between the transmission line and a secondary conductor having a high capacity to ground, so that a breakdown in the protective device will not cause a breakdown in the line insulation. A protective device of this type should be designed with small capacity so that it will have a high impedance for currents of low frequency, but much lower impedance for high frequency currents.

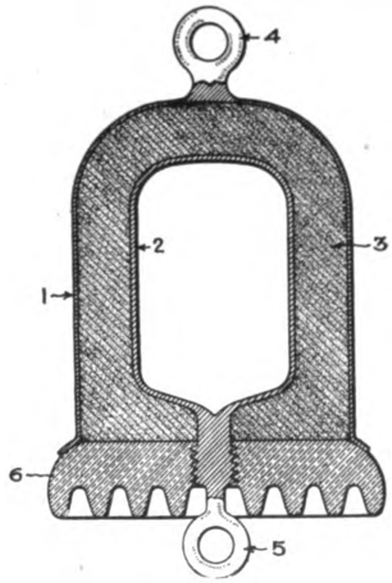


Figure 1—Condenser used to protect electrical transmission lines from the effect of high frequency disturbances

Alexanderson has discovered that the dielectric hysteresis losses of asbestos are much higher than those of materials such as glass, paper and mica, which are ordinarily used for the dielectric medium of condensers, and that these losses increase very rapidly with the frequency.

The power factor of a condenser having asbestos as a dielectric is also much higher than that of ordinary condensers. For example, the power factor of an asbestos condenser at 20,000 cycles was found to be about 38%, while the power factor of similar glass, paper and mica condensers at that frequency was 2% or less. With a frequency of 70,000 cycles, the power factor of the asbestos condenser was over 30%, and that of the paper, glass and mica condensers was about the same as at the lower frequency.

Aviation News

Atlantic Crossed in 24-Hour Flight

Though Navy Department officials said they knew nothing about it, and doubted the story, an article in the United States Naval Institute Proceedings, published in Annapolis, gives details of an alleged twenty-four-hour airplane flight across the Atlantic last July. A somewhat similar story was published in Baltimore in July, but was not credited.

The Annapolis publication says the airplane carried four passengers whose names are temporarily withheld, and that they took a number of photographs showing vessels they passed. The airplane, it says, left the Newfoundland coast at 7.02 A. M. on July 28 and flew continuously, attaining a height of 15,000 feet, for 24 hours and 10 minutes, alighting at Dingle Bay, Ireland, at 7.12 A. M., July 29.

En route the plane encountered an American troop convoy, was duly saluted by whistles and congratulated by a destroyer by wireless.

The actual line of flight was not perfect, as planned, but deviated a number of degrees southward until the destroyer was encountered several hundred miles off Ireland, when a due north course was followed for about fifty-five miles, after which the eastward course was resumed, practically along the originally planned route.

The departure was made under ideal conditions from Harbor Grace, N. F., the course being E. ½ N. true. When 170 nautical miles had been traversed, it was noon and a heavy squall caused the deviation in course.

As night came on, the flyers mounted to higher altitudes, eventually attaining 15,000 feet as a safety measure. It was blind flying at more than 660 nautical miles from land and continued thus throughout the night. The pilots alternated, sleeping and steering, and so did the mechanician and his helper.

At 4 o'clock on Monday morning, July 29, the position was satisfactory and the speed was most gratifying, the engines—12-cylinder affairs—working like a charm. Shortly before 7 o'clock the flyers "shot" the sun and found they were approximately 110 nautical miles from Sybil Head. They easily got their bearings and started on a straight course for Dingle Bay, where they touched the ground at 7.12 A. M.

* * *

Athletic Equipment for Army Aviators

An appeal for athletic equipment, and also musical instruments, for the enlisted men of our aviation forces has been issued by the National Aeronautic Committee, 289 Madison avenue, New York, of which Mrs. Newton D. Baker is honorary chairman, and Mrs. Charles A. Van Rensselaer, chairman. The committee, which is under the direction of the War Department Commission on Training Camp Activities, has received requests from officers in command of army air squadrons going overseas and also from all air training stations in this country, to supply equipment for baseball, football, soccer, basketball, track athletics, volley ball, indoor baseball, medicine balls, punching bags, boxing gloves, etc. Major General Kenly endorses this work, it is stated.

* * *

Lieut. J. A. ("Eddie") Rickenbacker Now an Ace

One of the newest of our American aces fighting with the air forces in France is Lieut. J. A. ("Eddie") Rickenbacker. Many thousands of Wireless Age readers have watched Rickenbacker pilot an automobile to victory in long and hazardous races. It will be recalled that among other trophies, he won the 300-mile speedway record. With such a record behind him it was to be expected that Eddie would give a good account of himself in his new activities.

Rickenbacker enlisted in the air service early in the war and was sent across with as little delay as possible. The same reckless daring which made large crowds all over the country hold their breath when "Eddie" appeared in an automobile has characterized his air fighting. He drives an airplane as he drove an automobile, with consummate skill and an absolute disregard for the hazards involved.

One of the most famous of his encounters occurred on Memorial Day of 1918. Rickenbacker as usual drove his airplane full speed ahead over enemy territory, even when surrounded and outnumbered by enemy fighting craft. He had encountered a German Albatross at an altitude of about 5,000 feet and pursued it fearlessly across the lines. The two had already flown for a distance of three kilometers when the German received reinforcements and two other machines of the same formidable type joined in the battle. The danger of fighting above enemy territory is of course obvious. If the machine from over the line is forced to descend, even if a landing is safely made, the pilot is instantly taken prisoner with his machine.

Rickenbacker was undismayed by the superior forces. His tactics were to keep in the rear of the first enemy airplane and match its evolutions. Although facing three German flyers, Rickenbacker succeeded in outflying and outfighting the fleet arrayed against him. He brought down his man and succeeded in regaining his own lines in safety. Although the battle won the most enthusiastic praise from the French, Rickenbacker insisted that his success was merely good luck.

Int. Film Svce.

With "his hat in the ring" Eddie Rickenbacker, former auto driver and now an "ace" with Pershing's fliers, has just brought down his eighteenth Boche airplane

Under Fire With the Signal Corps

(Continued from page 16)

would be impossible. It has recently been rendered possible for the airplane to carry on a radio conversation with the man behind the gun.

It can be seen how great is the advantage which radio communication has over the form of communication which requires the upkeep of wires, since with the radio there are no wires to be shot away, and it requires a direct hit to put the instrument out of action. A new and interesting development is radio telegraphy through the ground instead of through the air. This has been extensively worked out and amplified by the Americans.

The third and most extensive network of information is the visual net. The inventive genius of the French has substituted for our wig-wag and semaphore a small searchlight, resembling an automobile headlight, but with a parabolic reflector, which concentrates the rays and enables them to be directed upon one particular spot. This lamp is not only a complete system in itself, but also parallels and duplicates the telephone lines, so that in case they become inoperative they can be replaced by the lamps. It would appear to be no safer to shoot a beam from an automobile headlight into the face of the enemy than it would to get up and wave a flag at him, but the Signal Corps experts seem to have overcome this difficulty, and the way in which it has been done illustrates, we are told, an interesting application of science to the field of signaling.

The visual net makes elaborate use also of the old-fashioned fireworks, which have been in use in armies for years. Almost every infantryman as he goes over the top is equipped with one or more forms of fireworks, whose proper or improper use may mean for him life or death. While fireworks are used principally by the infantry and artillery men, they are trained by soldiers of the Signal Corps and supplied with the right colors and selections. The number of signals which are readily distinguishable from each other under all conditions are limited, and as the enemy is constantly on the alert to pick up their meaning and duplicate them with signals of his own to confuse and mislead his opponent, it becomes necessary to change the entire fireworks code throughout the entire area. It is up to the Signal Corps to develop the code and to transmit the order to change.

Signal Corps men at the battle front communicating by heliograph signals

The airplanes following the infantry in an advance depend upon fireworks for their communication with the various units whose progress they are watching, and it is only when the front line troops light flares, which they place upon the ground, that the airplane at night is able to determine how far they have advanced and notify their own artillery in case it might be firing on them.

The messenger net, which is a modern adaptation of the runners and mounted messengers, is the fourth means of conveying information. This net serves primarily to transmit long orders and reports, but it is so extensively developed that it may be relied upon in an emergency also to provide complete communication throughout the area. The runners operate as of old, but instead of working on the ground they are winding their way through trenches and into dugouts. A little further back mounted messengers are still employed, but they have almost wholly given way to motor cycle riders.

The feats of the American motor cycle men in France are a mystery to the French. While the French possess motor cycles, they have never made the extensive use of them which the Americans have, and consider them more of a toy than an instrument of warfare. Where the French rely upon the mail for the transmission of orders between various larger headquarters the Americans have established a motor cycle dispatch service with hours of departure and arrival as regular as train schedule in our own country. When the mail is of sufficient bulk it is carried in a side car.

Among the most trustworthy of the messengers must not be forgotten pigeons, which when released from their baskets at the front fly back to their lofts where the messages taken from the little carriers attached to their legs are transmitted to the proper destination. Dogs are frequently used in transmitting intelligence and orders in the present war. The Germans so far have been able to get better results from the use of dogs as information bearers than we have. The airplane also serves as a message carrier. It was probably due to its contemplated use in this manner that the airplane service was originally assigned to the Signal Corps.

These four nets may be developed or extended indefinitely in the future, but it is hard to see how any method of communication can be evolved that will not fit one of them. When we consider the care and patience with which these nets are installed and the amount of time required in their upkeep even in a quiet sector, the difficulties which are encountered in a large advance such as the Americans have just made can better be realized. All the nets in operation are heavily overloaded as the messages fly back and forth by the thousands. As the infantrymen go over the top, the signallers can be seen following behind them, some with fireworks, some with lamps, and some with little breast reels of wire which they lay over the ground, followed by other linemen to attach telephones wherever needed.

When the advance stops, from this flimsy skeleton the new system is built up, and finally again becomes the perfected network. But, as soon as the signaler gets his system once more in a state of perfection he moves again, and it all has to be done over.

The other activities of the Signal Corps offer opportunities for men interested in various branches of science. The meteorological department studies the atmosphere and compiles reports for commanders. These reports include information that affects the care of the troops and the maintenance of supplies, and predictions as to whether the ground will be favorable for troop movement or whether the wind will be right for a gas attack.

The listening-in service is not the least interesting activity of the Signal Corps. There is always a readiness to pick up any information of the enemy that might be of use to us. Accordingly, the Signal Corps has numerous listening-in stations which by means of devices recently perfected not only intercept any enemy radio message, but determine accurately the location of the radio instrument which transmits it. This information is, of course, at once furnished to the artillery, which proceeds to put that station out of business. Even German telephone wires have been made to divulge their secrets, though well within German territory, where it is impossible to tap their lines.

All this is accomplished by one of the most ingenious instruments which has yet been produced. By means of it our Signal Corps man can sit in his dugout on the front line with a receiver to his ear and hear any telephone message within the enemy's territory even though several thousand Huns all jabbering their lingo may intervene between him and the nearest point to the wires.

Some December Articles

A description of a rectifier using an inert gas under pressure in place of the usual vacuum in the enclosed medium.

Articles on: A Wireless Time-Signaling Device—An Incandescent Cathode Arc Used for the Rectification of Alternating Currents.

Experimenters' World

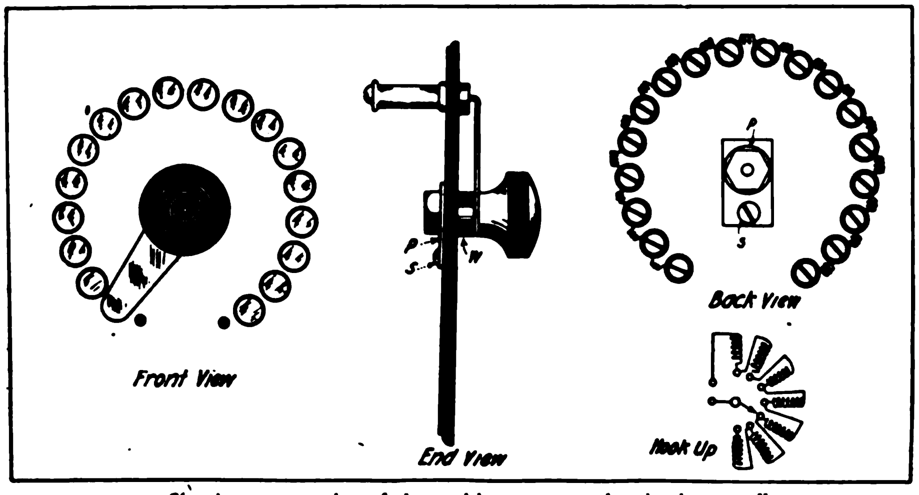
A Positive Vacuum Tube Circuit Controller

MANY of our amateurs intend to "be prepared" for the grand opening of stations when Autocracy has been wiped off the face of the earth. They are mentally designing wireless communication sets showing vast improvement over those with which they had previously been acquainted. In designing this "super-set" there is plenty of time to consider each proposed detail very carefully before incorporating it into the design, and it is very evident that this should be done, as raw materials must be conserved for war work and there must be no waste. While on the subject, it might also be suggested that any spare pieces of material, which in peace times would be considered scrap, should be utilized wherever practicable.

In designing the vacuum tube cabinet the amateur is confronted with the conventional porcelain-base rheostat, which, although it is quite acceptable for the ordinary set, would be wholly out of place in an efficient set. In the following paragraphs is described an improvement over the usual rheostat.

For the filament circuit the variable resistance need not be more than 9 ohms, and an eighteen-step variation will be sufficient when a proper circuit is used. The most important part of this controller is the resistance units; those made by the Ward-Leonard Electric Co. of Mount Vernon, N. Y., are preferable. If you order units with a resistance of ½ ohm each then you will know that each step in your controller will cut in ½ ohm resistance and you will be able to make tests for efficiency accordingly.

In most places the accompanying drawings will be found self-explanatory. Perhaps each experimenter has his own method of constructing his switches, but the type in the drawing has proven itself to be efficient and will not unloosen at a crucial moment. It consists of the usual composition knob with a machine screw through the center, over which is put the washer and switch blade; these being fastened in place by the threaded brass washer (W), which is ¼ inch in diameter. The remaining length of machine screw is then run through the carefully drilled hole in the Bakelite-Dilecto panel and a rectangular brass plate (P) put over the screw and is kept from turning by the machine screw (S) which is threaded into the panel. Next, a heavy brass hexagonal nut, ¼ inch thick, is screwed over the machine screw and is kept from turning by a small machine screw which is screwed in a hole drilled and tapped into one of the faces on the edge of the nut.



Showing construction of the positive vacuum tube circuit controller

The resistance units are composed of porcelain tubes wound with a special resistance wire and then covered with vitrified enamel, which completely eliminates oxidization. These tubes are fastened to the inside of the panel by long machine screws passing through the inside of the tubes, passing through the panel, and screwing into the brass switch contact on the other side. A flexible wire tap is placed at each end of the resistance unit. One of these (the one happening to be nearest the head of the machine screw which passes through the tube) is soldered to the head of this machine screw and then brought down to the tap of the neighboring unit which lies nearest the panel, and so on, until all the units are connected in this manner. The best kind of wire for inside connections is rubber-covered stranded wire. All leads should be as short as possible and connections soldered in every case. The connection to the switch arm should be soldered to the brass plate (P).

This same idea may be carried out in designing a potentiometer, but the resistance of each unit should be 500 ohms instead of the value of the rheostat units, making 9,000 ohms in all for the potentiometer. Of course the potentiometer must be connected in a different way than the rheostat. A lead must be brought from each end of the arc of switch contacts and another lead from the switch arm. If this design be used for both rheostat and potentiometer on the vacuum tube cabinet a much more uniform appearance will be obtained, due to the fact that each switch has the same outward appearance.

FRANCIS R. PRAY, *Massachusetts.*

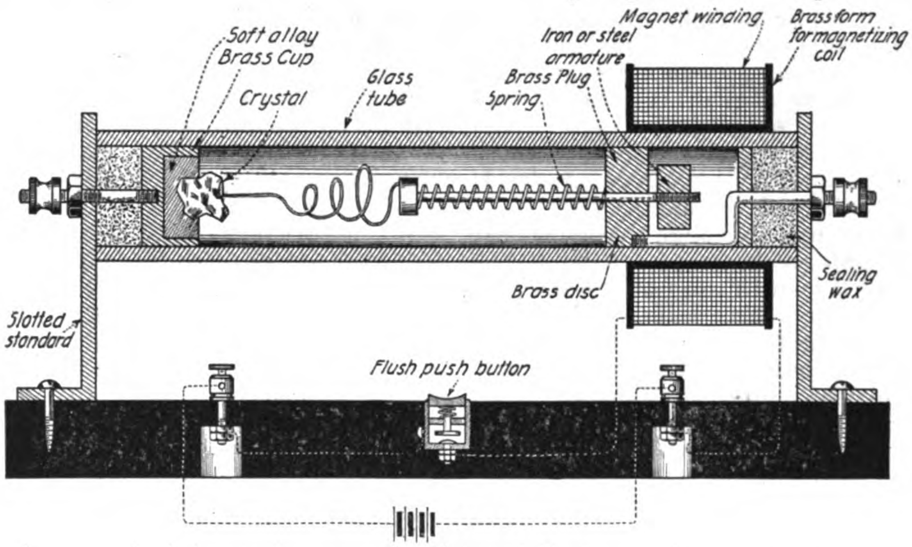
Sealed-in Detector With Magnetic Adjustment

INASMUCH as I have never seen this idea suggested before, I venture to present it to the readers of THE WIRELESS AGE, hoping that they may be able to find some interest in the scheme.

The object of the device is to allow both the crystal and contacting means of a mineral detector to be effectually and permanently excluded from the surrounding atmosphere and its deteriorating effects; by modification of the glass container and means of bringing out the connections it may be operated in a vacuum, or even surrounded by various gasses for purposes of experimentation, still permitting the detector to be adjusted as easily as if it were exposed.

The design of the air-tight detector given herewith is intended to be suggestive and not conclusive, as the main idea may be adapted to any form of detector design that will suit the builders' fancy, but this one has considerable merit in its simplicity of construction and operation.

As the cross-sectional view given in the sketch renders the construction and operation quite obvious, only a few words need be added. The mineral cup and metal plug carrying the movable contact should be turned to a snug fit for the inside of the glass tube, and a bit of glue applied before inserting so that they will remain in position without additional holding means. The spring of the movable contact should be relatively light, and its pressure should be adjusted to suit the crystal used before the tube is finally sealed. The armature should be made from a piece of round iron or steel rod. These parts must work free and easy. The binding post terminals of the tube are used to support it by engaging them with two slotted sheet-metal standards fastened to the base. The form for the magnetizing coil should be made of light sheet brass or copper. It must be easily rotated and moved along the tube and may be wound with about No. 22 or No. 24 wire.



A cross sectional view showing construction of the sealed-in detector with magnetic adjustment

A flush push button should be mounted on the base, and connected in series with the coil and battery terminals. This button is depressed while adjusting the detector, and of course the magnetic field is present only while doing so. The magnetic field does not cause any noticeable effect on the rectifying action of the detector.

J. A. WEVER, *Maryland.*

Improved Code Practice Apparatus

In using the code practice apparatus described by the writer in the February 1918 issue of The Wireless Age, I experienced a "static" annoyance which interfered with the successful operation of this device. The trouble may have been caused by arcing of the brushes on the generator at the power station. The problem was solved by the following changes:

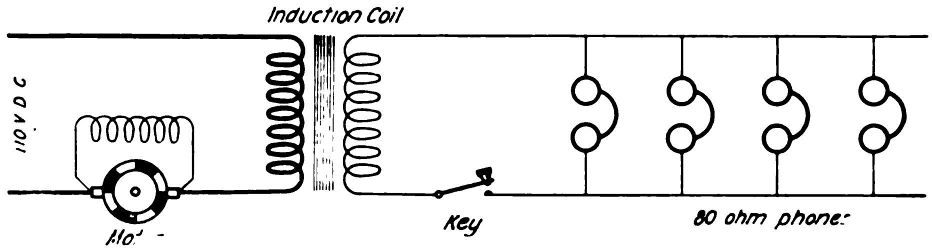


Diagram showing method of connecting the motor with induction coil

In place of the bank of lights, a small motor is connected in series with the primary of the induction coil. The secondary connections are made in the manner described in the February issue.

The accompanying diagram shows how the motor should be connected to the induction coil.

In case it is to be run without load only, a shunt motor should be used. If a small series motor is used a load must be kept on it to keep it from "building up" and finally breaking, either electrically or mechanically. If electric fans are used in the class room the motor of one of these may be connected in series with the coil.

The motor is more economical in use of current than the bank of lights and produces a much more regular sound. As a result of this a class can advance more rapidly than with the irregular type of apparatus used before.

Some radio schools have a system in which a small motor is employed to run a cast iron armature past two magnets, one of which is connected to a low potential source of current, generally a storage battery, while the other is connected to the telephones. For successful operation this type of apparatus requires that the parts be accurately machined and that they run true. The cost of all this work and material amounts to considerable in times when prices are normal, and now it would be very high.

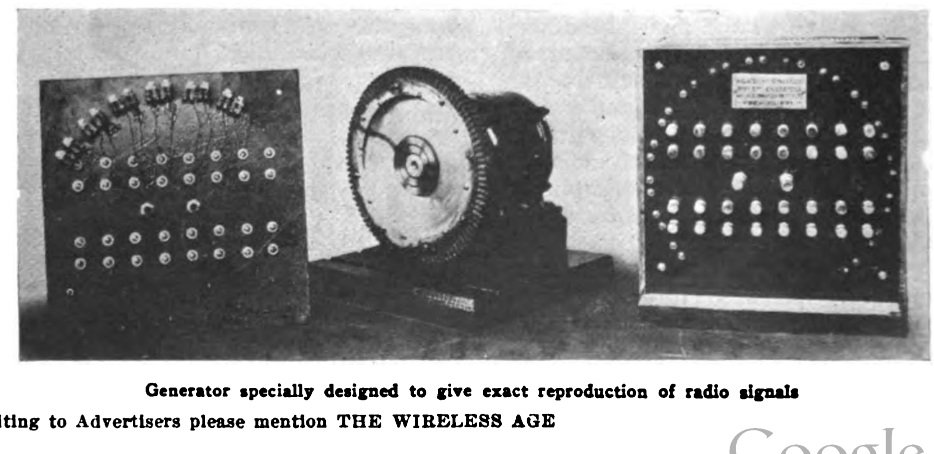
In the other system, with the motor in series with the coil, no machining is necessary, no storage battery is required, and the power from the motor may be used to run the automatic transmitter, a fan or any small device.

On the whole, this system will be found much cheaper to install and same as the more expensive method. to operate and the results will be the

Paul G. Watson, *Pennsylvania.*

Special Code Signal Generator

In the training school for radio operators at the Dunwoody Industrial Institute, Minneapolis, instead of using a buzzer for producing the practice signals in the telephones a high frequency generator is used. This generator has 98 poles and the rotor, which is the field, is revolved at a speed sufficient to give a clear musical note of about 600 cycles. The frequency as well as the strength of the signals can be easily varied so that the students get practice in receiving an exact imitation of the modern radio signals such as are obtained from undamped wave generators and quenched spark sets. The head telephones are connected directly to the stator coils of the generator through the transmitting key. It is driven by a one-sixth horsepower motor.



Generator specially designed to give exact reproduction of radio signals

The Monthly Service Bulletin of the
NATIONAL WIRELESS ASSOCIATION

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

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THE call for qualified radio instructors during the past month is unprecedented. Schools scattered throughout the country, having taken the responsibility of training several hundred young men for military radio service, ran up against the proposition of locating instructors of experience to direct the training of their student allotment. The Association is, in consequence, in receipt of inquiries from more than a score of schools asking assistance.

In only a few instances have we been able to connect with men of the proper calibre. These have taken up their duties within two or three days from the time of our notification, but there still remain a number of vacancies unfilled.

There is a definite reason for the scarcity of trained radio men. The great majority of those who gained their experience in the amateur field have since gone through a course of intensified training and are now serving in the Army and the Navy. As a matter of fact, of those within draft age, the percentage remaining is almost negligible.

It would seem, however, from a broad survey of the field, that there are still some who can carry on this great work of training. Any of our members or friends who feel at all qualified to take such an appointment is urged to communicate with the Association headquarters.

The duties which Uncle Sam requires of instructors for Signal Corps classes do not in every case require the services of a radio engineer; men who have a first rate knowledge of the practical adjustment and operation of radio apparatus will fill the greater need. All must have, however, the ability to teach. In other words, an essential of instructing ability is providing inspiration to listeners, by which they are spurred on to deeper investigation of the subject in hand. Such tutors will fill the bill.

The Signal Corps does not need 100.000 radio engineers. But good, practical operators are wanted—men who can handle the key at 25 words per minute and who can take down a set, reassemble it and adjust it to its maximum efficiency. Out there in the trenches men are required who can concentrate, fellows who make quick decisions in emergencies and "get the business through."

Are any more of our readers fitted to become wireless instructors? We'd like to hear from them. They will do our country an essential service. Nothing is more important in this great war than the services of a skilled worker. And few needs are more pressing than the call for radio instructors.

The Association has discovered a humorist in its ranks. Deference to his professional standing restrains us from publishing his name,

Suggestions for the Experimenters' World

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

WHAT IN YOUR OPINION IS THE BEST METHOD TO PURSUE TO PREVENT UNNECESSARY INTERFERENCE IN THE EVERY DAY USE OF WIRELESS TELEGRAPH APPARATUS?

This subject can be treated from both the technical and operating aspects.

Another suggestion:

AFTER THE WAR WHAT IN YOUR OPINION WILL CONSTITUTE THE IDEAL AMATEUR WIRELESS TRANSMITTER AND RECEIVER?

Limit your manuscript to 1.000 words.

but here is his plea: "I never knew until recently that my cosmic existence was so bound with electrons; and am I to assume, from the explanations that some of you scientific gents are putting forth at headquarters, that my personal atomic structure is basically electrical? Come out and be honest with we oldtimers—we want facts."

Facts!! Nothing easier, or more agreeable, we reply. We've always liked facts, and factors. Thrive on 'em, in fact. Which is a fact—absolutely. So, for fact Number One, dear sir, it should be recorded that the classification of atomic structures these days is determined by local draft boards. Moreover, with a normal congregation of atoms there will be no detectable manifestation of electrons or any other type of ethereal radiations.

It is sadly evident that you have not yet grasped the fundamentals underlying the structure of matter as agreed upon by authorities. But intelligible, so to speak, thought wave trains are occasionally permitted to emanate from the headquarters tower of erudition. Without fear of the law, therefore, you may listen in this time; and if you can—

Follow this . . . Experiment and reasoning point to the fact that a normal atom is made up of a distinct number of electrons joined to a positively charged nucleus of atomic dimensions, and a state of electrical balance thus exists which gives no external electrical manifestation.

Are you listening—carefully?

Suppose we drive an electron from an atom, what happens? The balance is destroyed. The unfortunate atom is minus an electron, and it therefore possesses an excess of positive electricity. It has been proven (over and over again) that the detached electron is negative electricity, and it is thoroughly believed that the so-called flow of an electrical current in a conductor is nothing more than the movement of electrons; that is, it is a movement of negative electricity from a negative source towards the positive terminal.

We never have positive electricity in a free state. It is always hooked up with matter in some way or another, in so far as we know. An electron, on the other hand, can exist independently of matter or in association with atoms or molecules.

Conductors of electricity such as metals are composed of free electrons which move among the assemblage of atoms at a normally slow rate. An electric force applied to the conductor will drive these electrons from the negative to the positive direction at the normal velocity of electricity—you know, 186,000 miles per second. If the applied electromotive force is great enough, the free electrons in the conductor will collide with the atoms, and produce heat. We ordinarily call this heat production electrical resistance.

Insulators or dielectrics, on the other hand, are assumed to possess no free electrons, therefore they cannot pass the flow of current in the ordinarily accepted sense; in fact, in order to detach electrons from insulators, we must, for example, pierce them with an electrical spark. We thus tear sufficient electrons out of the structure to cause a breakdown, and ionization takes place, resulting in the phenomenon of heat and light. In plain words, electrons are imprisoned in insulators and we can only remove them by disrupting the atomic structure.

In summary: Add an electron to a normal atom and you will have a negatively charged body. Take an electron away from a normal atom and you will have a positively charged body.

It follows, therefore, dear Sir, that your existence is basically electrical. Not insofar as appearances are concerned, for you are of atomic dimensions. But if you have lived a normal life—a life made up of a vaguely defined amount of positively charged nuclei (whatever they are) surrounded by the correct number of electrons to effect a balance—you are just an ordinary everyday normal atom.

You undoubtedly possess a number of free electrons in your physical makeup. These are easily set in motion. Grasp in each hand the terminals of a 60,000-volt transformer. The ordinary slow-moving free electron which travels to and fro in your body at a rate of about 60 miles per second will suddenly rush forward at a speed of 186,000 miles per second.

Disruption of the atomic structure may ensue.

But that is science.

And though here at headquarters we greet the frankly curious many times, yet—as originally noted—we are ever eagerly inclined to standing by the facts in our statements.

Come again.

Chats With Our Contribs

Should the author of a work of fiction expose the plot of his story in the first paragraph, you would probably seek to establish contact with his intellect with an armful of bricks. You expect to twist and tangle in a mental labyrinth of startling experiences, the outcome of which can not be conjectured by the keenest imagination. And you don't expect the climax till the last chapter—which accounts for our lady fiction fiends reading the last three pages first.

Apropos of which Assn. Hdq. wishes to officially announce that our organ, the AGE, is designed for masculine consumption; i. e., minus the "surprise" ending—and strictly non-fiction in composition. Whereas some of our contribs eternally try to surprise us with technical articles prepared a la novelist. It's a regular thing to find in the mail a technical article with the plot exposed in the last paragraph. It won't do, worthy scribes. Readers of this magazine naturally want to know, first, what your story is all about. And they're right.

It couldn't be expected, for instance, that an architect who designed a house supplied the builder first with a description and drawing of a window, then of a joist, next of a sill, then of a doorstep, and so on, without extending the faintest idea of what the final appearance of the house was going to be. The builder naturally requires first some idea of the general plan and the objects of the design.

And so it is with technical MSS. Many of our contribs hand us a long, uninteresting story of the construction of minor details, without giving the faintest idea of what the object of the apparatus is until the last paragraph is reached. This requires an extra effort to grab the verbiage bull by the horns and turn him around the other way.

What are we grumbling about? The way in which some of you fellows with basically good ideas in your craniums twist them reduces the article to the status of a Chinese puzzle for our scrutiny.

If you offer us the design of some new piece of amateur radio apparatus, it must have some particular use. All right, then state the object of it in a broad, general way. Then point out the fundamental parts of which it is composed. Next state briefly its operation and then go into the details. Follow this by a concise statement of the results secured in practice.

This is the standard form which all our contribs should follow. It doesn't mean adopting standardized forms of expression, however. We want your story to be natural, but constructed with some sense of order.

We can use a great many manuscripts on general technical subjects. Particularly articles bearing upon the construction of experimental apparatus. Descriptions of new inventions, too, accompanied by first-class photographs will be paid for at regular space rates.

You must have noticed from last month's issue that a very large majority of those in the radio fraternity are under instruction either in the Army or Navy. The figures run up into thousands. They are helping to solve one of the greatest problems the Government had to face. It was soon found that a picked set of men were required to operate complicated apparatus of modern telegraph equipment.

Men in the service cannot, of course, write for publication without permission from superior officers, but we believe that many experiences which raw recruits have undergone at these radio schools would prove of great interest to our readers. These fellows should get busy—take pen in hand, and all that. Routing the product: MSS., superior officer, us. We can handle a lot of these articles.

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.

A. B. S., Cleveland, Ohio:

The speed at which a synchronous motor will run when connected to an alternator supplying current at a given frequency may be determined as follows:

$$S = \frac{2 \times f \times 60}{P}$$

when S = the revolution of the armature per minute, f = frequency of the supply current, P = number of poles in the motor field.

A ten-pole motor, for example, would run 720 revolutions per minute.

Replying to your second query, synchronous motors possess several disadvantages, among which may be mentioned that they are not adapted to variable speed; they possess a small starting torque; they require an outside exciting current and very skillful attention during operation.

Replying to your third query, the synchronous motor adjusts itself to variable loads by the change of phase difference between the armature current and the applied E. M. F. This is too comprehensive a subject to be discussed here; an explanation will be found in any textbook of alternating current engineering.

* * *

D. M. A., Washington, D. C.:

The inductance of a dynamo armature may be obtained by sending through it when at rest a measured alternating current simultaneously measuring the E. M. F. between the collector rings. The following formula then applies:

$$E = I\sqrt{R^2 + (2\pi N)^2 L^2}$$
or
$$L = \frac{1}{I^2 \pi N}\sqrt{E^2 - (IR)^2}$$

If the armature resistance R and the frequency N are known, the foregoing formula will give the desired result. Be sure and take into consideration that the value of L varies largely with the position of the armature in respect to the field poles. The reason is, of course, obvious.

* * *

H. R. T., Sydney, N. S. W.:

Your queries in regard to armature reaction in an alternator will be found answered in any text-book devoted to alternating current engineering.

When the armature current of an alternator is in phase with E.M.F., the armature reaction is negligible and the field flux therefore remains practically constant. On the other hand, a lagging armature current opposes the magnetizing action of the field coils, whereas a leading current assists the magnetization of the field poles.

Obviously an alternating current circuit of high self-inductance will tend to decrease the voltage of the alternator.

* * *

L. W. Seattle, Wash.:

A graphite rod of approximately 2,000 ohms will give the required resistance to be placed in series with your 400-ohm potentiometer.

* * *

G. C. H., Fort Stockton, Tex.:

In the wiring up of a vacuum tube panel receiving set, care should be taken to run the grid and plate circuit wires as far from one another as possible, and preferably at right angles. The two secondary terminals of the receiving transformer should be fairly well separated or otherwise they would add a shunt capacity of considerable value to the secondary circuit.

You can readily see that if the grid and plate circuit wires are placed in inductive relation, a certain amount of regenerative coupling will be obtained which may not be desirable in the circuit you have under consideration. It is not necessary to go to extremes in this matter, but it is well to take a certain amount of precaution.

We would not advise the use of an ordinary plug strap switch board for experimenting with different circuits for the reason that the parallel conductors of the plug cords possess a considerable amount of capacity between wires. This may upset the working of certain circuits.

Replying to your third query, it will not harm matters to bring the taps from the primary and secondary coils of the receiving tuner through the inside of the tube. It would be well, however, not to make them of inordinate length.

* * *

S. F. McC., Mercer, Pa.:

Ques.—(1) If a receiving set is constructed so that the inductance can be varied one turn at a time, is it ever necessary to employ a variometer?

Ans.—(1) A single turn multi-point switch will give all the regulation required. In event, however, that a single turn switch is not provided, the variometer will be found useful.

* * *

R. D. L.:

Ques.—(1) Are there any opportunities open for qualified wireless telegrapher experimenters to train students in either the Army or Navy? What are the chances of securing such employment and would a first-class amateur experience aid the applicant in securing recognition?

Ans.—(1) We believe that the amateur's experience in manipulating experimental wireless apparatus has secured just recognition on the part of the Government. A radio engineer in charge of a large Government radio school states that the students who were formerly amateurs made by far the most rapid progress. He found it rather difficult to teach men who have not had such experience to manipulate radio apparatus to secure the best results.

We are informed by the directors of the Marconi Institute that they are in receipt of numerous inquiries from colleges and universities throughout the United States for the services of radio instructors to train men in the Students' Army Training Corps. If any who have had commercial or amateur experience believe themselves qualified to carry on such work they should communicate with the editorial office of this magazine. Recommendations to the proper parties will be made.

* * *

T. D. L., Denver, Col.:

We understand that radio students at Great Lakes, Ill., after they obtain a certain ability in the International telegraph code are transferred to the classes of Harvard University. If they pass the examinations at this institution they are assigned to land stations, aviation camps or battleships. The greater proportion of assignments are made to the fleet.

In reply to your second inquiry, we understand that promotions from third-class electrician up to the appointments of chiefs are judged from the results of technical examinations given from time to time to those of proper qualifications.

A chief electrician should have a general all-around knowledge of wireless transmitters and receivers. He should be able to make elementary calculations on oscillation circuits. It is a foregone conclusion that he will have knowledge of tuning by means of a wave meter and measurement of the logarithmic decrement. Graduates of the Naval schools are expected to transmit and receive at a speed of 25 words per minute.

* * *

A. B. D., Cleveland, Ohio:

Ques.—(1) How can one enroll in the Students' Army Training Corps?

Ans.—(1) It is our understanding that if a man coming within draft age is already a pupil of a properly appointed Government training school, he will be permitted to remain and complete his course if the course he is taking is of value to the Government in prosecution of the war. On the other hand, those who are not in attendance at colleges or universities are selected according to the number of vacancies in the Students' Army Training Corps, application being made through local draft boards.

This is not official information, but it seems to be the general procedure followed in New York.

Newspaper reports have it that the Navy will open enlistments for 15,000 men per month from the various draft boards.

In reply to your third query, we believe that your knowledge of radio telegraphy will receive consideration from the Government after you have been called to service or permitted to enlist. As you will note from the draft questionnaire a thorough classification of all selected men is to be made.

Book Reviews

Above the Battle. By Capt. Vivian Drake, R. A. F. Cloth binding, 5x7½ inches, 323 pages. Appleton. Price $1.50 net.

The candidate for military aviation honors seems to have been particularly in the mind of the author while writing this book. The viewpoint is British, and the places and machines dealt with are English in substance, yet the spirit of aviation training has been caught with universality of understanding, and incidentally set down with many a whimsical touch to lend charm to semi-technical descriptive passages. When the training chapters are passed and the voyage overseas begun, the reader views the proceeding with a tinge of regret. So graphic has been Capt. Drake's descriptions of sensations in first flights that it is natural to wish for more. But equally important phases of flying are later included and described with quite as much skill. Bombing raids and night flights, artillery control, the day's work—in fact one chapter is so called—all are interestingly told in an easy conversational style. Readers who care for a little extra substance with an amiable descriptive method will be pleased with this book.

Obtainable through the Book Dept., THE WIRELESS AGE.

High Adventure. By James Norman Hall. Cloth binding, 5x7½ inches, 237 pages. Houghton Mifflin. Price $1.50 net.

Cavalry of the Clouds. By Capt. Alan Bott. Cloth binding, 5x7½ inches, 266 pages. Doubleday, Page. Price $1.50 net.

Knights of the Air. By Lieut. Bennett A. Molter. Cloth binding, 5x7½ inches, 243 pages. Appleton. Price $1.50 net.

The three books listed above are of similar type, all personal narratives and dealing broadly with military aviation in somewhat the same manner as the two narrative volumes just reviewed. In full justice to all, it must be said that they are unusually well written and leave little upon which to base a preference for the reader. In view of which, and since the main purpose of a book review is to aid readers to a decision as to whether or not they wish to secure the volume, the only real distinction must remain in subject, rather than composition.

Mr. Hall bases his incidents and anecdotes on the Lafayette Escadrille and its members.

Captain Bott glimpses the early war work of the Royal Flying Corps in France.

Lieutenant Molter does not limit himself to his unit, Escadrille N-102, but includes rather broad observations of facts and methods, with less emphasis upon experiences.

All three books obtainable through the Book Dept., THE WIRELESS AGE.

Traveling Under Orders. By Major William E. Dunn. Cloth binding, 4½x6 inches, 80 pages. Harper. Price 50 cents net.

This volume is one of those supplementary texts for Army officers that take up the very details which govern recognition of an organization commander as a mediocre or successful leader of troops. Drill manuals and field service texts give, so to speak, only the rules of command. Major Dunn's little book takes hold of the unwritten rules which have recently been required by the problem of moving a battery from a cantonment here to the front in France. The small things that are supposedly learned only by experience are particular subjects for his discussion. This item, for example, will be greeted with a reminiscent grin by every officer who has once entrained his command: "Trucks are obtained from a quartermaster to haul the property from the camps to the train. After a certain number of trucks have been assigned to an organization, a non-commissioned officer must be detailed to remain permanently with each truck, both in going to and returning from the train. Otherwise, an organization commander will soon find his trucks busily engaged in hauling for other outfits." Equally pertinent is the warning that the train conductor and Pullman conductor check their account with that of the organization, and if a few extra vacant berths are occupied by the men for their additional comfort, a letter will eventually come from the War Department to the commander, "requesting him to explain why a charge for the same should not be deducted from his pay." Tips like these appear on nearly every page, outlining the journey by sea, arrival in France and quartering at the training camp, marching to the front, billeting and arrival on the firing line. Certain it is that an officer cannot make a better 50-cent investment than in procuring a copy of this little volume prior to departure overseas.

Obtainable through the Book Dept., THE WIRELESS AGE.

The Koehler Method of Physical Drill. By Capt. William H. Wilbur. Cloth binding, 4¼x6 inches, 149 pages. Lippincott. Price $1.00 net.

Every American knows and admires what is recognized as the West Point carriage. It is distinctive and more than ordinarily graceful—and exceedingly difficult of imitation. The reason for this is perfectly clear to the initiated, for the set of our cadets' heads and shoulders, swinging stride and easy position of arms are the direct result of a method of physical training that is quite as distinctive as the result it secures. To Major Koehler entire credit is due for this physical drill, and to application of its principles the text of the present volume is devoted. In the hands of the author, Captain Wilbur, the explanations reflect the Koehler personality which has contributed so greatly to his success. Captain Wilbur has been his assistant at West Point and special instructor at Plattsburg, and he manages to convey in the pages that running exhortation to special effort which in the Army is universally known as "boning Koehler." As an instance, in the breathing exercises we find the interpolating directions: "Fill them up! On your toes! S-t-r-e-t-c-h!! Come on!" And again, in counting: "one, two, three, four—mark, each, position, four—one, two, three, four—hold, your heads, up four," or for individual correction: "one, two—one, Brown—up on your t-o-e-s, two—one, two—one, that's right—one, two," etc.

Thus in this small volume the reader is given not only the exercises well illustrated by photographs, but clearly indicates how the instructor may make the men feel that these physical drills are helping to make their particular organization the best in the army. The advance in physical drill which marked the advent of Major Koehler's method, being perpetuated in this small volume, makes the contribution of its author of very material value in building up men physically and working them up mentally.

Obtainable through the Book Dept., THE WIRELESS AGE.

En l'air! (In the Air). By Lieut. Bert Hall. Cloth binding, 5x7½ inches, 153 pages. New Library. Price $1.65 net.

This book, which takes its title from

the command given French aviators to leave the ground on a mission, is the personal narrative of one among the first of Americans living in France to enlist at the outbreak of the war. This group, thinking a country good enough to live in was good enough to fight for, were first to the trenches with the Foreign Legion. Experiences there are briefly covered and then the balance of the book is devoted to aviation training and various episodes of war combat. Lieut. Hall's story is really an informal record of the now famous Lafayette Escadrille; the reader is introduced to the original ten American members and learns of their exploits and methods of attack.

Obtainable through the Book Dept., The Wireless Age.

Glorious Exploits of the Air. By Edgar Middleton. Cloth binding, 5x7½ inches, 256 pages. Appleton. Price $1.35 net.

By numerous anecdotes and comments on branches of the air service, Mr. Middleton has gathered into his volume a neat collection of human interest documents dealing with aviation in war time. The necessity, or supposed need, for designating the men as X, Y, or Z, instead of giving their real names is unfortunate, but in spite of this handicap the exploits in themselves are so dramatic, and in character so heroic, that the aviator stands forth as a distinct type of warrior, resourceful and agile-minded, brave and with high principles of honor. For an evening's entertainment, no better book of its kind could be found.

Obtainable through the Book Dept., The Wireless Age.

Glossary of Aviation Terms, English-French. Compiled by Capt. Victor W. Page and Lieut. Paul Montariol. Stiff boards, 5x7½ inches, 94 pages. Henley. Price $1.00 net.

This booklet does not give definitions of terms, but supplies the French equivalents for a list which is divided into four parts, namely, flying field, the plane, the engine, tools and shop. Fourteen illustrations are included, the parts of the apparatus shown in each being clearly lettered with the French term above a line under which the English designation is given. The book is intended only for use of those already familiar with aviation.

Obtainable through the Book Dept., The Wireless Age.

A French-English Military Technical Dictionary. By Col. De Witt Willcox, U. S. A. Cloth binding, 6¼x9¼ inches, 584 pages. Harper. Price $4.00 net.

Colonel Willcox's standard work appears in 1918 dress with nearly a hundred added pages to include all the new technical nomenclature of aviation and trench warfare. Even military slang and the special modern terms of the artillery and the camouflage corps appear, bringing the dictionary literally up to date. Its compiler's position as Professor of Modern Languages at West Point has given him unusual opportunities to collect the new words from reading official and standard texts. Thus for the officer about to engage in overseas service it may well prove an invaluable aid should he be assigned in time to liaison duty.

Obtainable through the Book Dept., The Wireless Age.

Fundamentals of Naval Service. By Commander Yates Stirling, U. S. N. Cloth binding, 4½x7 inches, 589 pages. Lippincott. Price $2.00 net.

Civilians in the draft who purpose arranging for induction into the Navy will find in this volume an exceptionally broad and practical explanation of the workings of all parts of naval ships and the duties of the various classes of personnel. It is a condensation in very readable form of an immense amount of official material from the Navy Department and a thoughtful abstract of the best essays on sea strategy.

Past and present naval policy is reviewed, principles of strategy given, and traditions, training, honors and distinctions explained. The evolution of the modern dreadnaught is traced and all types of battle craft described. Organization and administration of the department and a warship at sea is contained in a separate section. Seamanship, navigation, construction and ordnance lead up to a careful explanation of the multitudinous uses of electricity and the many engineering branches which comprise the naval establishment. Naval aviation is also dealt with, and the personal aspects broadened to include a survey of the navy as a career and the soldierly duties of the sailor. Even first aid and hygiene are listed among the subjects contained between the covers of this veritable "bible" of naval affairs.

It may be said without reservation that Commander Sterling has produced a notable contribution to naval literature in this handbook.

Obtainable through the Book Dept., The Wireless Age.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of The Wireless Age, published monthly at New York, N. Y., for Oct. 1, 1918.

State of New York,
County of New York. } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of Wireless Press, Inc., publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are.

Publisher, Wireless Press, Inc., 25 Elm St., New York, N. Y.

Editor, J. Andrew White, 25 Elm St., New York, N. Y.

Managing Editor, None.

Business Manager, Alonzo Fogal, Jr., 25 Elm St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Wireless Press, Inc., 25 Elm St., New York, N. Y.

E. J. Nally (851 shares), 233 Broadway, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. J. NALLY,
President.

Sworn to and subscribed before me this fifth day of October, 1918.

(Seal.) M. H. PAYNE.
(My commission expires March 30, 1920.)

Turn Your Spare Hours Into Dollars

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The men in various parts of the country who have represented us during the past summer have made good money considering the time they devoted to this work. More money can be made by men this winter because thousands of additional men will be training for radio service.

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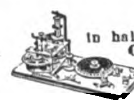

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