December, 1918 20 Cents

The WIRELESS AGE

Volume 6 Number 3

Practical Instruction in
Aviation - Modern Wireless - Military Signaling

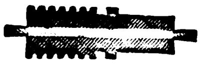
Special Feature:

How Science Beat the Hun

BUY WAR SAVINGS STAMPS

FOR ALL THERE IS IN IT!

165-A.



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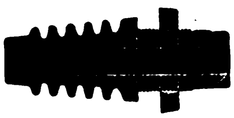

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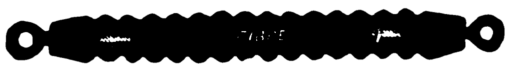

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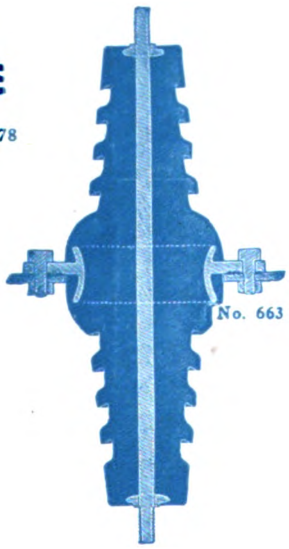

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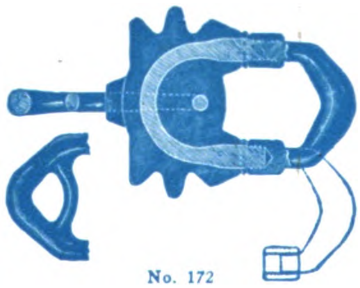

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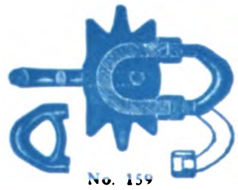

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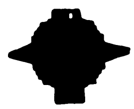

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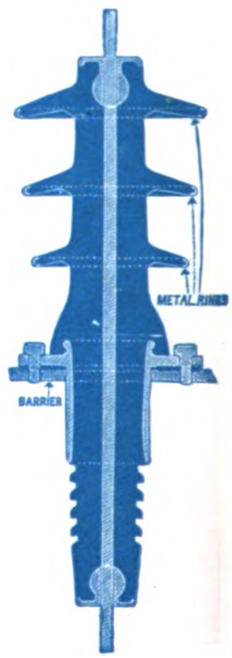

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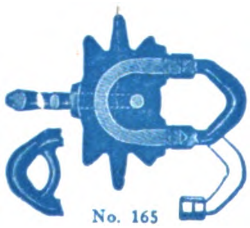

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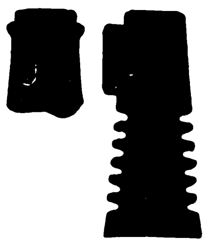

No. 7512

The Wireless Age

Edited by J. ANDREW WHITE
E. E. Bucher, Technical Editor.

Vol. 6 — No. 3

Contents for December, 1918

Index of Equipment

RENEWALS—When subscription expires, find a renewal blank enclosed. Return with remittance promptly.

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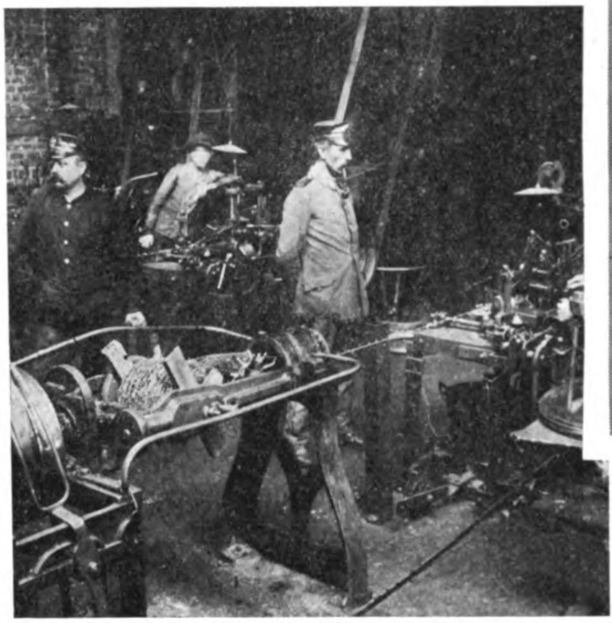
GREAT BRITAIN
Marconi House, Strand, London

AUSTRALIA
97 Clarence St., Sydney, N. S. W.

Barbed-Wire

Photos: British Official



That thousands of racks like those shown above and miles of barbed wire must be removed from France and Belgium is but one of the reconstruction problems facing the Allied armies

It is a safe assumption that shops such as shown at the left may be put to uses other than manufacturing the wire entanglements which have up to now been of so material a factor in warfare

When trees were felled to block a canal their removal by the enemy was impeded by weaving the wire through the branches

Vol. 6. No. 3. December, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Airplanes Directed By Wireless Phone

SQUADRONS of American airplanes fighting in France up to the moment of the armistice were maneuvering under the vocal orders of the squadron commander that reached each pilot by radio telephone.

News of the successful development of this device, hitherto a military secret, though some inkling of it had reached the Germans just before hostilities ceased, is now allowed to become public by John D. Ryan, director of aircraft production.

"There are some details concerning it which we cannot discuss yet," Mr. Ryan said, "but the radio devices worked out during months of experiment went into actual service some weeks ago. I have myself, standing on the ground, given orders to a squadron flying in the air and watched them maneuver accordingly. The transmission of the voice is clear enough to be heard distinctly through the sound of the airplane motor. It is in every way the most satisfactory means of communicating between planes in the air and from the ground to planes."

Mr. Ryan said he could not discuss the distances over which the radio telephone has worked, but it is known to be a matter of some miles.

W. C. Potter, of the equipment division of the bureau, explained that the idea of the radio telephone was conceived some time ago by a number of experimenters.

"For some months it has been possible in our offices in Washington to hear the airplanes flying miles over the city," he said, "talking to each other and to the ground as they worked out and perfected the device."

Loan to China Arranged by Marconi Co.

BANKERS interested in the proposed international loan to China said that the Chinese loan of £600,000 which London cables report will be offered there soon at 105 has no bearing on the Five Power Loan in which the United States probably will participate. It is merely a local loan arranged by the English Marconi Wireless Company in connection with the installation of wireless apparatus in China. The Five Power Loan still is in the diplomatic stage.

The issue arranged by the Marconi Company has been sanctioned by the British Treasury and Foreign Office, it is reported.

The Chinese Government has signed a contract with the Marconi Company for the construction of three wireless stations at Kashgar and Urumchi, in the province of Sinkiang, near the Turkestan border, and at Lan Chow Fu, capital of Kansu province, in central China.

A smaller station will be erected at Sian Fu, in Shensi province. These stations will establish communication between Kashgar and Pekin. They will be of greater transmitting power than any others in China.

Five New Stations for Philippines

THE Philippine Government has released an appropriation of $37,500 for the erection of a wireless station in Manila. Other appropriations provide for stations at Cebu, Bongao, Puerto Princess and San José, Mindoro.

Kirby in N. Y. World

"You Held Fast and We Won"

Institute Wireless for Forest Fire Emergency

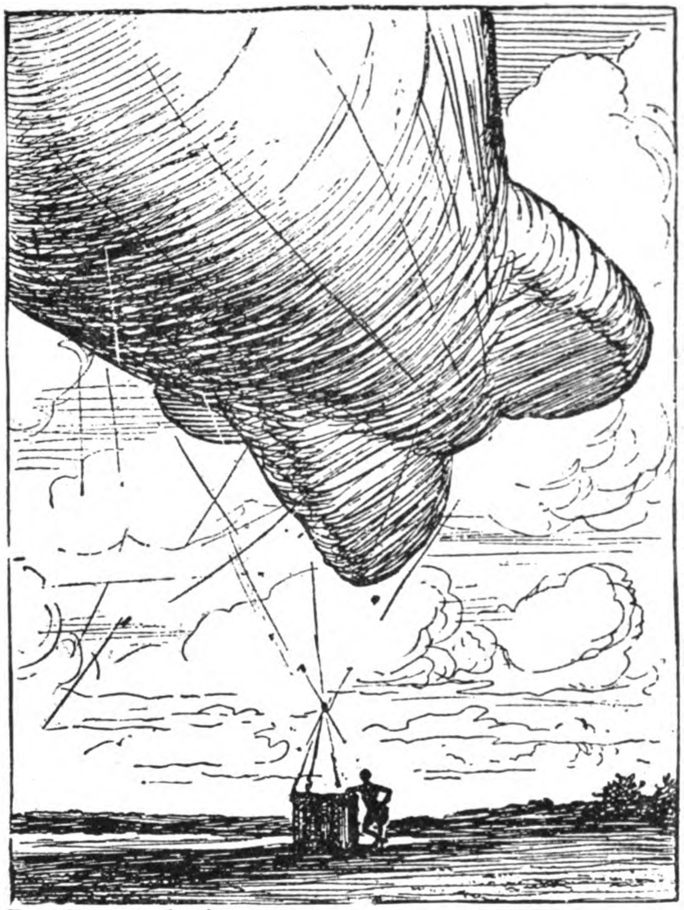
DUNWOODY INSTITUTE, Minneapolis, on October 13th, volunteered the use of its wireless plant in maintaining communication with Duluth, should other sources be broken by the forest fires. Dunwoody has the only authorized radio plant in the state, except the Government station at Duluth. It has been able to maintain the station only through the fact that naval operators have been trained at the institute.

H. W. Kavel, acting director of Dunwoody, when informed of the possibility of the loss of other sources of communication with Duluth, promptly proffered use of the station, if it be needed.

"Although we have no authority for using our plant in this kind of work," he said at the time, "loss of other communication would constitute an emergency for which, I believe, we would have no difficulty in obtaining permission to use it."

Report That Holland Contracted for German Station

LITTLE comment has been aroused by the report that Germany contracted for a wireless station in Holland less than two months ago. The radio profession is, however, extremely interested in the dispatch which was cabled to the Christian Science Monitor on October 12th announcing a Berlin message which stated that the Dutch Government concluded an agreement with the German Telefunken Gesellschaft, empowering the latter to build a wireless station at Kootwijk in Holland, of the same power as the Nauen station, to enable Holland to hold wireless communication with North and South America, and the Dutch East Indies.



From Punch (c) London

Sent in reply to the following request: "Darling, do send me a picture of yourself standing by the machine you fly in"

Enemy Submarines Radio Weather Reports

IN connection with the work of the German Army Meteorological Service, it has, since the beginning of the war, been a matter of some interest to know how the enemy obtained the observations, especially from the western coast of Ireland, which are very necessary in constructing weather maps and in making forecasts. Captured documents show that their meteorological reports were fairly complete, despite the fact that no publication of weather data or forecasts were permitted in English newspapers. An English meteorological expert declares that the answer to the question is not through any system of spies and land wireless, but that the data were obtained from observations taken by submarines. He thinks that a submarine working off the western Irish coast was detailed to send weather reports to Germany by relays through the wireless apparatus working around the British Isles.

Sites for Japanese Station Decided

ACCORDING to the Japanese department of communications, the new duplex wireless station, the construction of which this magazine predicted in the October issue, is to be built in Fukushima prefecture and will cost 860,000 yen ($430,000). The transmitting station will be at Hibarigahara, near Haria-machi, and the receiving station will be at Hosoya-cho. Survey work has been started by engineers of the department. The direct distance between the new office and San Francisco is 4,600 miles, while that between the Funabashi office and Honolulu is 3,250 miles. Service will not be opened for two years.

Ship's Radio to Report Gulf and Coast Weather

"IF VESSELS of any size at sea and plying the gulf had necessary wireless instruments so as to notify the weather bureau stations of weather conditions it would be a great benefit in forecasts," is the opinion of Meteorologist W. J. Bennett of Tampa, Fla. "Had such been the case and if war conditions permitted boats to be stationed at certain points, warnings of such disturbances as the Clearwater and west coast storm would be forecasted in time for an advisory," he adds.

"The hurricane or series of tornadoes which apparently originated in the central section of the gulf was the first storm of any intensity to occur in years of which no warnings were given. It is possible that warnings were sent to Washington of this storm but it was too late for advisories to be given out," he explains.

Mr. Bennett thinks that with the war over the Government may take some action in putting vessels with wireless equipment at such points that advices may be sent by wireless to the weather department in Washington in time for warnings.

Secret Wireless Station Helped French

SINCE the armistice brought hostilities to an end it has been learned that the morale of the population of Lille was maintained by news given from a French wireless station hidden from the Germans. Good news spread quickly through underground channels. The people knew that 10,000 American soldiers were arriving daily. Airplanes also dropped many leaflets, which were eagerly taken despite German efforts to prevent their distribution.

Constabulary Seize Unsealed Set

AFTER troopers of the State Constabulary had maintained a vigil three nights outside the home of Christian H. Siebs in Spring Valley, N. Y., where they discovered a wireless telegraph station, Lieut. John Walton seized the apparatus on October 17th.

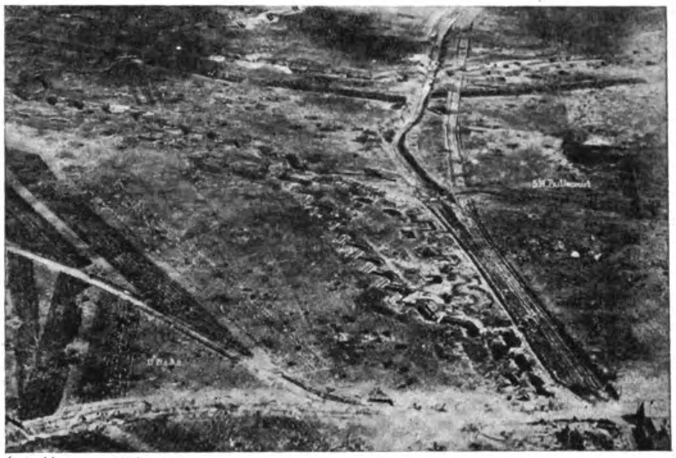
Police and military authorities long have been trying to trace mysterious signals and surreptitious wireless outfits in the hills of Rockland County. Recently, through Major Ord of West Point, signallers were warned they would be shot.

Lieut. Walton found the set dismantled but in such shape it could be very quickly set up and operated. It had never been sealed, as the Federal law requires, the police allege.

No further action will be taken, it is announced, as there was no evidence that the apparatus had been in use for several months, and that the only complaint against Siebs was that the apparatus was not sealed, as required by Federal regulations.

British Official Photo

Perfection of signaling systems using sound and light has been one of the principal achievements of American physicists



(c) Comm. Pub. Info.

A trench system like this, a view of the Hindenburg Line, became possible only through the help of the geologist

How Science Beat the Hun

The Accomplishments of the Trained Man of Science in the War *

By J. S. Ames

Professor, Johns Hopkins University

I THINK it is only fair to say that the universities of this country have played their part well. Before we actually entered this war, in those anxious years when we were waiting to see whether we would be given an opportunity to join in the fight for the cause of honor, freedom and the teachings of Christianity, or whether we must walk through the years of our lives with heads hung in disgrace, no group of people did as much to hold aloft the illuminating torch revealing the iniquity of the enemy of civilization, as did the presidents of our universities. Theirs will be the honor forever. They would not keep silent. Then, as soon as we were by official act in a state of war, the first to step forward and say "use me" were the faculties and the student bodies. It was indeed a sight which brought tears to the eyes, and even further, to see our young men, the chosen men of our land, struggle against all restraints, eager to bring to an end that evil thing which threatened to destroy all the joy of life, all that made life worth living. Every teacher has felt thrilled by the daily farewells of his students, as one by one has obtained permission, by fair means or otherwise, to enlist in the grand adventure.

It is the privilege of being a young man today, a college man or not, to be a soldier in the cause of civilization and to help bring victory to its colors; and what a glorious privilege this is! But upon whom rests the duty of interpreting events and their causes in language so clear that every man understands? Surely, upon the university man. And, when victory is won and men can give their minds to thoughts of safeguarding the world, there is no one to guide them but the students of history and of political science.

It would be a simple matter to show how a special and particular responsibility has already come to and will continue to remain with each and every university group of scholars. I can speak with more definite knowledge of the relation borne by various branches of science with the war; and it is to this feature that I shall confine myself.

A recent writer has alleged that the study of science at the expense of morals in German universities has led to this war.

This is a bitter charge, but it is supported only by fallacies. Macaulay, in his brilliant essay on Dryden, shows, by a series of striking illustrations, how little is the influence upon the age of any individual, or any special group of individuals, when compared with the influence of the age on the man or group. When the time is ripe, the idea is born; the special man who reveals it is immaterial.

So it is today, no one man, no particular department of thought or study can be held responsible for the present conditions in Europe.

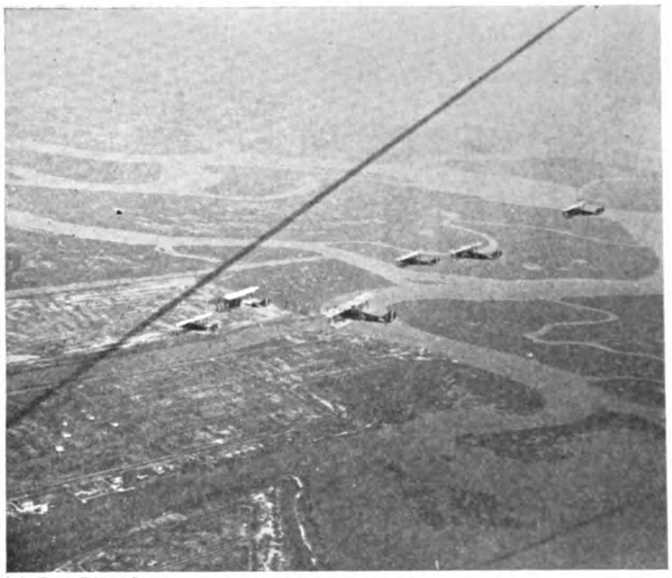
It is no more fair to say that the pursuit of science perverts character than to assert that the study of morals results in ennobling it. This war is due to a gradual debasement of character and nothing else, and the cause is to be sought in the will of the leaders of Germany.

One reason why science has been thought of as the scapegoat is because it was so evident from the very beginning of the war that Germany had mobilized for the purpose of war all her men of science, and was using the fruits of their investigations in ways entirely unexpected. This was a matter of great surprise to most Americans, and illustrates clearly the comparatively insignificant position held by scientific men in the minds of our people.

This feature of Germany's long preparation for war, and of her manner of waging it was recognized instantly; and preparations to combat it were made promptly by all the allied peoples. Fortunately for us, the essential advantages were all with the French and British, inasmuch as their men of science had for nearly a generation been the ones who had given to the world its great discoveries and their most important applications. So their scientists came to the problems with ideas and methods which in many cases far surpassed the power of Germany to equal. The result was instantaneous; and today the efficiency of the forces of the Allies on the sea, on the land and in the air is due in no small degree to the men whose previous lives had been devoted to the pursuit of the pure sciences in university laboratories.

When this country entered the war, it is true beyond any doubt that American people had great expectations, nay a conviction, that with our so-called inventive genius

* Abstract of an Address at the University of Virginia.



(c) Int. Film Svce.

These airplanes remind us that the so-called Liberty engine, the result of scientific investigation, has no superior in the world. It weighs but 2 pounds per horse power

we would seriously influence the war, perhaps stop it, by the epoch-making inventions which our professional, highly advertised inventors would quickly make. The newspapers helped in fostering this belief, and many were the proud boasts which we heard. There was a great disappointment, almost a shock, as the days went by, the periods promised for great accomplishment passed, and certain names almost disappeared from the public press. We have in fact stopped asking what has happened to the "wizards."

The reason is that the problem of this war is not to perfect an old device, but to design a new one; the knowledge required is not that of the amateur or even of the trained engineer, but definitely that of the scientific investigator, the man who by his own laboratory investigations has added to our store of knowledge.

One illustration of this may suffice; one government board, with whose activity I am familiar, has had submitted to it in the course of the year 16,000 projects and devices, proposed by so-called inventors; of these only five had sufficient value to deserve encouragement.

I have nothing but admiration for these 15,995 men, whose disappointment must have been keen. Most of them were more than willing to give their inventions freely to the government. The point I wish to emphasize is that the ability and knowledge required in waging this war successfully are not those possessed by any body of men except those with a profound knowledge of science and of scientific method. The problems are too complicated. It is true that with the help of trained technical men we will get better engines, better explosives, better guns; and for these we should be truly grateful to our much-boasted American genius. But, consider a problem like this: to devise a light signal, which can be used by day or by night, and which will be absolutely invisible to the enemy.

Who can solve that? The answer is obvious: only a physicist.

In times of peace, when commercial development is uppermost in men's minds, the university scholar is at a great disadvantage. He rarely knows what problem is to be solved. He is busy with his own studies and researches, and does not come in contact, in the ordinary course of life, with the demands of the technical trades. His discoveries are made use of, and are always—sooner or later—of commercial value; but in this later stage he does not take part.

Nearly all of our great technical companies maintain extensive laboratories where trained men pursue investigations in pure science; but problems are rarely given them to solve. Today, in order to meet the insistent demands of the war, the whole process is changed. On every battlefront of Europe, attached to the various staffs, are men from university faculties, skilled in observing, quick to learn what is needed. In Paris, London and Rome there are groups of university men whose duty is to collect data from the Allied powers along similar lines. Reports containing clear statements of the problems are cabled to Washington. To this same center come requests for help from our own forces on this side of the ocean. Then, as soon as the problem can be formulated with definiteness, one or more men are asked to find the solution.

For the first time in the history of science, men who are devoting their lives to it have an immediate opportunity of proving their worth to their country. It is a wonderful moment; and the universities of this country are seizing it. The stimulus to scientific work is simply enormous; and the growth of our knowledge is astounding. In many cases investigations are prolonged for months, and in the end possibly the much desired solution is not obtained; but in any case new methods are made available for future use, new instruments are perfected, and the store of human knowledge is vastly increased.

Let me give one illustration of this reaction of the demands of war upon pure research. In the construction of a mask to be used in case of a gas-attack it is obvious that one method of defense is to make use of charcoal which is known to absorb many gases with great rapidity. A scientific problem was to try to increase the efficiency of this absorbing action; and it was soon discovered that by a special treatment of charcoal made in special sizes from special wood the absorptive power could be increased enormously.

Here is a fact of the greatest importance to the chemist, a fact which will be remembered in countless investigations of the future; and yet it is doubtful if it would have been discovered for many years to come if a particular chemist had not been asked by the military officers to help them.

My thesis is the importance of the work of the trained man of science in this war, with emphasis upon the fact that his great usefulness should not be a matter of surprise, as it is to most Americans. The best way of demonstrating this is to give a few illustrations, chosen from a wide field and not limited to the scientific work of any one country. Naturally I can refer only to those matters which have been revealed to the public; but I trust that many of them will be new. I have this confidence because so far the newspapers of this country have not believed that these questions would make what is called a "story."

(c) Press Ill. Svce.

This model of the monster 75 mm. gun illustrates how profound must be the knowledge of science which wages war successfully

It is not easy to make a selection of the scientific problems, nor to arrange them in any logical order. There are two subjects uppermost in the minds of everyone: the airplane and the submarine. The scientific questions which have arisen in regard to each are most varied.

The airplane itself is an engineering structure; and we have confined ourselves in this country largely to the design and production of an engine. This does not really come under my general subject, but every one is so interested in it that I feel justified in referring briefly to what we have done. Our task was to produce on a great scale a powerful, efficient engine. This is now being done. The so-called Liberty 12-cylinder engine does not have its superior in the world, and further, it was so designed that it could be manufactured on an enormous scale, at least 1,500 a month. This engine has over 400 horsepower and weighs close to 800 pounds, and therefore it is useful for seaplanes, two-seater machines and bomb-droppers, but not for small machines.

When the same engine is made with 6 cylinders, developing about 220 horsepower, and weighing about 400 pounds, we will have an ideal engine, not equalled by any now in existence, for speed scout machines.

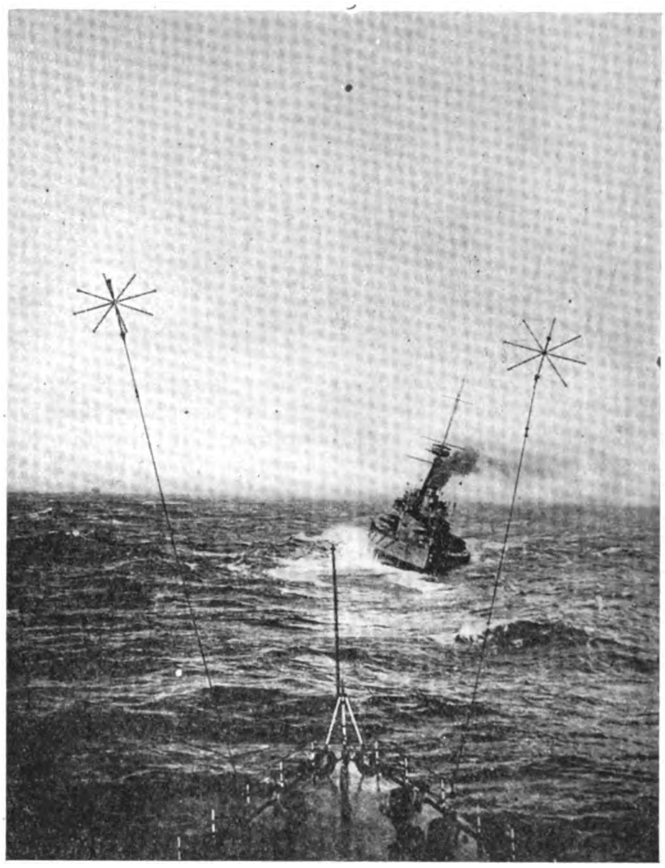
We could not have followed any plan more useful to ourselves and the Allies than to make this concentration of effort. Our eminent success is a cause of pride to every American.

With regard to the airplanes, considered apart from their engines, a few statements of fact must suffice, but they are facts. The best airplanes in service today, for each and every purpose, are those of British and French design. This is the result of real scientific investigation. The resistance offered by wings of different sections, the stability of the airplane, the character of the covering surfaces have all been investigated, and the finished product is the result of the knowledge thus acquired.

We are doing similar scientific work in this country today, and, as we have engineers and manufacturers unsurpassed in the world, the time is not long distant when a truly American airplane will be made. We shall suffer, however, one serious detriment during the war; we are so far away that it will be extremely difficult for us to make the alterations in design which the varying conditions of modern war impose. Difficulties of transportation are great, and it is a serious question whether it would not be best for us to remove bodily our most important airplane shops directly to the Continent.

From a scientific standpoint the most important questions arising in connection with airplanes are instruments of navigation and methods of signaling to and from the ground and each other. Each machine should have for ordinary flights an instrument to indicate height above the ground, another to give the speed of flight through the air, another to tell how steep is the ascent or the descent, and many others. For long-distance flights a compass is necessary, and other instruments as well. The design of each of these is a distinct scientific problem.

Think of the requirements for a compass to be used with an airplane; for a ship on the ocean the problem is complicated, but how much more so for a vessel which turns rapidly, revolves in spirals, and which practically never keeps a constant course. In practice even more difficulties arise. The whole question of airplane instruments is still unsettled to a certain extent; many essential instruments have not as yet been designed, and improvements are needed in them all. Scientific men in all countries, including our own, have the matter under study; and the results so far accomplished are truly wonderful.



Central Photo News Svce.

This close up view of an armed cruiser's wireless aerials calls to mind the improvement in naval communication, which also may be credited to the work of trained physicists

In the use of airplanes for observation purposes, or in squadron formation in making attacks, it is essential for the men in the machines to communicate with the ground. Many systems are in use, involving the application of light signals, wireless telegraph, etc. Obviously the proper instrument would be the wireless telephone, and that is surely coming, and soon it will be possible for one pilot to talk to another or with the commanding officer on the earth; and the latter can give orders to all of his machines in the air.

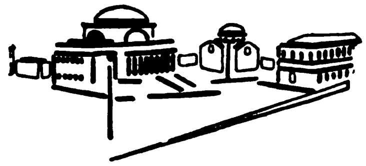
The objection to the use of all forms of wireless apparatus, telegraph or telephone, is that the enemy may confuse the signals by using the same wave-length for his disturbing impulses. This may be prevented however. Under the demands of the modern army, all forms of wireless have been so perfected that the progress made is a source of surprise and wonder. In fact there have been made in this country certain modifications and improvements which are held rigidly secret. It is interesting to note that every one of these alterations in wireless operation was first worked out in physical laboratories, by trained physicists.

Closely associated with the airplane is the balloon, either a dirigible or an observation one. The great problem here is to find a means of inflating it with some gas which is non-inflammable.

Hydrogen is now used in general; and, when a balloon is brought down in flames, it means that the hydrogen has caught on fire. This problem is partly physical and partly chemical; and numerous experiments are now in progress, all being directed by university men.

The tactics of fighting in the air are essentially unique, and before long we shall see a land-service, a sea-service and an air-service.

Progress In Radio Science



An Enclosed Rectifier

A RECTIFIER suitable for use with alternating currents over a current and voltage range comparable to the capacity of a mercury arc rectifier has been designed by G. S. Meikle.

It differs from devices employing incandescent cathodes exhausted to a lamp vacuum in that an inert gas such as argon at a considerable pressure is injected into the enclosed medium.

No very definite lower limit of pressure can be assigned; for practical operation it should be below one millimeter of mercury, for at very much lower pressures the cathode disintegrates rapidly.

The electrical characteristics of the tube shown in figure 1 are substantially those of an electric arc; and as a rectifier currents of many amperes—depending upon the size of the apparatus—can be rectified, without discharge of any current in the reverse direction. These results are obtained with a low voltage drop, which in argon is approximately 1 to 2 volts, and which varies with the temperature of the cathode, pressure of gas and other conditions.

Various inert gases may be introduced into this rectifier. Among these gases argon possesses several marked advantages. For example, an arc in argon exhibits a very low voltage drop. Under favorable conditions the difference in potential across the electrodes between which the arc is operating is only

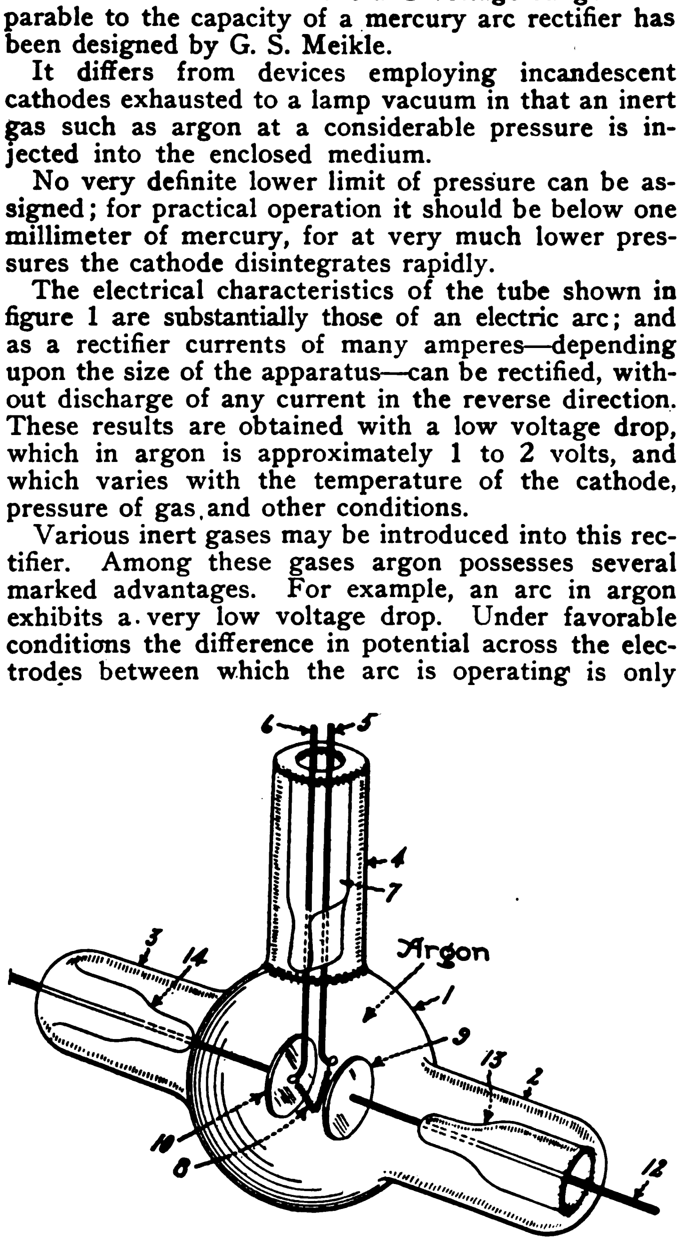


Figure 1—A full wave rectifier containing argon

about 1 to 2 volts. Argon, being gaseous at ordinary temperatures, protects the incandescent cathode from disintegration at the very start of the operation of the rectifier, whereas mercury vapor, which exhibits the next most favorable voltage consumption to argon, is condensed to the liquid state when the arc is not operating, so that some disintegration of the electrodes takes place before the mercury has become vaporized. A bulb filled with argon is also more transportable than one containing mercury.

Figure 1 illustrates a full wave rectifier containing argon; figure 2 illustrates one particular form of half wave rectifier, and figure 3 is a diagram of electrical connections.

The full wave rectifier shown in figure 1 comprises a glass envelop 1, which has three side arms 2, 3 and 4, provided for the convenience of sealing in the leading-in conductors. The cathode conductors 5, 6 may, for example, consist of tungsten sealed directly into a stem 7 of low-expansion glass, such, for example, as

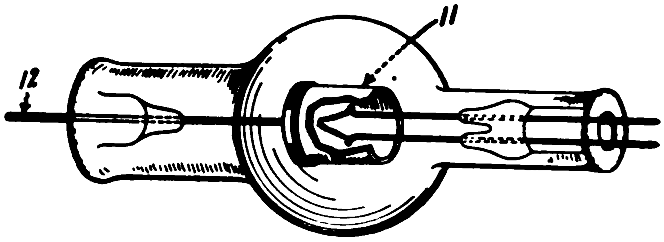


Figure 2—Illustrating one particular form of half wave rectifier

sedium-magnesium boro-silicate, although any convenient seal may be used. The cathode comprises a filament 8 of tungsten, or some other highly refractory material, operable at a temperature of about 2,000° C., at least. The cathode is heated to incandescence during operation, by a battery as indicated at 16, figure 3, or from any convenient source of current. In some cases, the heating current may be cut off after the discharge or arc is started, particularly when the gaseous atmosphere is at high pressure; enough energy will be liberated by the arc to maintain a portion of the cathode at a sufficiently high incandescence.

A clean, refractory metal, such as tungsten, at incandescence is a primary source of electrons. As indicated in the drawings, the cathode filament is conveniently coiled so as to minimize the heat losses and at the same time provide maximum surface within a given space.

The anodes 9, 10, are relatively much larger than the cathode and may have the form of disks, as shown in figure 1, or may consist of a cup, or cylinder in a half wave rectifier as shown at 11, figure 2. The anodes consist of tungsten, although any highly refractory material may be used. The tungsten anode terminals 12 may be sealed directly into stems 13, 14, of low expansion glass.

The envelop is first very carefully evacuated and baked out at as high a temperature as the glass will stand without softening, so as to remove residues of air and water vapor. Unless the anodes have been freed from gas previous to mounting—for example, by heating to a high incandescence in a vacuum—they should be freed from deleterious gases in the tube by electron bombardment, by impressing between the cathode while at incandescence and the anode to be purified a voltage high enough to cause an electron current to flow, but insufficient to produce appreciable positive ionization. Deleterious gases are thereby driven out of the anode. The evacuation may then be continued and the voltage progressively increased as gas is removed.

A quantity of argon is then introduced into the envelop. The gas is preferably at a pressure varying from about one centimeter of mercury pressure upward to atmospheric pressure. No definite lower limit of pressure can be assigned, but the pressure should be high enough to largely suppress electrical disintegration of the cathode by bombardment of ions.

When the gaseous pressure is low, it is necessary to provide for greater electron emission at the cathode than is necessary to convey the current; for example, by increasing the temperature of the cathode. A negative field is thereby established about the cathode; the bombardment of the cathode by positive ions and its disintegration, is reduced by the presence of these electrons, which apparently return to the cathode.

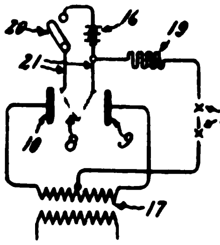


Figure 3—Diagram of electrical connections for enclosed rectifiers

At the higher pressures the electrical disintegration, or sputtering, of the cathode is correspondingly less and the useful life of the device is correspondingly longer, so that a high electron emission is not necessary to give a long life; although, of course, a high electron emission may also be employed even at higher gas pressures. The thermal disintegration is also less at higher gas pressures. As the pressure of the gas increases beyond a certain limit, varying with the nature of the gas—which, as in the case of argon, is somewhat less than one centimeter of mercury pressure—the voltage drop in the tube increases. In most cases, however, it is desirable to operate at a gas pressure substantially above the region of minimum voltage drop in order to secure a fair life. However, when currents of low voltage are to be rectified and the highest efficiency is desired, the voltage drop permissible may make it desirable to sacrifice life to efficiency to some extent, and therefore, to operate at the pressure of minimum voltage drop. Ordinarily this is not desirable.

As shown in figure 3, the anodes 9, 10, may be connected to the terminals of a source of alternating current, such as the secondary of a transformer 17, the cathode 8 being connected to an intermediate point of potential in series with a load 18, and a series resistance 19. The device is started after suitable connections have been made by closing the switch 20 in the heating circuit 21 and heating the cathode to incandescence.

The electrical operating characteristics of the device are those of an arc; that is, an increase of current produces little appreciable instantaneous change of voltage. However, inasmuch as an increase of current will also increase the gas pressure, an increase of current is accompanied by an increase of voltage drop if sufficient time has elapsed for adjustment of pressure.

Wireless Time-Signaling Device

EDOUARD BELIN, of Paris, has developed an apparatus for synchronizing time clocks from one main radio station, permitting at predetermined intervals a correction of errors encountered in the clock mechanisms. Several methods are available for obtaining coincident effects at the transmitter and receiver, one described by M. Belin, follows:

Figure 1 shows a diagrammatic representation of the apparatus and electrical connections, while figure 1a is a view similar to figure 1 of the apparatus located at the receiving station. Figure 2 shows a sectional view of the auxiliary adjusting apparatus.

At the regulating station A a clock or chronometer 1 periodically closes a contact in the circuit of the battery 2. This circuit passes into the relay 20, causing the wires 3 to radiate electric waves and form the regulating signal; at the same time current passes through the electro-magnet 4, attracting the armature 5, which on being displaced releases a stop 6 on the main drum 7, which in turn is driven by a motor through the friction clutch 8 and runs at a speed rather greater than that corresponding to the period of the chronometer 1. Therefore, between two consecutive closings of the circuit by the chronometer, the drum 7 makes one turn.

At the receiving station, shown in figure 1a, a chronometer or clock 1′ is provided which is identical and isochronous with the chronometer 1 of station A. Its operation is also similar to that of the station A in that it releases at similar intervals by means of the electro-magnet 4′, its armature 5′ and stop 6′, and a drum 7′ driven by a motor through the friction clutch 8′. This is not the driving drum. The drum 7′ must control, and bring into synchronism with it, a drum 7″ driven through the friction clutch 8″ by means of a system comprising the electro-magnet 4″, the armature 5″ and the stop 6″, but the moment at which it can release the stop 6″ can be regulated to coincide with the moment when 4′ is operated.

For this purpose the drum 7′ is provided with a contact 9, which at each revolution strikes against a contact 10, closing the circuit of the battery 2″ through the electro-magnet 4″. In parallel with this circuit is arranged the receiver E, in such manner that the clos-

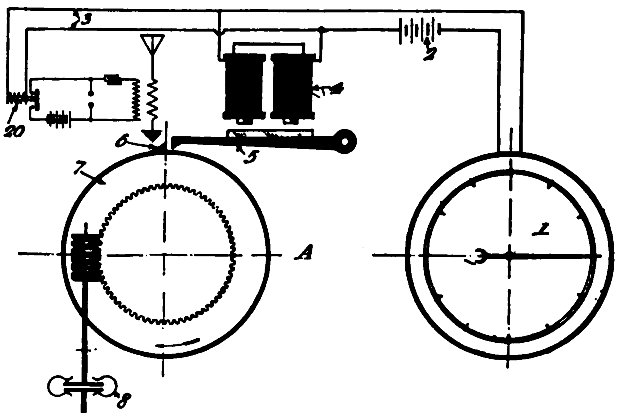


Figure 1—Diagram and electrical connections of wireless time-signaling device at the regulating station

ing of the contact can be detected. By listening, it is then possible to hear both the signal emitted by the main battery 2 and the signal by the controlling battery 2′. This in practice will hardly ever be in coincidence. All that is necessary then is to move the contact 10 by displacing it, manually through the screw 11 and the wheel 12 around the axis of rotation of the drum 7′ in such manner as to obtain an exact coincidence. At this moment the synchronism of the drum 7′ will be identical with the drum 7 which were formerly only in isochronism. The synchronism will therefore remain as long as isochronism exists between the two chronometers or the clocks 1 and 1′.

In figure 2 is a sectional view showing the method of operation of the parts 7′, 8′, 9, 10, 11 and 12. A support 13 carries the shaft 14 of the drum 7′ driven by means of the screw or pinion 15 through the direction clutch 8′. This shaft 14 is provided at its other end with a disk 16, in which is embedded the contact

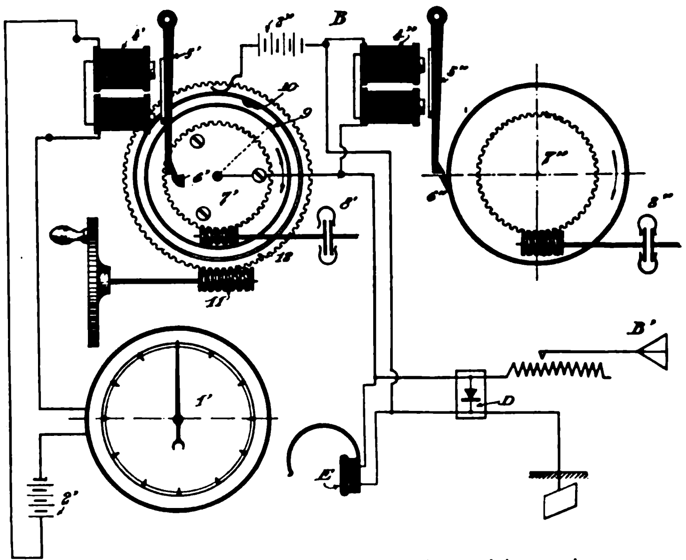


Figure 1A—Diagram of apparatus at the receiving station

9 in the form of a ball spring pressed outwardly. The shaft 14 serves as an axis and as a support to the hollow shaft 17 of the wheel 12, which carries the contact 10. The wheel 12 may be displaced by the screw 11 and consequently regulate the instant at which contact is made between 9 and 10. The electric circuit is connected to the shaft 14 and to the wheel 12. It will never be necessary to regulate the coincidence of the signals detected in the receiver E for a duration greater than that of a half period of the clock, because the wheel 12 can turn in either one direction or the

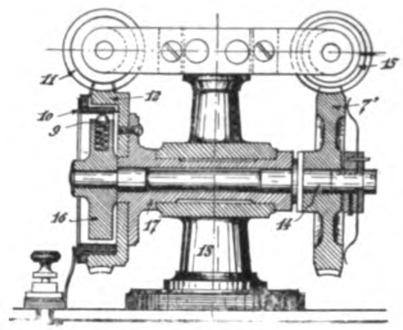


Figure 2—Sectional view of the auxiliary adjusting apparatus

other, and consequently this regulation can be made very accurately in a very short time.

The drums 7 and 7″ can be employed for very different purposes and may be connected either by wire or without, which in itself is independent of the solution of the synchronizing problem; for example, the exact time may be received by means of a series of suitable rotations occurring once every second. The signals transmitted by the one may be received by the other with great accuracy. Also synchronism may be obtained, for example, for the transmission of messages, photographs or pictures by wireless or line telegraphy, the synchronism in these latter cases being regularly regulated in a simple manner during the transmission of the other emissions.

Incandescent-Cathode Arc Device for the Rectification of Alternating Currents

IN the accompanying drawings, figure 1 illustrates diagrammatically a discharge tube which may be used as a rectifier; figure 2 a modification in which the standing filament is omitted and the arc is started by means of a high-voltage discharge from a pointed cathode. Another modification having a mercury anode is shown in figure 3. These rectifying devices have been developed by Chas. V. Ferguson.

Referring to figure 1, the discharge device consists of a sealed glass or quartz envelop 1, and the cathode 2 and anode 9, both of these electrodes being sealed into the container in the usual manner and consisting of highly refractory substances, such, for example, as tungsten, tantalum or carbon. The cathode 2 consists of several parts, namely, an arcing tip 3, connected to a stem 4 having a diameter small enough to afford enough resistance to the conduction of heat to enable the arcing tip 3 to operate at incandescence. The stem 4 is connected to a current-conveying conductor 5 sealed into a stem 6. The arcing tip should be so arranged and supported that the heat lost by conduction through the supporting stem consists of such a small fraction of the total heat, developed by the cathode that the arcing tip is maintained at a uniformly high temperature by a comparatively small amount of energy. Consequently, with a given current the total voltage across the arc is lower than it would be if no section of reduced diameter was provided. This result can be conveniently obtained by reducing the diameter of a small section 7 of the supporting stem adjoining the arcing tip as shown in figures 2 and 3. In some cases the cathode has a pointed or sharpened tip (as shown in figures 2 and 3) to facilitate starting and secure greater stability of the arc.

Near the arcing tip of the cathode is the starting filament 8, consisting of refractory material such as tungsten, tantalum or carbon spirally spaced about

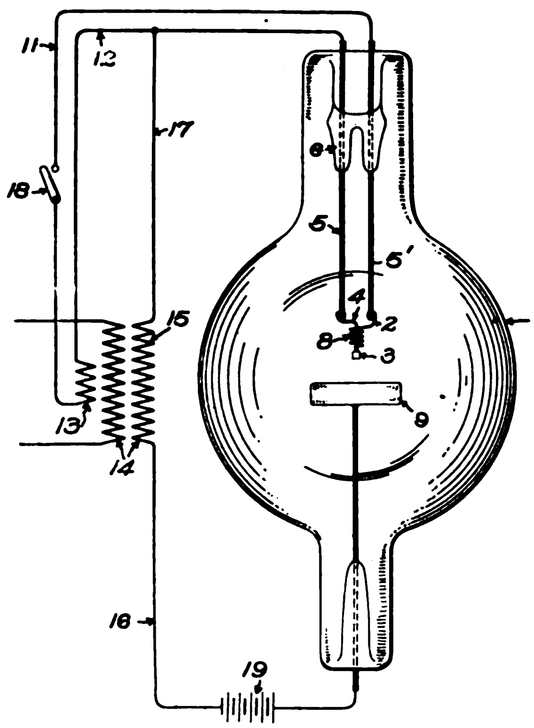


Figure 1—Diagram of a discharge tube used as a rectifier of alternating currents

the cathode stem and connected to the cathode stem 4 at one end near the tip 3 as indicated, the end remote from the arcing tip of the cathode being attached to a

(Continued on page 43)

Military Lines of Communication*

A Series on Reconstruction for American Soldiers Abroad in U. S. Army Service

By Major J. Andrew White

Chief Signal Officer, American Guard

Nineteenth Article—Aerial Line Construction

SHORT and stout poles are favored by the Signal Corps for telegraph-line construction, as these are more durable than the high poles of former days and better able to stand load strains and attacks of storms.

To avoid using a large number of aerial wires, cables are utilized whenever practicable in aerial construction, lightning arresters being always installed and telephones connected to an aerial circuit. Outside distributing wire is provided for leading from the pole to substations.

Erection of the Line

The route of the line having been decided and materials prepared, the distance is measured and stakes driven to indicate the places where the poles are to be erected. When the line is to follow highways or other defined routes, the stakes are placed so as to avoid, as far as possible, danger to the line from passing vehicles. The line is generally removed from the road a distance of about 30 feet, which insures that traffic will not be interrupted or endangered should a line become detached from insulators and hang down. The line is so placed that it can be readily examined and inspected from the road. Roads are crossed only when necessary to avoid bad ground or numerous trees, or when a material shortening of the line may be thus gained. Crossings are made at half a right angle, the distance between poles being shortened and a minimum height of 18 feet observed between wire and the crown of the road.

When the road is through rolling country, poles are planted near the crest of hills, so the wire between will be at sufficient height above the ground. Longer poles are used in hollows so the line will be graded.

In open, or unfenced country the poles are, as a general rule, set in a straight line, but wherever there is a well traveled road the line follows its general direction.

Wooden Poles

Red cedar, black locust, or chestnut are preferred woods for poles. Where these are not procurable, or the cost is too great, redwood, white cedar, red cypress, yellow cypress, tamarack, fir, larch, spruce, white or post oak and sassafras furnish timber from which good service may be expected.

Live green timber, free from rot and sound in every respect, is sought for poles. November to the end of February is the cutting time, each pole being trimmed closely and smoothly and containing the natural butt of the tree and presenting an approximate uniformly decreasing cross section from butt to top.

The table following gives the desired dimensions of wooden poles:

Length of Poles—Ft.	Circumference—Ins. At Top	Circumference—Ins. 6 ft. from bottom	Length of Poles—Ft.	Circumference—Ins. At Top	Circumference—Ins. 6 ft. from bottom
20	14	24	35	22	37
20	16	25	35	25	40
25	16	25	40	22	40
25	19	27	40	25	43
25	22	30	45	22	45
30	19	30	45	25	46
30	22	34	50	22	46
30	24	36	50	25	48

For permanent lines under ordinary conditions preservatives will be found worth the additional cost, for they not only delay the starting of decay but retard it when once it has started.

Computing the increase of life of poles by the use of preservatives requires consideration of the factors represented by the kind of wood, nature of soil, the amount of preservative and depth of impregnation; owing to these varying factors it is believed impracticable to definitely state the life increase thus obtained. Most important among these factors is the depth of impregnation and the amount of preservative per cubic foot of wood. A heavy coat on the outside is not so efficient as the same amount forced into the pores of the wood.

A line for temporary use, shown for contrast with the semi-permanent lines described

Three methods of applying preservatives are in use: (a) brush, (b) open tank, (c) pressure process. The brush method applies the preservative by a brush to the part of the pole to be treated, after it has been thoroughly cleaned. The second method immerses the pole or its butt into a tank of preservative, the solution being kept hot until the bubbling caused by air or water in the pole ceases. The hot preservative is then allowed to cool, assistance in drawing the preservative into the wood being given by the vacuum created in the timber while heating. The pressure process obtains great penetration but is seldom used on account of its cost. The brush method secures a penetration of 1/16 inch to less than ¼ inch, whereas the open tank treatment ranges from ¼ inch to ½ inch.

* For complete text on this subject see the book, "Military Signal Corps Manual," by the same author.

The part of any set pole most susceptible to decay is a section from a few inches above the ground-line to 2 or 3 feet below the ground-line.

Pine poles have a short life both above and below ground, and if this timber is used for a line in any way permanent, the entire length should be treated.

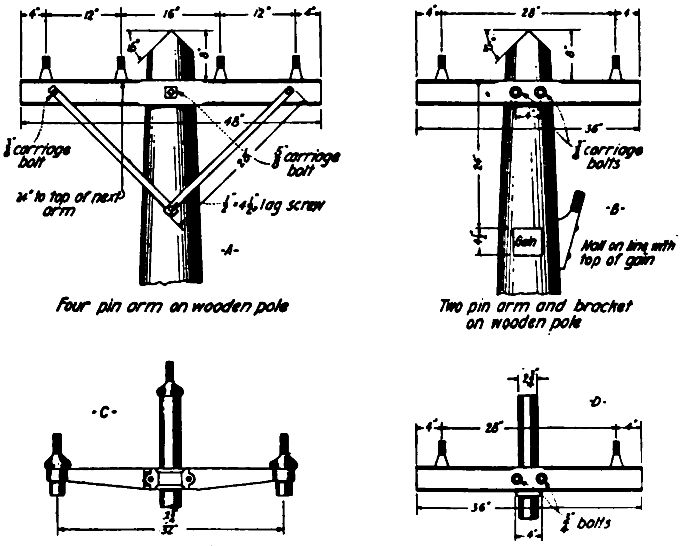


Figure 1—Method of preparing wooden and steel poles for cross arms

Concrete Poles

Difficulty of transportation and delivery along the route makes the use of concrete poles inadvisable for telegraph lines. For post telephone systems, however, reinforced concrete presents several advantages.

The forms are prepared by securing 3 pieces of 2-inch plank, free from knots, and dressed on one side. Top and side cleats prevent spreading when the concrete is poured through the open side, or top.

For longitudinal reinforcements, four ⅜-inch square or twisted steel bars are used for 24-foot poles, and ½-inch bars for longer poles. The four bars are set about ½ inch from each corner, being spaced by a piece of wood at each end of the form, with holes to take the ends of the rods. At four or five points the four rods are bound together by iron wire. Wooden blocks or wire hold the reinforcing rods in position at various points to prevent sagging. These are removed as the concrete is poured.

The concrete used should be a very wet mixture, 1 part cement, 2 parts sharp sand, 4 parts crushed stone of less than ½-inch size. It is important to have sharp sand. Gravel may be used in place of crushed stone, but it should be cleaned well.

The two side walls may be removed the next day after pouring, the bottom plank remaining three days longer, at which time the concrete is sufficiently set to remove it, heavy ice tongs being employed to slide it endwise. Before the concrete is entirely set the surfaces should be finished by a small amount of troweling. Concrete poles should be allowed to cure about 30 days before use.

When bolt holes and pole steps are desired, wooden pins should be placed in the form before the concrete is poured.

Concrete poles having a length of 24 feet should be about 8 x 8 inches at the base and 5 x 5 inches at the top. Beveled corners improve the appearance. The weight of a 24-foot pole is approximately 1,100 pounds, and 30-foot poles, 1,400 pounds. A 24-foot pole having an 8-inch square base and 5-inch square top requires about 7 cubic feet of concrete. Twenty-four-foot poles should be set approximately 4 feet in the ground, and 30-foot poles approximately 5 feet in the ground.

Depth of Setting Poles

Character of the soil, height of the pole and load it is to carry, determine the depth to which poles should be set. Less depth is required in rock, gravel or stiff clay than in light loam or sand. The following table gives the depths for average conditions:

Length of Pole Feet	Depth in Ground Feet	Depth in Solid Rock Feet
18	{3[1] / 3½[2]}	3
20	4	3
22	4	3
25	5	3
30	5½	3½
35	6	4
40	6	4
45	6½	4½
50	7	4½

[1]On straight lines. [2]On corners.

A foreman follows with a sufficient number of men equipped with digging bars, spoon shovels, the ordinary long-handled shovels, or post-hole diggers, where the soil will admit of their use. This party digs the holes for the poles as marked out by the stakes. If there is a sod, one of the men, equipped with an ordinary spade, is sent ahead to remove it, indicating the size of the hole to be dug and facilitating the work by performing the part for which the bars and spoons are not well adapted. The foreman sees personally that the holes are put down to the proper depth, has direction of the detail and is held responsible for good service.

Setting the Poles

Holes should be dug large enough to admit the pole without the necessity of cutting away the butt, and space should be allowed to move the pole about for bringing it into line. The diameter of the hole should be great enough so the tamping bar may be used full depth.

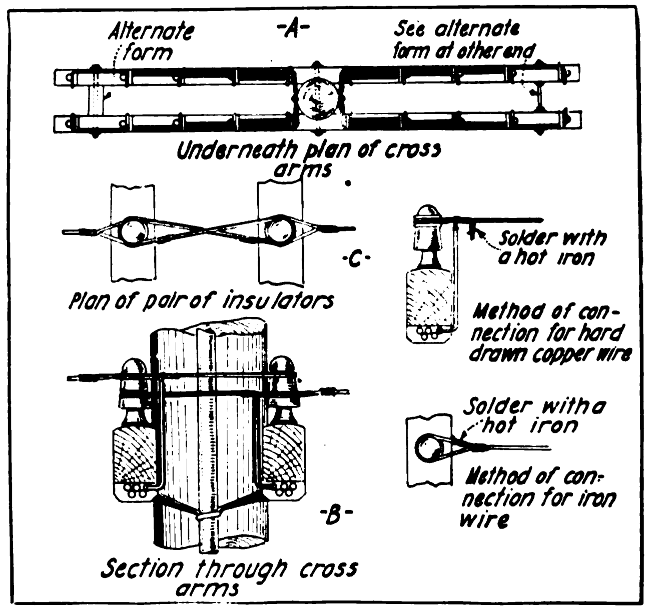


Figure 2—Double arming for aerial line construction

Thorough tamping as the hole is filled is important to the proper setting of the pole.

On straight lines, the cross arm should be placed at right angles to the direction of the pole line, the arms on adjacent poles facing in opposite directions. At line terminals the cross arms on the last two or three poles should be placed on the sides of the poles which face the terminal. The poles are set vertically.

On curves, the cross arm should be placed on the sides of the poles which face the middle of the curve. Corner poles should be given a slight rake when set, varying from 10 to 20 inches with the conditions.

After the pole has been placed in position, the hole filled, and the earth well tamped, the soil should be well banked up about the pole and firmly packed in place; otherwise, subsequent settling of the earth will form a depression about the base of the pole. Coarse material, soil or gravel, should be used at the top of the holes. Where the poles are set in rock, the pieces should be firmly wedged in about the poles.

Wooden poles usually have more or less pronounced curves; these curves should be placed in setting so as to be least apparent when viewed from the direction of the line.

In obtaining uniform height of lead by grading the poles, differences in height of poles up to 2 feet may be taken care of by digging the holes deeper. Poles should be cut only as a last resort, and then at the top, not at the butt.

Number of Poles Per Mile

The character of the country and the number of wires or cables to be supported determines the number of poles to be provided for a line. The minimum provision is 35 poles per mile, but in timbered country, with crooked roads and heavy leads, it may be necessary to increase this number to 45 poles, or even more in special cases.

Delivery of Poles

As soon as practicable after the holes have been dug the poles should be delivered. Carrying hooks to move them as they are unloaded from trucks is the only special equipment required.

The heaviest and longest poles should be selected for crossings and long spans, the stoutest poles where angles and sharp curves occur. The butts of the poles are laid at the edge of the holes, with the tops pointing along the ground in the direction from which the raising party will come.

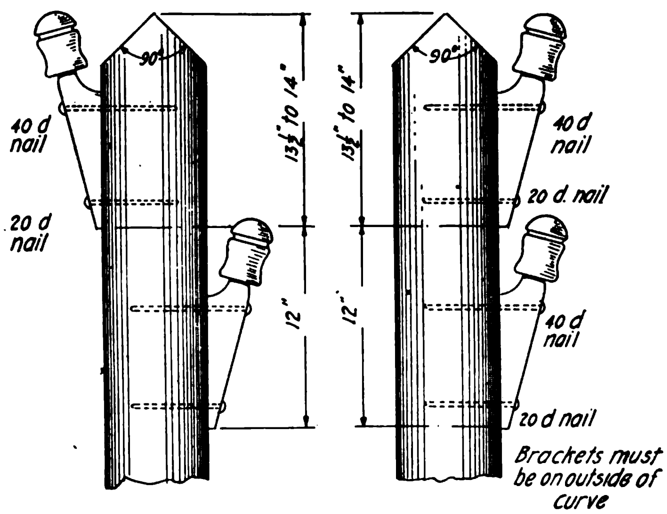


Figure 3—Method of roofing wooden poles and attaching brackets

Pole Preparation

So that the poles will effectively shed rain and snow, the tops are roofed by cutting each side to a peak at an angle of 45 degrees, as shown in figure 1.

Cutting poles when the sap is down, removing the bark and allowing them to season, increases durability and facilitates transportation and erection.

Lightning Rods

Sometimes, every fifth to tenth pole of an aerial line is provided with a lightning rod. The rods ordinarily consist of a piece of number 6 galvanized iron wire, extending not less than 1 foot above the roof of the pole and attached to its sides by means of staples placed about 1 foot apart. Lightning rods should extend continuously down the entire length of the pole, and are usually soldered to a ground rod driven into the earth near the base of the pole. An alternative method provides for their ending in a small coil of wire at the base of the pole which gives a good surface contact with the earth. This wire should be kept as straight as possible without turns or coils in its length and should be attached before the pole is erected.

In this illustration may be seen the roofing of the top, method of placing brackets and erection of the pole so as to avoid danger to the line from passing vehicles on the highway

Cross Arms

The Signal Corps specifies the following dimensions for standard cross arms which it supplies:

Length in Feet	Number of Pins	Pin Spacing—Inches		
		Ends	Sides	Centers
3	2	4	..	28
4	4	4	12	16
6	6	4	12	16
8	8	4	12	16
10	10	4	12	16

Framing Poles

The following directions cover the method of framing poles which support cross arms:

The pole should be raised at the top and placed in a framing buck or horse so that the heaviest sag or curve will be nearest the ground. If the pole is crooked or badly shaped, it should be turned with a cant hook until the best side for framing is uppermost. With the pole then held rigidly in place it is roofed, after which the gains should be cut, leveling them with a straightedge or sighting stick.

Before holes are bored for the cross arm bolts, a line should be set off from the center of the pole's top to its butt, and the bolt hole center laid off along this line.

Half-inch holes for steps should be bored at right angles to the line, or in line with the cross arms, beginning 18 inches from the lowest cross arm and continuing to a point 8 feet from the ground, spaced 18 inches apart, or 36 inches apart when measured on the same side of the pole.

Cross arms carrying four or more wires must be braced. Figure 1 shows the method. Gains for cross arms have a maximum depth of 1¼ inches.

A distance of 8 inches is allowed between the extreme top of the pole and the upper side of the top gain. The distance to be observed between centers of gains is 2 feet. Cross arm braces should be attached to the face of the pole and to the face of the arm. Cross arms which are not braced require two lag bolts. Except where special conditions require otherwise, cross arms must be placed on opposite sides of alternate poles.

Cross arms should be set at right angles to the pole length. This applies as well to corner poles, no matter what the degree of rake.

Cross arm fixtures should, if practicable, be attached to buildings (other than residences) with bolts passing through the wall. If this is not practicable, large expansion bolts should be used. Window casements or woodwork of buildings should never be used for resisting the strain of the line.

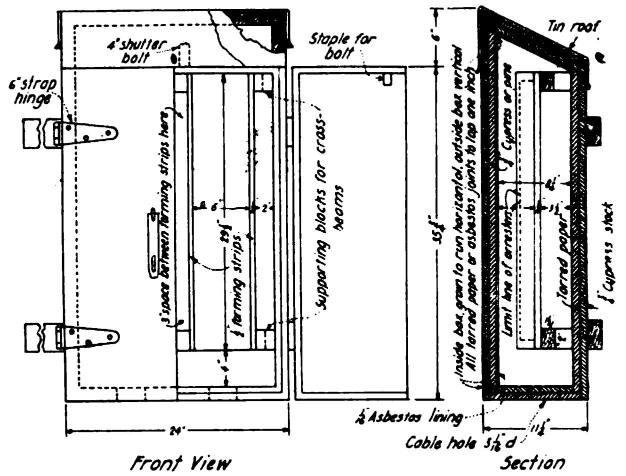


Figure 4—Construction details of cable box for terminal or office pole

Telephone line wires terminating at residences are provided with either outside distributing or outside twisted pair wire connections, the line wire being terminated at the cross arm or bracket at the nearest pole and the service completed by means of the outside distributing or outside twisted pair wire. A bracket or other type of fixture makes the wire fast to the residence, entrance being made through two porcelain tubes, each conductor of the duplex wire entering through one of these tubes. The tubes should be slanted downward toward the outside of the building so water will not enter them in stormy weather. If this is not practicable the same result will be secured by having the wires outside sag below the tubes. Wires thus arranged are termed "drip loops."

Wherever practicable, arms are placed on poles before they are erected.

Methods for attaching cross arms for leads not exceeding four wires are shown in figure 1: (a) illustrates the attachment of the four-pin cross arm with braces; (b) the two-pin cross arm attached with lag bolts; (c) and (d) show two methods of attachment to steel poles. These steel poles are only used occasionally to meet special conditions; they are not suitable for supporting more than four wires and should be installed only in hard earth or concrete.

Double Arms—The approved method of installing double cross arms is shown in figure 2. The heaviest poles available should be selected for double arm construction as these require extra strength for the additional load. Figure 2 also shows the method of dead ending wires on double cross arms. Where wires pass through they are tied to both insulators, in the lower groove of the glass if double-grooved glasses are in place.

Porcelain-coated bridle rings may be used for supporting bridle wire, instead of cleats as shown in figure 2, and copper connectors may be used for splicing bridle wire to hard-drawn copper line wire, instead of as shown in the same figure.

Bracket Lines

Where not more than two wires are required on a pole line, oak brackets may be used in place of cross arms. General arrangements are shown in figure 3, brackets being attached to the pole with one 40d nail above and one 20d nail below. So that the poles on which brackets are placed may later be used to support cross arms, the top end of the brackets should be about level with the correct location of the top of the gain, so that the bracket and its wire will not interfere with the subsequent use of the cross arm.

Terminal or Office Pole

The terminal or office pole of a line carrying a number of wires is the most important part of the line and demands careful attention to secure construction that will be serviceable and easy to maintain. Frequent access to this pole being necessary, all wiring should be substantial in character and arranged to facilitate repairs and extensions. Typical construction of an office or terminal pole is shown in figure 5. This illustration shows the method which is to be followed as far as practicable, although it is not likely that in any construction work taken up it can be exactly duplicated.

This figure shows a can terminal installed; a cable box, shown in figure 4, may be used in its place and, in fact, is considered preferable except in the tropics. In ordering cable boxes the number of pairs to be accommodated should be stated, as well as the number of pairs of lightning arresters and fuses. No aerial line should be cross-connected at a terminal pole or to a central exchange except through fuses and lightning arresters. The terminal or cable-box poles should be stepped, using galvanized iron pole steps as shown in figure 5. The lowest of these steps should be at least 8 feet from the ground. To reach these steps ladders are used, or brackets, as shown in figure 6.

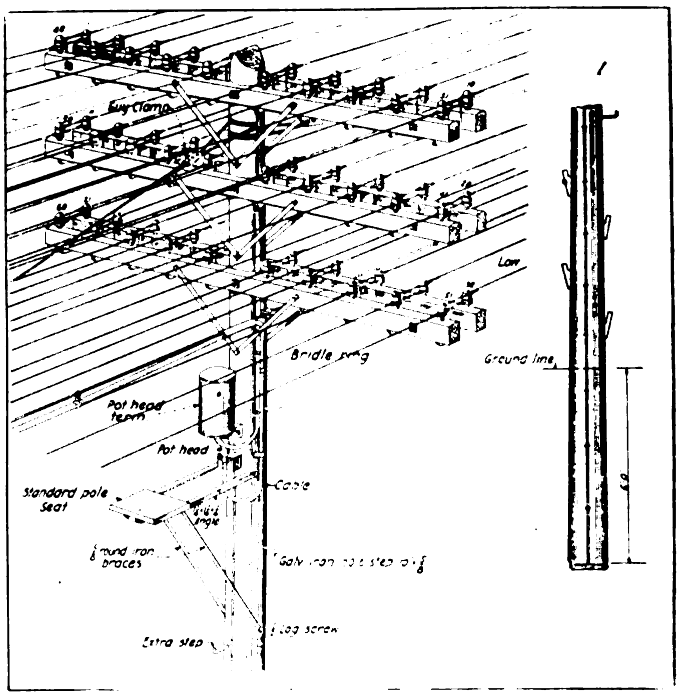


Figure 5—A typical terminal pole; Figure 6—Pole steps

Bridle wires, which are used to connect the line wires with the can terminal or cable box, run through hardwood cleats, are shown in figure 2. Particular attention should be given to all wiring about the pole to see that it fits neatly and is so placed that it will not be injured by the workman in the performance of his duties.

Where the wires which dead end on a double arm lead from one direction only, it is necessary to counterbalance the strain by running a small guy from this cross arm to the next pole.

Where poles are provided with steps, linemen should not use climbers, unless of course, such use is clearly unavoidable.

Static and Interference Eliminated

The Achievement of Roy A. Weagant

ROY A. WEAGANT, chief engineer of the Marconi Wireless Telegraph Company of America, has perfected an invention which has taken the "static" out of wireless telegraphy, thereby removing the greatest obstacle to the clear transmission of radio messages.

The invention prevents "by a selective system" the interference or crossing of one wireless message with another, regardless of the operation of any number of high-power stations, and it reduces the amount of power heretofore required to operate a wireless station by about one-half, making possible a saving of 50 per cent. in fuel. The following official announcement of the invention is made for the company by Edward J. Nally, vice-president and general manager of the Marconi Company:

With the conditions that pledged us to absolute secrecy no longer prevailing, the Marconi Wireless Telegraph Company of America is permitted to announce a discovery and invention in wireless telegraphy that will mark a new era in world communication. It is America's contribution to science in solving a problem that has engaged the best scientific minds of the world.

Ever since the genius of Marconi made wireless telegraphy a fact, the only limitation of this method of communication was the deadly phenomena of "static conditions." It was "static"—the presence of a large amount of uncontrolled electricity in the air—that at the beginning of the war often entirely prostrated the wireless service even between the most powerful stations erected in Europe and America. Static conditions were responsible for abnormal delays and for the mutilation of words in wireless messages.

It was the one great obstacle to continuous communication by means of electro-magnetic waves in the air. So baffling was the problem that Marconi issued a personal appeal to every wireless operator in the world to record his observations and to collect data on the subject. Some of the leading scientific minds in the universe struggled to overcome the effects of the static disturbances. Worldwide researches were instituted and large sums of money expended, but the end sought was not obtained.

It remained for an American radio expert, Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company of America, to discover the solution of the static problem. Weagant practically had devoted his life to a study of this perplexing phenomena, and the result of fifteen years of experimental work was about to be published to the world, when the United States entered the Great War.

Although patent applications had been made and the claims allowed by the United States Patent Office, the Weagant system was immediately placed at the disposal of the American Government, and every precaution was taken to keep the invention secret until the discovery could be safely announced. With the spirit of research that has made the Navy such a magnificent arm of our military service, officials of the Navy Department assigned naval experts to co-operate with the inventor in installing experimental stations in various parts of the country. These stations are now receiving messages from all the high power wireless stations of the world.

With the consent of the Marconi Company, the United States Navy Department disclosed the Weagant invention to our Allies, and special representatives of the French and British Governments were sent here to study the system.

Among the revolutionary changes that the new system effects in wireless installations will be the immediate disappearance of the huge steel towers heretofore built at great height to catch the incoming wireless waves. Equipped with the Weagant invention, the wireless receiving antennae are stretched merely a few feet above the ground.

Heretofore, also, the increasing number of high power stations that were being erected in every part of the world raised the difficult question of "interference." Crossing wireless messages that shot through the ether sometimes made the wireless signals so indistinct that they could not be understood, or drowned the weaker transmission entirely. The Weagant system, based on a unique selective principle, eliminates "interference" and permits absolutely clear communication, regardless of the operation of other stations even in the immediate vicinity.

The notable contribution to wireless telegraphy opened by Mr. Weagant's discovery makes continuous wireless communication over the oceans and between continents an absolutely assured fact for twenty-four hours of the day and at every season of the year, regardless of atmospheric conditions. All the Marconi high power stations are being equipped with the Weagant system, and the stations of the Pan-American Wireless Telegraph and Telephone Company, which are to link North and South America in a closer bond of brotherhood, will likewise be so equipped. In all probability the United States, as well as the Allied Governments, will adopt this system.

Mr. Weagant, who has been a distinguished radio engineer for fifteen years, is only 37 years old. He is a graduate of McGill University in Canada and a Fellow of the Institute of Radio Engineers.

Mr. Weagant was born March 29, 1881, at Morrisburg, Ont. His father, William Weagant, the inventor of various mechanical devices, died when he was a baby, and his mother shortly after married T. J. Flint, a druggist, of Derby Line, Vt. The boy spent most of his school days behind the drug store counter. He attended the village school and later the preparatory school and college at Stanstead, Que. His interest in mechanics began when he was five years old, and he was encouraged by Dr. M. L. Baxter, a retired physician of Washington, who taught him about electricity and loaned him scientific books.

Radio Frequency Changers

Reported Progress in Their Application to Wireless Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

(Continued from the November, 1918, *issue of* THE WIRELESS AGE)

Control of Antenna Currents

A PROBLEM of considerable magnitude is encountered in controlling the energy output of a high-power radio station so that rapid signalling can be effected. It is a relatively simple matter to interrupt the primary circuits of a low-power spark transmitter, but when several hundred kw. of energy is involved, very special means must be provided to permit the breaking of the current without undue arcing or lag.

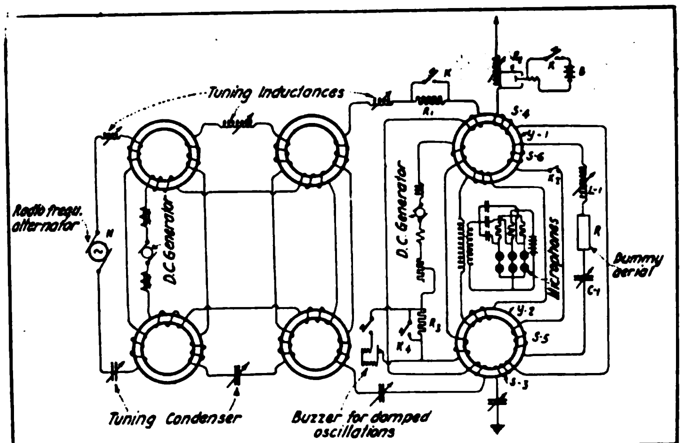


Figure 9—Frequency changer system for the production of damped or undamped oscillations with the complete circuits for wireless telephony

Marconi gave a satisfactory solution for high-power rotary spark transmitters when he devised his battery of special electro-magnetic keys to interrupt the high voltage current at points between the secondary of the transformer and the high-voltage condenser.

It has been customary in the arc radio system to effect signalling by changing the length of the radiated wave, but a disadvantage arises in this method that the antenna radiates two waves, one of which may cause interference to the operation of other stations.

Von Arco and Meissner have devised several interesting methods for controlling the antenna current for radiotelegraphy and telephony, which, in general, do not involve duplex radiation. They have shown as in the figure 9 the complete circuits of a radio system serviceable for telegraphic signalling by means of undamped oscillations, for the production of speech variations of the antenna current for telephony, and for the production of groups of damped oscillations, all from the same source of energy—a high frequency alternator.

In regard to the circuits for telegraphic signalling shown in this figure, a telegraph key operates a solenoid relay R_1 fitted with contacts which tune and detune the antenna circuit. The advantage of the frequency changer systems over the arc method is that, when the antenna is thrown out of resonance, no radiation takes place, for then no energy is withdrawn from the alternator N. However, the inventors observed that in controlling the antenna current in this way, the resulting shift of phase between voltage and current caused a dangerous rise of potential in the high frequency generator. To prevent this they placed a resistance R_1 in series with the primary circuit of the last group of the radio frequency changers, shunted by the key K' which operates in conjunction with key K so that the signal is produced by tuning the antenna and short-circuiting the resistance R_1 simultaneously.

Controlling the antenna current in this way brought forth another problem, viz: the unloading of the generator N each time the antenna is detuned by the key K, causing the speed to vary, throwing it out of resonance with the complete system, with a consequent decrease of output. The well-known method of loading the generator by a special non-radiating circuit is then suggested so that when the antenna is not radiating the shunt resonant circuit takes the load, keeping the speed of the generator nearly constant. Practical circuits will be shown in the diagrams to follow.

In previous systems based upon this principle, it is necessary to interrupt the antenna circuit and the auxiliary loading circuit each time a telegraphic signal is made and in case large amounts of energy are involved, it is difficult to devise a signalling key that will operate satisfactorily. However, Arco and Meissner have shown a system of connections by which the antenna remains permanently connected to the source of high frequency current and the transference of the load from the antenna circuit to the auxiliary loading circuit and *vice versa* is obtained simply by variation of the tuning of the two circuits. The circuit is shown in figure 10 where two magentic relays R-1 and R-2 are connected so that their contacts shunt the antenna loading inductance L-1 and the auxiliary load inductance L-2 alternately, signalling being effected by closing key K. The secondary windings S-1 and S-2 of the last group of frequency changers are connected with the antenna and also with the loading circuit

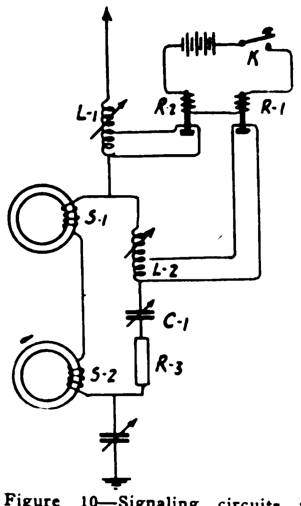


Figure 10—Signaling circuits for maintaining a constant load on the radio frequency alternator

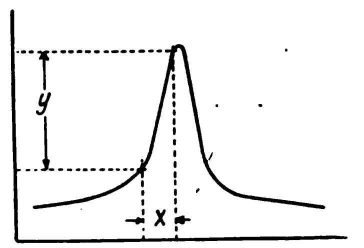


Figure 11—Curve showing antenna current for various values of impedance of the control system

containing the ballast resistance R-3, the condenser C-1 and the inductance L-2. It is readily seen that the connections with the relay R-1 can be so arranged that when the antenna circuit is tuned to resonance with the frequency changers, the relay R-2 detunes the load circuit and when the antenna circuit is de-

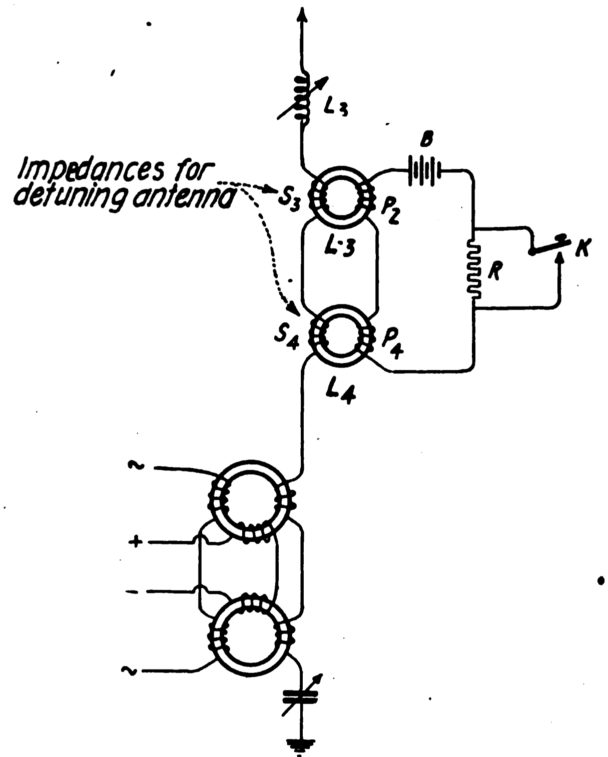


Figure 12—Diagram of a simple system for varying the antenna current

tuned, the load circuit is tuned to frequency of the alternator.

While this method of control possesses operative features, it still carries the disadvantage that circuits carrying high frequency currents of considerable power are actually interrupted. However, by providing mono-inductive impedances for the purpose of detuning, it is possible to adjust the auxiliary magnetising current so that no actual interruptions of the high frequency circuit are required to shift the load from the antenna to the auxiliary loading circuit. Such a system is shown in the diagram of connections in figure 13, but before entering into a description of this system we shall disclose another method of connection whereby the antenna current can be varied in a simple manner. The diagram therefor is shown in figure 12, where two one-way impedance coils L-3 and L-4 have their secondaries S-3 and S-4 respectively, connected in series with the antenna circuit. Their primaries P-2 and P-4 are fed by the direct current source B, the circuit including the key K and the shunt resistance R. Just how this circuit functions will be clear from consideration of the resonance curve shown in figure 11 where the current through the windings S-3 and S-4 is plotted against their self-induction, variation of which is obtained by change in the value of the direct current through P-2 and P-4.

If the impedances S-3 and S-4 are properly designed, it is clear from the curve that a very small variation of the magnetising current will cause a large change in their self-induction. The change of inductance may then be selected so as to completely detune the antenna circuit. The resistance R is of such dimensions that when it is not short-circuited, the direct current is decreased to a value so that the antenna is detuned by change of impedance and accordingly very little energy is withdrawn from the radio frequency changers. When the key is pressed the self-induction of S-3 and S-4 is reduced so as to tune the circuit, the antenna radiating at the frequency of the frequency transformers. It is obvious that a microphone could be inserted in the circuit instead of the key K and speech signals transmitted as in ordinary wireless telephony.

The windings S-3 and S-4 are so disposed on their cores that one-half cycle of the generator output is impeded by one impedance and the other half-cycle by the other impedance. Sufficient modulation could be obtained by the use of one coil, but for wireless telephony it is desirable that both halves of the complete cycle be prevented from flowing in the antenna circuit.

In case an auxiliary loading circuit such as previously shown in figure 9 is connected with the radio frequency changers, the two one-way impedances may be used for alternately tuning and detuning the antennna and the loading circuit, that is, the load is alternately shifted from one to the other. The diagram of connections is shown in figure 13 where the one-way impedances have their secondary windings S-3 and S-4 in series with the antenna and with the secondary windings S-5 and S-6 of the radio frequency changers. The complete antenna circuit is shunted by

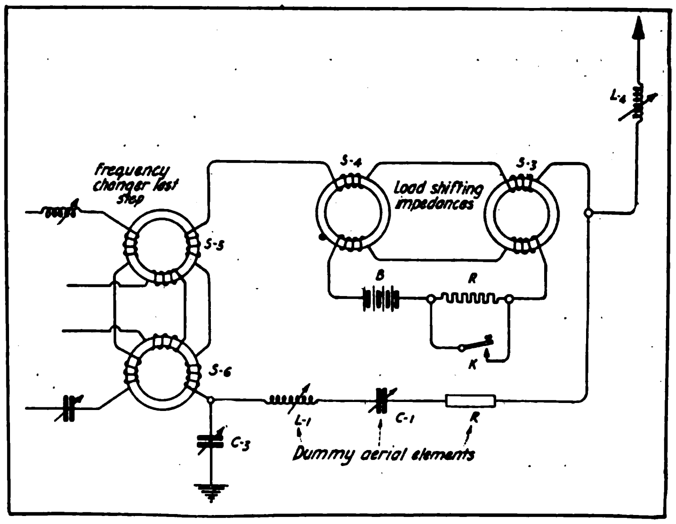


Figure 13—Mono-inductive impedances for detuning the antenna circuit and transferring the load to a dummy aerial

the load circuit, including the ballast resistance R, the variable capacity C-1 and variable inductance L-1 which constitute an auxiliary loading circuit. As usual the primaries of S-4 and S-3 are energized by the source B in series with key K shunted by the resistance R. The antenna inductance is indicated at L-4 and the series variable condenser at C-3.

It is clear that by proper design of the auxiliary loading circuit, and careful adjustment of the D.C. magnetization of the cores of S-4 and S-3, a combination can be effected whereby when the key is closed the change in the self-induction of S-3 and S-4 will tune the antenna circuit to resonance with the alternator and at the same time will place the circuit S-3, S-4, S-5, S-6, L-1, C-1, R out of resonance with the alternator. On the other hand, when the key is raised the self-induction of S-4 and S-3 will be varied by such an amount as to place the auxiliary circuit in resonance with the generator simultaneously detuning the antenna circuit thereby maintaining a constant load on the generator.

A particularly effective arrangement for tuning and detuning the antenna and the loading circuit is to

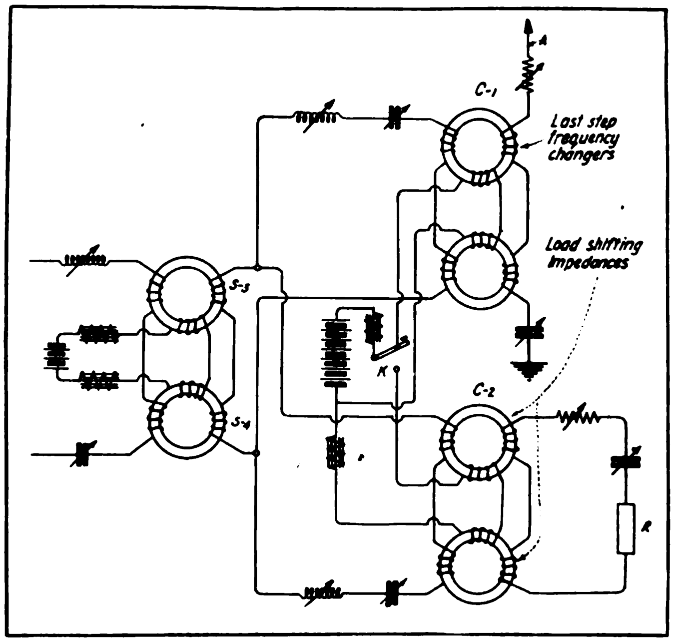


Figure 14—Special load shifting circuit

employ the auxiliary magnetising circuit of the frequency changer as shown in figure 9. The yokes Y-1 and Y-2 of the group of radio frequency changers, in addition to the secondary windings S-3 and S-4, carry the windings S-5 and S-6 which are part of the auxiliary loading circuit comprising the inductance L-1, the variable condenser C-1 and the ballast R. This circuit also includes key K-2. If the current intensity of the magnetising circuit is varied by operating the key K-4 (shunting the resistance R-3) the antenna may be automatically tuned when the key is closed and the auxiliary loading circuit may be tuned and the antenna detuned when the key is open. This circuit, however, operates with the disadvantage that through variation in the direct current intensity, the energy output of the frequency changer is varied so that it is difficult to maintain the output constant for necessary resonance.

This fault may be corrected by employing the connections shown in figure 14, where the second last frequency changer group is connected at its secondary windings S-3 and S-4 with two frequency changers, both being connected in parallel to the last group. The group C-1 discharges its current into the antenna A and the group C-2 is connected with a non-radiating circuit including the load R.

If the group C-1 and C-2 are of uniform dimensions, the load of the generator and that of the changer groups C-1 and C-2 remain constant if one or the other of the two parallel sets is thrown into operation. These sets are alternately operated by changing the auxiliary magnetising current from one set to the other by means of a key K fitted with double contacts.

In place of this key a relay such as shown in figure 10 operated by an auxiliary circuit and an ordinary key may be employed. In this case, satisfactory operation

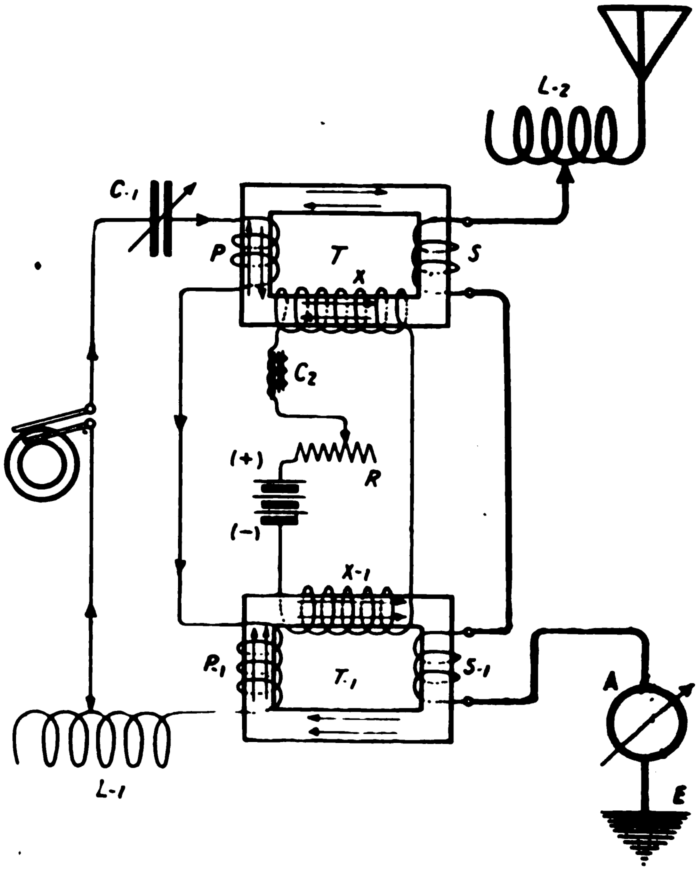


Figure 16—Fundamental wiring diagram of a single step radio frequency changer. The primaries of the transformers T and T-1 are mono-inductive, their cores being saturated by excitation windings X and X-1. When in either transformer the flux generated by the current from the alternator opposes the flux of the excitation winding, a complete cycle of current is induced in the secondary winding. In the diagram, transformer T is active, transformer T-1 inducing no current in the secondary winding S-1 because the fluxes are in the same direction and the core is saturated by the D.C. source

is secured by weakening the direct current as has already been shown in figure 13, but this must take place alternately in sets C-1 and C-2.

The only objection to the parallel arrangement of these two sets is that when the circuits in which they discharge their energy are detuned, the primary current rises to an excessive value which in some cases may completely upset the working of the apparatus. This may be overcome by arranging groups C-1 and C-2 in a series connection with the preceding group as shown in figure 15. In this case the tuning and detuning of two circuits is obtained by means of magnetically operated relays R-1 and R-2 as shown in connection with a previous diagram.

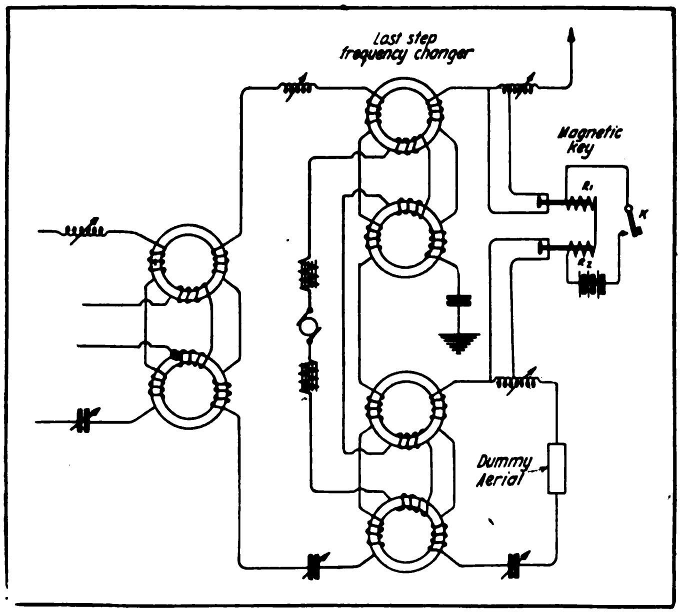
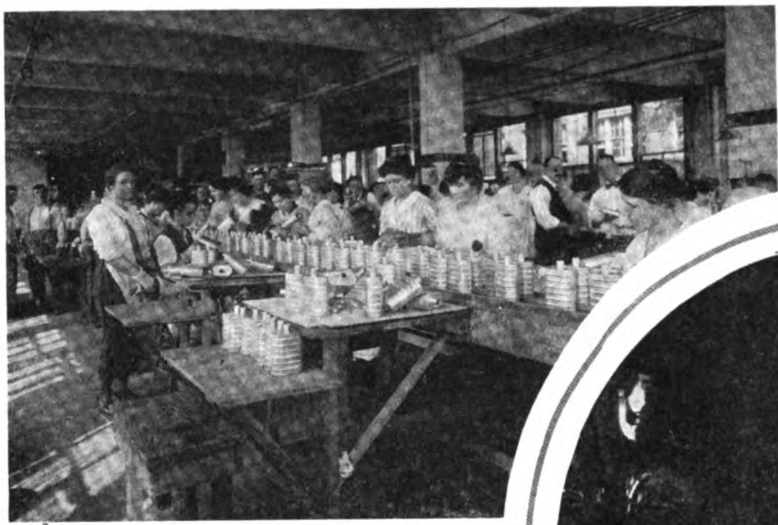


Figure 15—Diagram for tuning and detuning the antenna load circuits alternately by means of magnetically operated relays

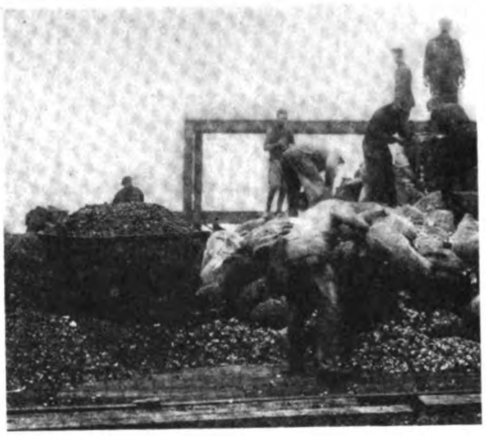
(To be continued)



Gas Masks

A Triumph of Science

Factory inspection of the carbon and chemicals which are contained in the respirator canister



Photos: Press Ill. Svce.

Above, in circle, the great retorts wherein the fruit pits are changed into charcoal

At the left, piles of fruit pits on the docks being loaded for transportation to tne furnaces to be turned into charcoal, which, with chemical compounds, has made poison gas harmless

The finished product in use; a drill which requires adjustment of the masks in six seconds

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE II, OF WARTIME WIRELESS INSTRUCTION

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*.

RADIO FREQUENCY ALTERNATORS

(1) The direct generation of radio frequency currents in dynamos has been accomplished. Such dynamos are generally termed **radio frequency alternators.**

Radio frequency alternators may be classified as follows:

(a) **The type in which radio frequency currents up to 100,000 cycles per second are generated by an armature rotating at very high speed-up to 20,000 R.P.M.**

(b) **The type in which radio frequencies below 50,000 cycles per second are generated by a normally low speed alternator at shaft velocities up to 3,500 R.P.M.**

(c) **The type in which frequencies are multiplied in the same machine—the armature rotating at comparatively low speeds. In this type the frequency is multiplied by the "reflector" principle.**

(d) **The type in which a comparatively low speed armature generates currents from 5,000 to 15,000 cycles per second, the frequency being further multiplied by external mono-inductive radio frequency transformers.**

Examples of (a) and (b) are the **Alexanderson** high speed and low speed **radio frequency alternators.** An example of (c) is the **Goldschmidt reflector alternator.** Examples of (d) are the **Joly-Arco** and the **Arco-Meissner systems.**

COMMERCIAL UTILITY

(2) None of the aforementioned systems have been employed extensively in commercial radio communication, but some promising results have been obtained in experimentation. All four types with the possible exception of the Arco-Meissner system **are not adapted for transmission on the shorter wave lengths below 2,500 meters.** These systems therefore require aerials of rather large dimensions, the use of which is not possible on vessels of small tonnage. They have proven feasible, however, for long distance land station transmission at fixed wave lengths.

(3) The design of high speed radio frequency alternators involves advanced mechanical and electrical problems, chief among them being

(a) **The high peripheral velocity of the rotor.**

(b) **The limited space available for the stator windings consistent with a rotor of small diameter.**

(c) **The expenditure of extraordinary driving power to overcome air friction.**

(d) **Special design of the bearings to withstand high speeds.**

It is essential that the iron and copper losses and magnetic leakage be reduced to a minimum.

To reduce heating losses due to hysteresis, the stator and rotor supports are made of fine iron laminations. Artificial cooling means must be provided. For example, in one system refrigerated air is supplied to the rotating armature and in another system the radio frequency alternator is specially designed for water cooling.

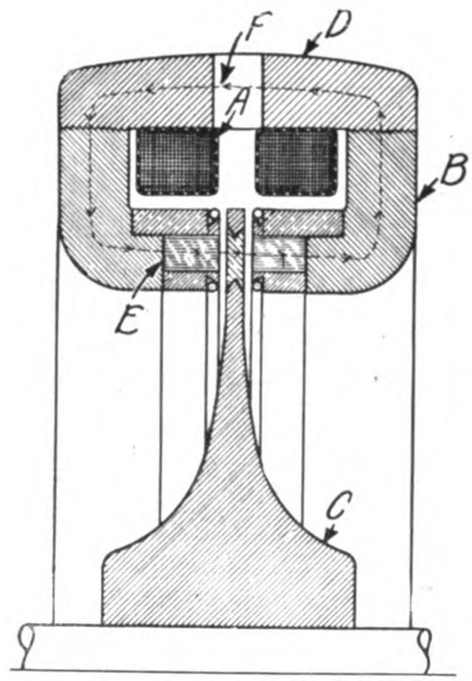


Figure 187

OBJECT OF THE DIAGRAM

To show the fundamental construction of one type of Alexanderson's radio frequency alternator.

DESCRIPTION OF THE DRAWING

The diagram is a cross-section of the machine. The **armature windings** are stationary and are supported by the **laminations** E. The **field magnets** are indicated at A which send a flux through the cast iron frame D, the armature winding supports B and E, and the disc C. The air gap between the armatures and the disc C can be carefully regulated for maximum efficiency.

The circumference of the disc C is provided with **slots** which are milled through the rim. The remaining spokes of steel are filled between with **phosphor bronze lugs** which are riveted in place to withstand the high armature velocity and are trimmed down to provide a smooth surface to reduce air friction.

The standard 100,000 cycle rotor is made of chrome-nickel steel with 300 slots.

The shaft of the alternator is long and flexible permitting the rotor to find its center and thereby avoiding extensive shaft strains.

The armature coils consist of **U shaped windings.** Two consecutive U formed wires may be considered as a pair of coils of one turn each joined in series.

(*Continued on page 25, first column*)

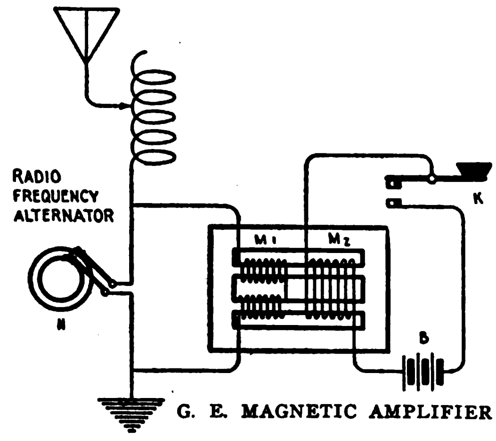


Figure 188

OBJECT OF THE DIAGRAM

To show the fundamental circuits of the Alexanderson magnetic amplifier for controlling the output of a radio frequency alternator and therefore the magnitude of the antenna current.

DESCRIPTION OF THE DRAWING

A specially constructed iron core transformer has the parallel windings M-1 wound oppositely on the two legs of the core as shown. The terminals of M-1 are connected to the radio frequency alternator N. The control winding M-2 includes both legs of the core of M-1, DC current being supplied by the battery B.

OPERATION

If the key K is closed, DC current from the generator or battery B saturates the core magnetically and the inductance of the windings of M-1 will be that secured without an iron core. On the other hand, if the key K is open, the iron core is saturated by the winding M-1 and its self-induction is then maximum. It is thus seen by closing the key K that the current generated by the alternator is withdrawn from and fed to the antenna circuit to form the dots and dashes of the telegraph code.

SPECIAL REMARKS

(1) If a **microphone transmitter** is connected in the control circuit of M-2 the reluctance of the magnetic circuit of M-1 is varied at speech frequency and the magnitude of the antenna current varied accordingly.

(2) Inasmuch as the two branches of winding M-1 are wound relatively opposite to M-2, one branch will oppose the ampere-turns of M-2 on one-half cycle of the radio frequency current, and the other branch during the next half cycle.

(*Continued from page 24*)

OPERATION

The magnetic flux set up by the field poles A has the direction indicated by the arrows. When a tooth on the rotor comes opposite the armature B, flux passes through the coils B, and as the rotor revolves the non-magnetic material between spokes occupies the same position, whereupon the path of the flux is broken. Currents of radio frequency are thus induced in the windings B, the terminals of which may be connected directly to the aerial and earth wires of a complete transmitting system.

SPECIAL REMARKS

(1) The terminals of the radio frequency alternator may be connected to the earth and aerial directly. It is preferable, however, to place a **step-up** or **step-down transformer** between the aerial and generator.

(2) When the terminals of a radio frequency alternator are connected to the aerial and earth directly, a rise in voltage takes place so that the E.M.F. in the alternator may approximate from 2,000 to 3,000 volts.

(3) Alexanderson has eliminated this phenomenon by providing an **air-core radio frequency transformer between the alternator terminals and the antenna.** For example, in one design the primary winding had 32 distinct coils connected in parallel to 32 different circuits leading from the stator windings of the alternator. A variable connection from the secondary is attached to the antenna to provide voltages suitable to aerials of different characteristics.

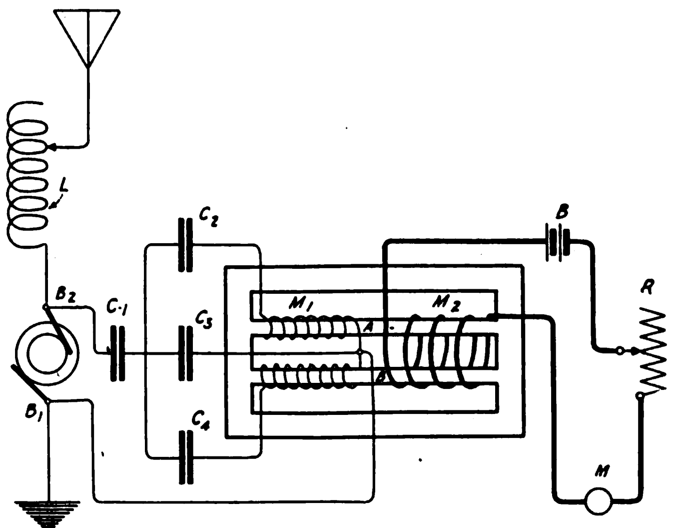


Figure 189

OBJECT OF THE DIAGRAM

To show the complete circuits of Alexanderson's magnetic amplifier for obtaining large modulations of antenna current at audio frequencies with a minimum of control current.

DESCRIPTION OF THE DRAWING

The brushes B-1 and B-2 of the radio frequency alternator are shunted by the AC windings M-1 of the magnetic amplifier.

Coils A and B of M-1 **are connected in parallel** and in magnetic opposition.

Condensers C-2 and **C-4** are in series with branches A and B respectively, and **condenser C-1** is in series with impedance M-1 to minimize its reactance and to permit a linear control of the current diverted from the antenna system through M-1. M-2, the DC control winding includes the legs of both branches of M-1. **DC excitation current** is supplied by battery B in series with which is the regulating resistance R. M may represent a **microphone transmitter** or a **telegraph key,** or the current in M-2 may be controlled by a **vacuum tube relay.**

OPERATION

It must be remembered that the object of the magnetic amplifier is to modulate the antenna circuit **at audio frequencies** either for **wireless telephony** or **telegraphy.** This modulation is effected by diverting the current from the antenna circuit through the turns of M-1 by variation of its impedance. For the best operation it is essential that the ampere turns of M-2 approximate those of M-1. Variation of the DC excitation current causes a marked variation in the self-induction of M-1 and accordingly the voltage drop across the alternator. By the addition of the several condensers in the circuit shown, a very sensitive control of the impedance of winding M-1 is obtained with a minimum of excitation current in the control winding M-2. As a general explanation of the phenomenon of the amplifier it may be said that if the core is saturated by M-2 the **self-inductance of M-1** is that of a **simple winding without an iron core,** and, therefore, the current through M-1 or in other words, the voltage drop across the alternator is relatively great; but with zero DC current in the coil M-2, the **self-induction of M-1 is maximum** and the flow of current from the alternator through M-1, relatively small. Some of the relations between excitation-current, alternator E.M.F., and corresponding current flow through M-1 will be shown in the curve to follow.

With the connections of figure 189 applied to a particular set of his design, it was shown by Alexanderson that a current of **0.2 ampere turned on and off in the coil M-2 caused the output of a 50 kw. radio frequency alternator to vary between 5.8 kw. and 42.7 kw.**—a variation of 37 kw.

Special Remarks

(1) The branches of M-1 in figure 189 are in parallel instead of in series as in figure 188.

(2) This connection gives a lower impedance, which, with a certain control current in M-2 gives greater sensitiveness and permits the handling of large currents without arriving at an undesirable condition of instability of operation.

(3) The effect of the condensers C-2 and C-4 is as follows: If the branches A and B were in parallel without condenser C-2 and C-4 in series as shown in this diagram, and the control current in M-2, for example, was varied at an audio frequency, there would be produced a short circuit current between the branches A and B, without producing any flux variation for the radio frequency current; but since the branches A and B

need carry only radio frequency current, condensers C-2 and C-4 are chosen of suitable value to act as a short circuit for the radio frequency current and an open circuit for the audio frequency current generated by the control winding M-2.

(4) The condenser C-1 increases the sensitiveness of the entire system so that a very much smaller DC control voltage is required to vary the output of the alternator. This condenser also permits a linear control of the antenna current; that is, a control whereby the antenna current varies directly with the amplitude variation of the current in the control circuit M-2. Such control is necessary for perfect speech reproduction in radio telephony.

If the capacity of C-1 is selected to neutralize the inductance of M-1 for some definite value of control current in M-2, the impedance of the alternator shunt circuit becomes a minimum. For any lower value of control current, the impedance is determined by the difference between the inductive reactance of coil M-1 and the capacity reactance of C-1. The smaller the difference between these two values of reactance the lower will be the control current required to reduce the alternator voltage to a minimum. In other words, a very slight variation in the DC control current will cause a very great drop of E.M.F. across the alternator and therefore will vary the antenna current in accordance.

(5) Still better control of the alternator output is obtained by providing a shunt condenser C-3. Its value is so chosen that the current through the amplifier at low excitation will be a leading current instead of a lagging current. The condenser, therefore, permits the alternator to assume its full maximum voltage.

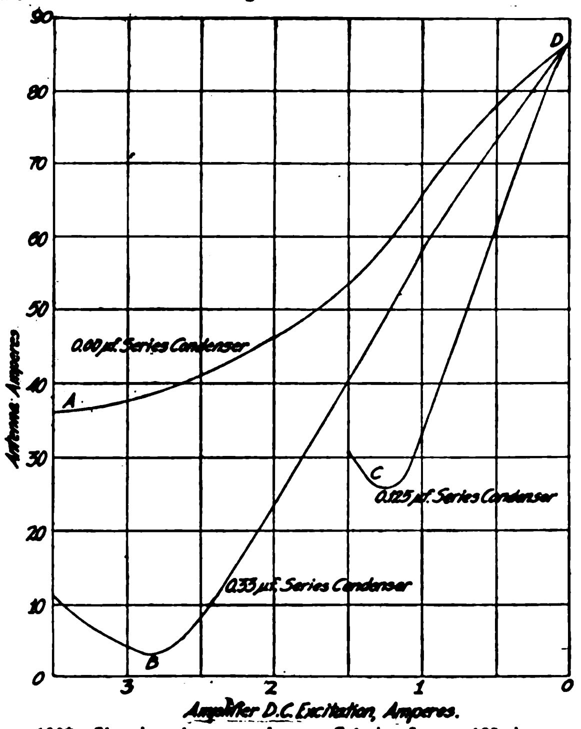


Figure 190*—Showing how condenser C-1 in figure 189 increases the sensitiveness of the magnetic amplifier. The horizontal axis shows the DC excitation current and the vertical axis the actual antenna current. It is clear that with the condenser of .33 microfarads and with DC excitation current less than 2.8 amperes, the change in antenna current is very much greater than with the other two values of capacity shown. Besides a linear control of the antenna current is secured

*Taken from "Radio Telephony" by Dr. Alfred N. Goldsmith.

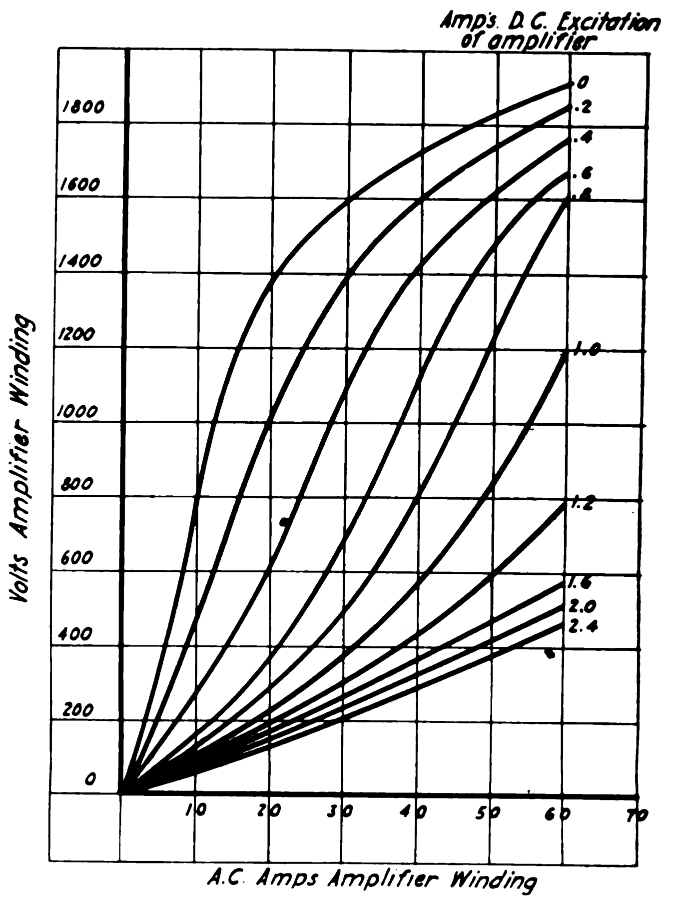


Figure 191*—Showing how the impedance of the magnetic amplifier varies with different alternator voltages and different values of DC excitation current in the control winding of M-2, figure 189

For example, at 800 volts the current through the amplifier varies from 10 amperes for zero current in the DC control circuit to 60 amperes for 1.2 amperes in the DC control circuit. In other words, if a telegraph key be inserted in the DC control circuit of figure 189 and the magnetizing current in M-2 be varied from zero to 1.2 amperes the alternator output would change between 60 and 10 amperes and there will be a corresponding change of current in the antenna circuit

Again at 1200 volts, the current through the amplifier varies from 15 amperes for zero DC control current to 60 amperes for 1 ampere DC control current; and at 800 volts the current from the amplifier varies to 10 amperes for zero DC control current to 33 amperes for .6 amperes DC current. It is clear that with a given alternator and amplifier, some combination of DC current and alternator voltage can be selected whereby a ridiculous small value of DC excitation current can cause an extremely large variation in the output of the alternator. Particularly so, if the capacities of the condensers shown in figure 189 are properly chosen

*Shown by Alexanderson in volume 4 No. 2, Proceedings I.R.E., April, 1916.

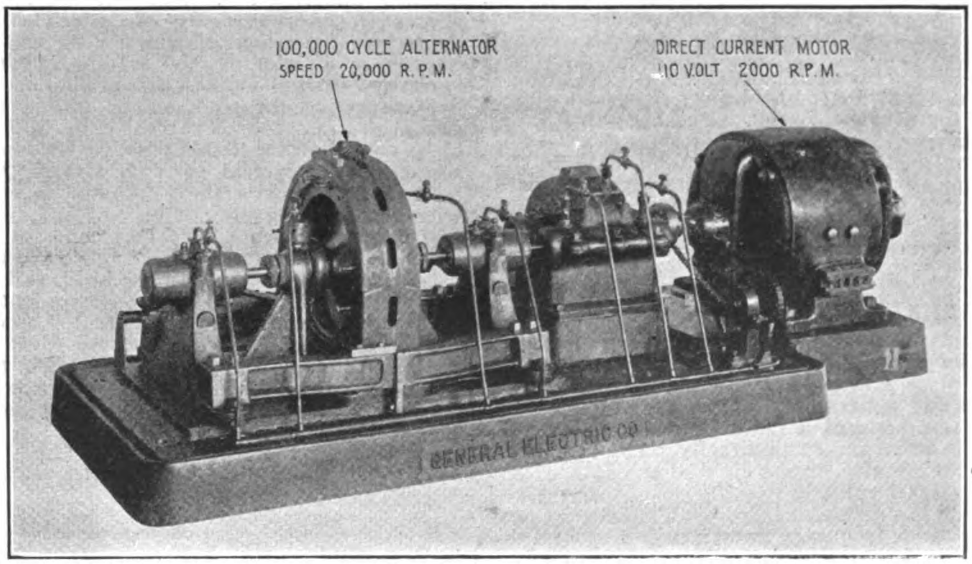
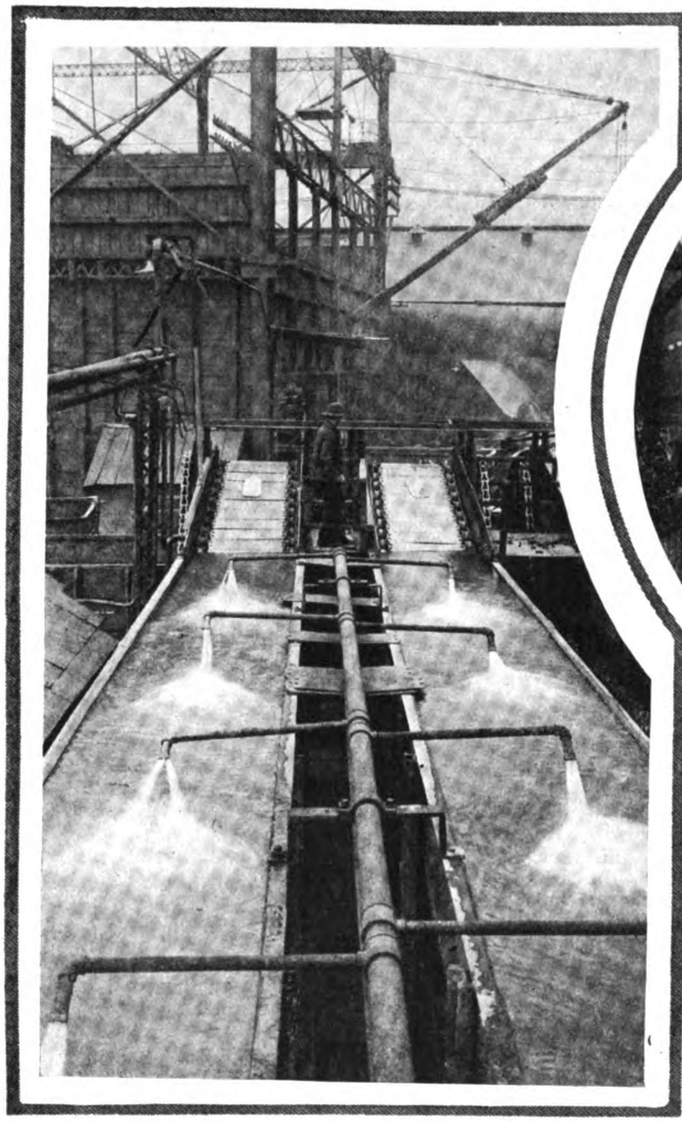
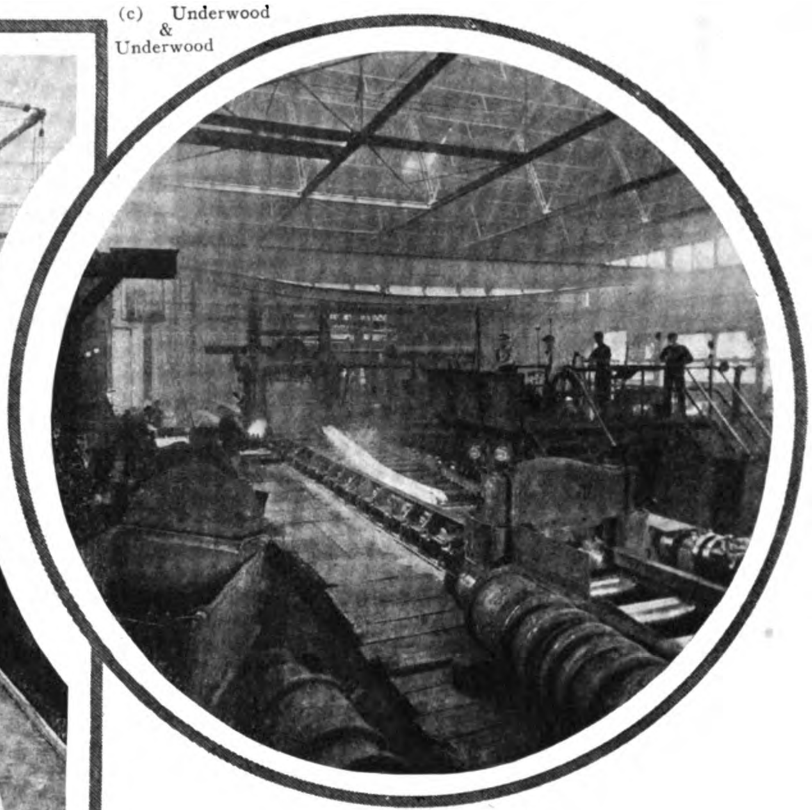


Figure 192—The 2kw. 100,000-cycle Alexanderson radio frequency alternator. The normal speed of the alternator is 20,000 revolutions per minute. It is driven through a turbine 10 to 1 gear by a 110-volt DC motor rotating at 2,000 revolutions per minute. Oil is supplied to the bearings under pressure and a special cutout valve is attached to the oil pipes, which if the oil stops flowing, trip the circuit breaker in the DC line thereby protecting the generator bearings. To prevent binding of the thrust bearings, the generator is provided with a system of equalizing levers which compensate for shaft heating

The output of these alternators is approximately 10 amperes at 200 volts or 20 amperes at 100 volts, depending upon the load and the mode of connection between the armature and the output circuit. The inductance of the armature is .08 microhenries, the armature resistance 1.2 ohms at the frequency of 100,000 cycles

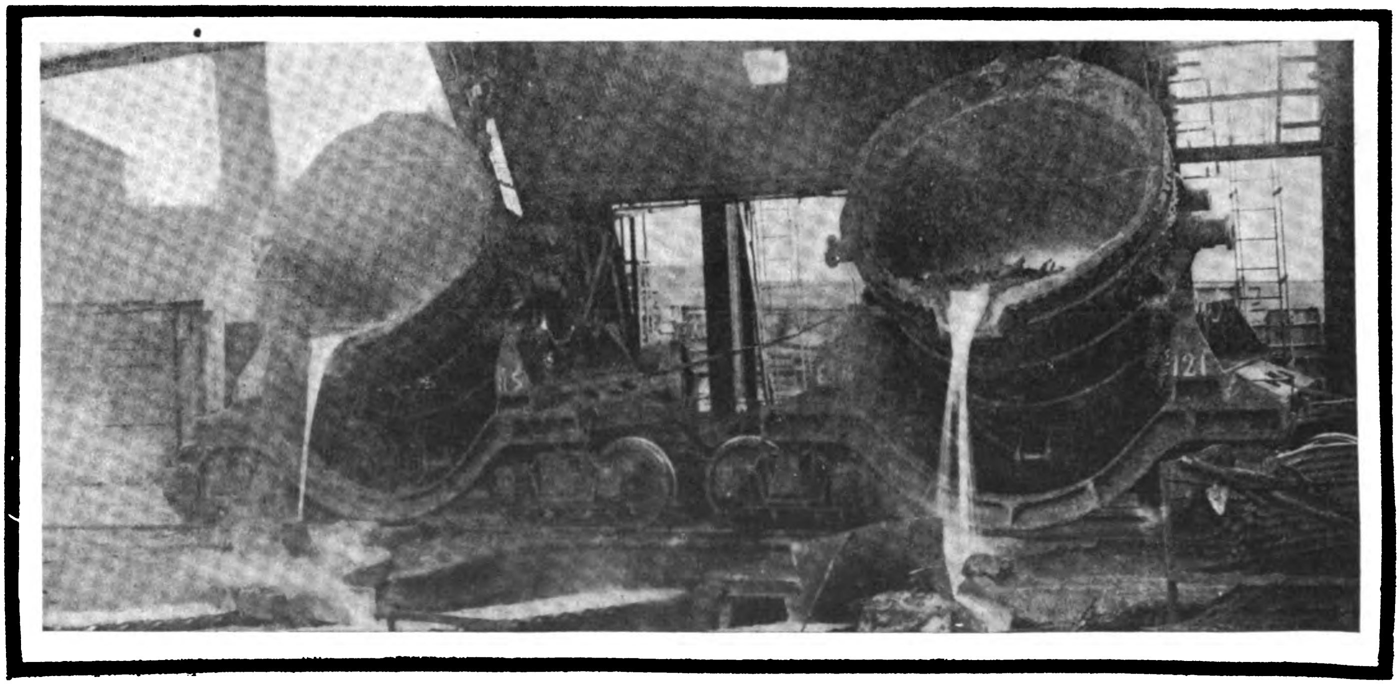


(c) Underwood & Underwood



Steel for France

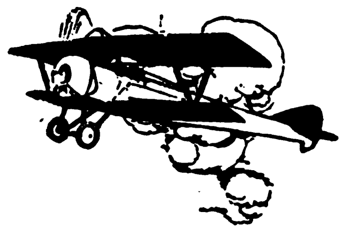
How the United States has turned its commercial genius from making war to preparing for rebuilding devastated countries overseas, is illustrated in these three views of one industry's activities. Above, in circle, is seen a rolling mill interior with a rail emerging for eventual use in transporting material and supplies through Flanders and Lorraine. At the left, pig iron on belt conveyors passing through the cooling troughs



Speed, and yet more speed, is the eternal cry of those who make the steel for the victorious nations. Here is shown the start of the operation revealed above; the giant ladles pouring molten metal into the moulds which the belt conveyors carry directly to the cooling troughs

How To Become An Aviator

The Seventeenth Article of a Series Giving the Elements of Airplane Design, Power, Equipment and Flight Problems



By J. Andrew White and Henry Woodhouse

Laying Off a Course

DETERMINING THE STEERING DIRECTION

It is obviously important for the aviator to know the direction to head his machine to arrive at a given destination. When flying above clouds, over water, or at night, when landmarks are not discernible, he has no means of determining how far the wind may be blowing him off his course. Calculations are therefore made in advance by the following method:

DATA REQUIRED:

Flying speed of his airplane.
Compass bearing of his course from point of departure to destination.
Direction and speed of the wind.

The map of the country over which he is to fly will give him the compass bearings; the points joined by a line (see Figure 106) determine the direction and its angle to the north of the compass bearing.

Direction and speed of the wind can be found from the weather vane and anemometer of the airdrome. The anemometer is a device with four arms carrying cups on the end of each, turning about on a vertical axis at a speed varying with the wind velocity. When the wind velocity at the ground has been determined, the aviator must decide upon the height at which the flight is to be made, for as height increases the velocity and direction of the wind changes. The table below will be found useful in estimating the proper allowance:

WIND VELOCITY AND DIRECTION CHANGES WITH ALTITUDE
(Based on Wind Velocity of 25 miles per hour)

Height in feet	At the earth's surface	500′	1000′	2000′	3000′	4000′	5000′
Velocity change in per cent	100%	135%	172%	188%	196%	200%	200%
Clockwise deviation in degrees	0	5°	10°	16°	19°	20°	21°

Example: Assume that the anemometer shows a wind velocity of 25 miles per hour at the ground, and the weather vane indicates the direction of the wind 89° west of north. The aviator plans to fly his course at a height of 3,000 feet. From the table he learns that the wind velocity at this altitude is 196% greater than at the ground; then, $25 \times 1.96 = 48$ miles per hour. Likewise, from the table, it is seen that the wind direction at this altitude shows a clockwise deviation of 19°, so at 3,000 feet the direction of the wind will be $89° - 19° = 70°$ west of north.

A DIAGRAM TO DETERMINE THE WIND FACTOR

With the data in hand the aviator can lay out a simple diagram for his course. Assume that his orders call for a flight from Fort de Villeneuve to Bougy (see *A-B*, figure 106). The route, according to the map, is 30° east of north. The speed of the aviator's airplane is 80 miles per hour. The wind, as already determined, has a velocity of 48 m.p.h. in a direction of 70° west of north at 3,000 feet, at which height the flight is to be made.

Either on the map or on a separate sheet of paper, the starting point is designated *A* (see figure 107). A line is then drawn with the proper compass bearing to the destination *B*. From point *A* a line is drawn parallel to the direction of the wind, blowing 70 degrees west of north. On this line the velocity of the wind is measured off, the aviator establishing a scale, say 1 inch = 10 miles, *or any other convenient scale*. Assume that the scale 1 inch = 10 miles is the one selected; then 48 m.p.h. would be measured, 4.8 inches to point *C*. With a pair of dividers opened to represent the speed of the airplane by the same scale (in this case, 80 m.p.h. = 8.0 inches) an arc is described with *C* as the center. Where it cuts the line *A-B* (see *D*, figure 107) a line is drawn from *D* to *C*; this line gives the proper direction to steer the airplane to neutralize the drift of the airplane in one hour's flight from *A* to *B* in the cross wind. The steering is by compass bearing to the fore and aft axis of the machine.

Measurement of the line *A-D*, applied to the scale will give the actual velocity in miles per hour of the flight. In the example it is seen to be 85 m.p.h., that is, the cross wind increases the airplane's speed 5 miles per hour.

The student should reconstruct the diagram for the return flight. That it will not do to steer in exactly the opposite direction will then be made clear. In all cross-country flights a separate diagram for the return is required, unless, of course, the wind happens to be exactly parallel to the course.

RADIUS OF ACTION

To determine the distance outward the airplane can go and have sufficient gasoline to return, requires a simple calculation.

The aviator knows his gasoline capacity; i.e., how many hours of flight can be obtained before the tank is empty. With this and the other data he can figure his radius of action in miles.

Example: Assume that the flight is to be made straight into a head wind of 30 miles per hour, the speed of his airplane is 80 m.p.h., and its gasoline capacity 4½ flight hours. (For climbing and as a general margin ½ hour gasoline consumption is deducted, leaving 4 flight hours.)
On the outward trip his speed is $80 - 30 = 50$ m.p.h.
On the return trip his speed is $80 + 30 = 110$ m.p.h.
The ratio for both trips is, then, as 50 is to 110, or 5 is to 11. The time required for the outward trip is thus 11/16 of 4 hours, and the return trip the remaining 5/16 of 4 hours; or, outward = 2¾ hrs.; return = 1¼ hrs. Since his outward bound speed is 50 m.p.h., then $50 \times 2\frac{3}{4} = 137\frac{1}{2}$ miles radius. Return speed being 110 m.p.h., then $110 \times 1\frac{1}{4} = 137\frac{1}{2}$ miles. This, then, is the radius of action.

A wind blowing directly along the course is a rare occurrence, however. A diagram similar to figure 107 must therefore usually be made, both for the outward and return trips. The calculation for radius of action is then carried on as above, or by the simple formula:

$$\text{Radius of Action} = a \times \frac{b \times c}{b + c}$$

Where
a = gasoline hours.
b = outward speed.
c = return speed.

Figure 106—How an airplane must be steered off the direct course to allow for side wind drift

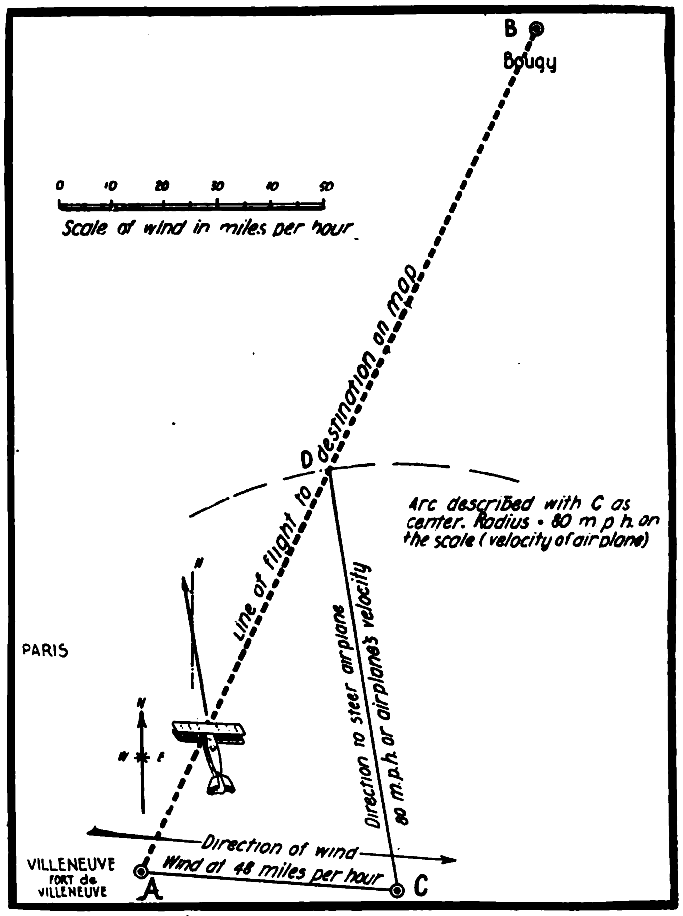


Figure 107—Diagram solution of the flight from A to B shown in figure 106

SOME FLIGHT CONSIDERATIONS

PROPER PREPARATION

Care must be observed by the aviator that his preliminary preparations are properly made. This refers particularly to a study of the course from the map.

Ordinarily the country over which he is to make the flight will be on one sheet with features and landmarks clearly indicated. Should the use of two sheets be necessary these should be pasted together before starting and cut to fit the map roll. In war flights foreign maps with the scale in fractions are often the only ones available; the aviator should immediately construct the corresponding scale at so many miles to the inch, which will facilitate rapid calculation. Distances from the starting point should also be marked at ten mile intervals or by distinctive objects to be passed. High hills should be marked as bad for landing.

HEIGHT

Where there are no high hills or mountains in friendly territory the flight is best made at heights from 1,500 to 3,000 feet. An altitude of 1,500 feet should be attained by an initial circling climb before the aviator sets off on his course. Speed and steadiness of wind increases with height, and landing or righting in case of mishap is better accomplished with a good margin; but above 2,000 feet contour of the country is not readily distinguished, so if the flight is to be at a higher altitude the poor landing places should be clearly marked on the map. It is well for beginners to keep the ground in view throughout the flight, flying under or around any clouds.

CLOUDS, FOG AND STORMS

Pupils are cautioned to avoid heavy cloud banks and not to rise above clouds when near the seacoast for a wind off shore may carry the airplane out to sea without the pilot's knowledge. When navigation above a cloud bank is necessary, the cloud formations may be used as a basis for keeping the airplane horizontally level, for cloud formations are ordinarily sufficiently level for this purpose. Fog should be avoided; in fact, when a heavy mist is encountered a landing should be made as soon as possible. River valleys should be avoided, for they very often hold a ground fog up to a height of 700 feet. At times when the flight must be continued through clouds or fog, the instruments should be carefully watched and the stick control and rudder kept in central position as much as possible. Heavy rain, sleet and hail chip the propeller slightly and when encountered a landing should be made at the earliest favorable opportunity. A whistling sound indicates that the propeller has been chipped.

AIR DISTURBANCES

Initial cross-country flights by the student are usually made under favorable weather conditions, ordinarily in the early morning or late evening, when the atmosphere is calmest. Bumps caused by heat, as explained in a later chapter on meteorology, manifest themselves early in the day as close to the ground as 100 feet; their influence is gradually extended upward as the morning progresses until they are perceptible at noon at altitudes up to 3,000 feet. Clouds and inland waters generally predict bumps, while over the sea the air is ordinarily smooth, although of high velocity. Landings in strong, bumpy winds are best made with additional speed, caution being exercised when nearing the ground in sheltered spots as wind eddies may cause a sudden roll or a drop of 10 feet or so.

LOST BEARINGS

Should something happen to the compass and the aviator be unable to get his bearings, his wrist watch will be of assistance in locating the points of the compass. With the hour hand pointed to the sun, the point midway between the angle it makes with the numeral 12, points to the south. Thus, at 8 o'clock in the morning, with the hour hand pointed at the sun, the point midway in the angle formed by 8 and 12, i.e. 10 on the watch dial, will point to the south.

LANDMARKS

The principal landmarks of a map should be firmly fixed in the aviator's mind prior to the flight, memorized if possible. Experience has shown that the following features are the most useful:

Towns—These are the best guides and should be marked with a circle or underlined on the map. A village is sometimes difficult of identification; location of its church and its reference to the roads will aid in placing it. If flying below 2,000 feet altitude the aviator should not pass directly over the town as the heat from factory chimneys causes marked air disturbances.

Railways—Railroad tracks are of great assistance. Tunnels, bridges and cuts are marked on the map and aid in locating the line to be followed should the aviator mistake a branch line or siding for the main route. It should be remembered that the track disappears when it passes through a tunnel.

Water—Water courses and lakes are usually clearly defined and may be seen at some distance. Allowances should be made, however, for possible flooding of streams after heavy rains which may change their appearance as recorded on the map. The bearing of a river with reference to the course should be noted; following its windings may involve loss of time.

Roads—From a height all roads look very much alike and are therefore not very good guides. Main roads can occasionally be identified by the paving and the amount of traffic, and are useful because they lead into towns. Telegraph lines may be expected along them, which makes landing nearby dangerous.

Woods—Small forests serve as excellent guides.

Hills—From altitudes of 2,000 feet and over, hills are flattened out in appearance and valleys are not clearly discernible.

General Characteristics—The physical features of the country are very helpful to the aviator if his preliminary study of the map fixes in his mind their relationship to each other. How railways and streams join or intersect, how they enter and leave towns, and their relation to wooded areas, supply useful information. Dividing the course into four progressive parts also aids, if the general nature of each sector is noted for its chief distinguishing characteristics, whether water, woods, farm lands, towns or villages.

FORCED LANDINGS

Engine failure is the main cause of forced landings. As soon as it is known that the failure is complete, the engine should be switched off and the gasoline pipe closed to lessen the danger of fire. The airplane is then turned into the wind and if the ground directly beneath makes landing impossible the descent can be made in a long glide. While selection of landing ground is not practical from a recognition standpoint at altitudes greater than 1,000 feet, entirely unfavorable areas such as water, marshes or forests may be avoided by long glides. The radius of the forced landing is about five times the height at which the airplane is flying. An aviator forced to land from a height of 2,000 feet, therefore has about 10 square miles of land to choose from. At a height of 5,000 feet he has selection in an area of about 70 miles.

When a forced landing has been made the aviator's first thought should be for his machine and the immediate possibility of resuming flight. Examination of the engine is the first step; it should then be determined how much, if any, damage has been done to the airplane structure. A telephone call to his headquarters should then be made and a report given of his location and diagnosis of the trouble. If the damage requires staying where he is for the night, then the airplane should be moved to some spot sheltered from the wind and made secure.

TIME CHECKING

It is difficult to estimate time while flying, yet checking by the watch the time when successive objects are passed is an important detail often overlooked. The tendency invariably is to expect the next landmark long before it is due and confusion will arise in the aviator's mind unless time elapses are carefully checked. Knowledge of elapsed time is also valuable in steering a compass course over the clouds.

SELECTING LANDINGS

Choosing a suitable field to land in is by no means an easy task for the novice. A few primary rules governing selection will be useful.

It is better to pick out a *group of fields* as the glide may take the inexperienced aviator beyond or short of the mark.

Stubble fields, brown in color from a height, are generally smooth and, excepting sandy beaches, make the best landing ground.

Grass fields, green in appearance, often can be identified by cattle grazing. Mounds may be looked for in grass land, so they are therefore second choice.

Cultivated land is ordinarily fairly level, but landings made therein are successful only when pancaked. A ploughed field is black in appearance, vegetable and corn fields have a hue considerably darker than the green of grass lands.

A field *near a town* is the best choice, as its proximity to the source of supplies is a great convenience. The landing field selected, however, is preferably to windward of the town, so it will not be necessary to rise over the buildings when re-starting.

Telegraph wires usually border *main roads and railways;* these wires cannot be seen until the aviator is close upon them, so nearby landing places are undesirable.

When *snow* is on the ground the selection of a good landing place is practically impossible; the frozen ground, however, makes its selection of less importance.

Light variations are important. Flying into the rays of the sun, a slight haze appears which distorts objects. In the late evening, too, the light may be good at the flying altitude, but when descent is made the ground appears much darker. Before landing, therefore, a wide circle should be made until the eyes are accustomed to the relative dulness.

PEGGING DOWN

The airplane should be placed head into the wind and the tail lifted up and supported at a height which will place the airplane's wings edgewise to the wind. The controls should be locked and the wings and fuselage near the tail pegged down, some slack being left in the rope. The propeller, engine and cockpit should then be covered. If a strong wind is blowing, trenches should be dug for the wheels to a depth of about ¼ their diameter.

RE-STARTING

A minor trouble which does not require calling a repair crew may leave the aviator without assistance for starting, although spectators willing to hold back the airplane are generally more numerous than too few. Stones or fence poles will serve as chocks under the wheels if assistance is not at hand. Any mud which may be gathered on the wheels should be cleaned off as it will be drawn to the propeller by centrifugal force and chip or break it. Before starting, the ground over which the machine is to taxi should be walked over carefully and any serious obstacles removed. The possibilities of dead wind in the lee of buildings should be estimated and allowance made to get clear of these areas as the airplane rises. Small obstacles, such as hedges, may be cleared if good taxying speed is acquired and the control stick pulled back suddenly. Getting rid of extra weight will also aid the machine to take the air quicker, should there be doubt of getting out of the field.

Inventions the Army Needs

J. Andrew White, Editor The Wireless Age:

The Inventions Section of the General Staff of the United States Army has submitted to the War Committee of Technical Societies the attached problems requiring scientific and inventive talent for solution.

The War Committee, therefore, transmits this request of the General Staff to its membership and requests that the Engineers of America give them serious thought and consideration.

War Committee of Technical Societies,
3549 New Navy Bldg., Washington, D. C.

Ideas and suggestions should be submitted to

Inventions Section, General Staff,
Army War College, Washington, D. C.

Problem No. I.—Liaison Communication

In operations of our troops fighting in France, all have seen the necessity of perfecting liaison between different elements of the command. This is especially true as regards liaison between elements of the front line troops and between front line troops and elements further to the rear.

Our infantry advances in spite of the most serious resistance offered by the enemy, and the losses suffered are necessarily heavy. These losses can be lessened by increased artillery activity. Liaison between the infantry is now maintained in so far as is practicable, by sending forward with the infantry a large artillery liaison personnel, well equipped with the material of liaison—telephones, wire, flags, projectors, rockets, radio, etc.

This personnel is charged with sending back information whereby fire may be directed on the hostile elements which are causing losses to our troops.

The present system of liaison does not always give satisfactory results. The enemy's fire frequently cuts off the infantry, and cuts regimental commanders from the units in the front lines. Wire is almost immediately cut by shells; optical signaling becomes impossible on account of smoke and dust, and frequently is interfered with by fog; runners become disabled or killed; pigeons go astray; radio is interfered with by enemy stations, and the antennae are destroyed by enemy fire; ground telegraph is limited in range, and interfered with.

The War Department is desirous of finding new means of communication whereby closer liaison may be maintained by the different elements of a command.

A device for this purpose should be small and compact, without antennae exposed to shell fragments; it should be easily transported by one man, or at the most by three men; it should be capable of being set up quickly, and not present a target to the enemy; it should operate over a distance of at least five miles and be certain of action.

It is believed that the War Department is in possession of the latest developments in so far as radio, telephony, signaling devices and similar apparatus are concerned, but is now seeking for something that is an improvement over all these devices. So far as known, nothing of the kind exists at present, but it is believed, with the inventive genius of the country concentrated along these lines, something desirable may be developed.

PROBLEM NO. II.—AN AVIATION NEED

On night bombing expeditions and even in the daytime, when passing through fog or clouds, an airplane, like a ship, is guided entirely by a compass. Some of the new instruments designed for this work are beautiful examples of the instrument maker's skill, but, unfortunately, when placed where the aviator can see them, they are directly between him and the engine, a position which greatly affects their accuracy.

If a compass should be placed near the outer end of a wing, or at the rear end of the fuselage, it would be practically outside of the magnetic influence of the engine, but at present there is no way to read a compass in either of those positions.

What is needed is some device or arrangement whereby a compass can be mounted far enough away from the engine to be outside of its magnetic influence and still be so arranged that it can be easily read.

PROBLEM NO. III.—A BETTER FIRE CONTROL GEAR FOR FIXED MACHINE GUNS ON AIRPLANES

The forward machine gun on an airplane is fixed and fires between the propeller blades in the direction in which the machine is headed at the time of firing.*

The function of a fire control gear is to control the fire of an aircraft machine gun shooting through the propeller so that no shots will be fired when the blades of the propeller are in a position where they are in danger of being struck. This is done usually by a cam attached to the crank-shaft or geared to the propeller which sends an impulse by mechanical or hydraulic means to the trigger mechanism of the gun only when the propeller is in a safe position for the gun to be fired. This impulse trips the trigger and a shot is fired. As gears are now designed, two impulses are given to the gun every time a blade of the propeller is in a certain position with reference to the bore of the gun.

Fire control gears are of two types: hydraulic and mechanical. The advantages and disadvantages of each type are listed below.

*The considerations governing airplane machine-gun fire and full descriptive test of the armament are contained in the book "Practical Aviation for Military Airmen" by Major J. Andrew White.

HYDRAULIC GEAR. Advantages: Allows gun to be placed in any position with reference to the engine, inasmuch as the hydraulic pipe line can be bent.

Disadvantages: Difficult to fill and take care of. Requires a good deal of special training and experience to get good results. Many small parts to get out of adjustment. Difficulty from leaking.

Lag in impulse due to time taken by hydraulic wave to pass down pipe line. This causes a wide dispersion of shots for changes in the R.P.M. of the propeller. Shots fired at low R.P.M. fall too near one blade of the propeller and shots fired at high R.P.M. too near the other blade; thus the safety margin is cut down and R.P.M. the gun may safely be fired at is limited.

At low R.P.M. the impulse changes from a pressure wave to a simple hydraulic action and the gear cannot then be depended on.

MECHANICAL GEAR. Advantages: Action always positive and certain. No lag of impulse in transmission. Easily taken care of and adjusted.

Disadvantages: Position of gun limited with reference to the engine as it is difficult to send impulses around corner. In case where impulse is transmitted by rods difficulty is encountered from whip. Wear in rods and cams affects timing.

Disadvantages of both types of gears:

In both types of gears the principal drawback is the dispersion of shots between zero speed and maximum speed which limits the type of propeller used and limits the safe firing speeds. This is greatest on hydraulic gears.

Rate of fire of gun dependent on R.P.M. of propeller. For example, if a machine gun is designed to shoot 800 shots per minute and the propeller is turning over at 400 R.P.M., or 800 impulses are given per minute, the gun will fire on every impulse and the rate of the geared gun will be 800 shots per minute. If the propeller is turning at 500 R.P.M., or giving 1,000 impulses per minute, the gun cannot use every impulse, but will use every other impulse, and the rate of fire will only be 500 shots per minute or the efficiency will be decreased. This is an important disadvantage of the present system.

The ideal fire control gear:

(1)—Maximum rate of fire is obtained at all R.P.M. of the propeller. (2)—The time of impulse is advanced as the propeller speed increases so that shots at maximum speed will fall in the same position with reference to the blades of the propeller at the plane of the propeller, as shots at zero speed. (3)—Easily placed at any position with reference to the engine. (4)—Simple to take care of and adjust.

It is obvious that if the first advantage is obtained, the second must be sacrificed, but a better combination of the two is desired than we have at the present.

The problem which presents itself is to devise a fire control gear which incorporates the above advantages. The solution seems to lie in an electrical system.

Calculations must be based on the following data: Distance from muzzle of gun to plane of propeller varies from 3 to 6 feet. Maximum propeller speed 1,600 R.P.M. Rate of fire of airplane machine gun 1,200 shots per minute.

PROBLEM NO. VII.—IMPROVEMENT IN AIRPLANE CABLE BRACES

The present method of attaching the ends of cables to turnbuckles and anchorages is by bending the end of a cable around a protecting liner and wrapping the overlapping end with brass wire, and then soldered.

This is an unsatisfactory, wasteful and expensive method. If some very simple method of anchoring cable ends could be devised, it will greatly speed up the production of aircraft.

Aviation News

Pershing Honors Gallant Aviators

The Commander in Chief of the American Expeditionary Forces, in the name of the President, has awarded the distinguished service cross to the following officers and soldiers:

First Lieut. Joseph C. Raible, Jr., 147th Aero Squadron. — For extraordinary heroism in action near Château-Thierry, on July 5. He and three other pilots, at an altitude of 4,700 meters, attacked an enemy formation of eight battleplanes flying at an altitude of 5,000 meters. Home address: J. C. Raible, 2,102 Chestnut Street, Hannibal, Mo.

First Lieut. Arthur H. Alexander, 6th Aero Squadron.—For extraordinary heroism in action on September 4. While on a bombing expedition with other planes from his squadron Lieutenant Alexander engaged in a running fight over hostile territory, with a superior number of enemy battleplanes, from Friauville to Lamorville. Home address: Mrs. Stella H. Alexander, Box 105, Wellesley, Mass.

First Lieut. Donald B. Warner, 96th Aero Squadron.—For extraordinary heroism in action on September 4. During the combat he was severely wounded, his right thigh being badly shattered. In spite of his injuries, he continued to operate his machine guns until the hostile formation had been driven off and one plane shot down burning. Home address: Mrs. C. E. Warner, 175 Humphrey Street, Swampscott, Mass.

First Lieut. Alfred A. Grant, 27th Aero Squadron. —For extraordinary heroism in action near Château-Thierry, on July 2. By skilful maneuvering and good marksmanship he destroyed one machine and drove off the other two. Home address: Alfred A. Grant, father, 86 Syracuse Street, Denton, Texas.

First Lieut. Charles W. Drew, 13th Aero Squadron. — For extraordinary heroism in action near Flirey on August 15. He operated one of a patrol of four machines which attacked four enemy battleplanes. In the fight which followed he attacked in succession three of the enemy airships, driving one of them out of the battle. He then engaged another machine at close range and received ten bullets in his own plane, one of which penetrated his radiator, while another pierced his helmet. In spite of this he followed the German plane to a low altitude within the enemy's lines and shot it down in flames. Next of kin: Mrs. S. E. Drew, 246 West Seymour Street, Philadelphia, Penn.

Second Lieut. Arthur H. Jones, 147th Aero Squadron.—For extraordinary heroism in action in the Toul sector on July 16. He and four other pilots were attacked by nine German pursuit planes. Without hesitation, he dived into the leader of the enemy formation, pouring machine-gun fire into him at 100 yards. After a quick and decisive combat, the enemy leader fell out of control. Lieutenant Jones then attacked two of the other enemy planes, which were attacking him from the rear, and succeeded in driving them off. Home address: Mrs. A. H. Jones, Haywood, Alameda County, Cal.

First Lieut. Walter L. Avery, 95th Aero Squadron. —For extraordinary heroism in action north of Château-Thierry on July 25. Home address: F. E. Avery, 1,199 Franklin Avenue, Columbus, Ohio.

First Lieut. Louis G. Bernheimer, pilot. Home address: Sidney Bernheimer, 138 72d St., New York City.

* * *

Lieutenant Alan Winslow Receives the War Cross

Lieutenant Alan Winslow of Chicago and Yale has recently been awarded the much coveted War Cross for conspicuous service while flying in France. This American airman is the son of a wealthy Chicago manufacturer and a member of the class of 1918 at Yale University. After two years of training he attracted the attention of the authorities by his fearless flying at the front.

In the air encounters just prior to the cessation of hostilities much was demanded of the antagonists. It was not sufficient for the airmen to be fearless and skilful in ordinary air maneuvers. His life depended upon his skill in performing feats in midair which a short time ago were considered merely circus stunts too perilous for any useful purpose. To out-maneuver and out-fight the Germans, the airman had to outmatch them in "looping the loop," in spinning nose dives and in all the feats of modern airmanship. Among the thousands of airmen flying at the front, Winslow distinguished himself and has been officially recognized for his skill.

Lieutenants Winslow and Campbell (the first American-trained aces) were near the front one day playing cards when the alarm was sent out that an enemy fleet of airplanes was approaching. The two airmen, running to their machines, leaped to their seats and rose to meet them. Each airman picked a Boche from the fleet and started after it.

Lieut Alan Winslow, the first American-trained ace to receive War Cross

The German was in full retreat when Winslow, using all the speed at his disposal, succeeded in overtaking his man. Seeing himself in danger, the German resorted to the desperate expedient of "looping the loop" at close quarters. The German machine succeeded in describing a circle about Winslow's machine which made it practically impossible for him to train his gun effectively, but by resorting to the same tactics Winslow finally succeeded in gaining a favorable position. When his aircraft had swung to the right angle Winslow fired with a sure aim and the German plunged down out of control.

The moment his enemy was disposed of Winslow turned and started to help Campbell, who was engaged in a lively battle in another part of the sky. Between them the other Boche was disposed of, and the rest of the fleet then retreated. The two Americans, communicating with each other by means of the radiophone had achieved their victory by cool teamwork. On landing after the battle the two Americans were the subject of an enthusiastic demonstration by the French aviators who had watched the battle from the ground.

Experimenters' World

A High-Speed Key of Unique Design

MORE amateur dreams of a high-speed sending key have been wrecked upon the rocks of mechanical difficulties that were insurmountable, than any other device that I know of. The prohibitive price of the manufactured article places it beyond the reach of the average amateur's pocketbook, and the complicated nature of the instrument prevents its successful manufacture in the average workshop.

I present herewith, however, an automatic key operating by an electrical slow acting relay instead of mechanical mechanism.

If we encircle an electromagnet with a closed copper ring of very low resistance, and if a current passing through the electromagnet is suddenly broken, there will be a secondary current induced in the copper ring which will in turn magnetize the core, thus tending to prolong the magnetic action.

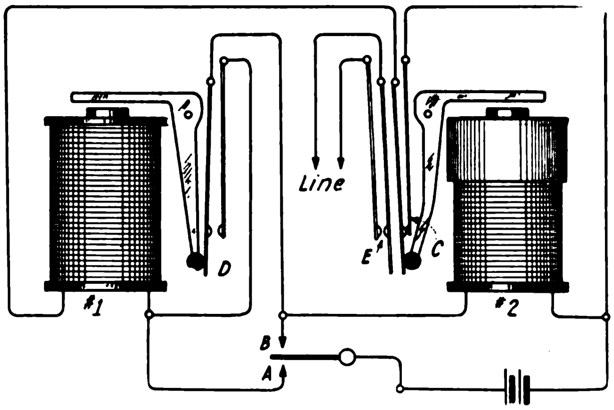


Figure 1—Showing the circuit of the high-speed key

This is precisely what is required for the electrical operation of our dot-making device in the high-speed key. In figure 1 is shown the circuit for the instrument, this consisting of a double contact key at AB, a battery and two electromagnets, number 1 being an ordinary magnet of about 20 ohms resistance, and number 2 being one of the slow-acting type just described. In order to give satisfactory results, the copper slug should be about ½" long and 1" in diameter, with a hole in the center of the diameter of the core.

The operation of the device is as follows: Closing the contact A allows the battery current to flow into coil number 1 through the contacts C. This pulls up the armature of number 1, closing contacts D, thus allowing current to flow into coil number 2, which in turn pulls up and opens contacts C, at the same time closing contacts E, which are connected to the main line. But the opening of contacts C releases coil number 1, thus opening contacts D and releasing coil number 2. This coil, however, requires an instant before releasing, which then starts the cycle over again.

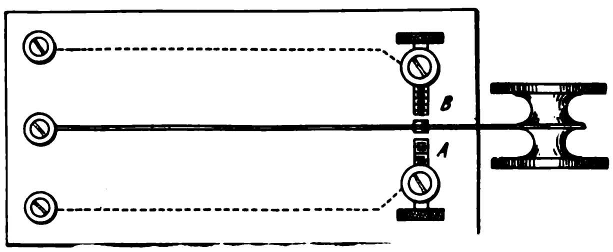
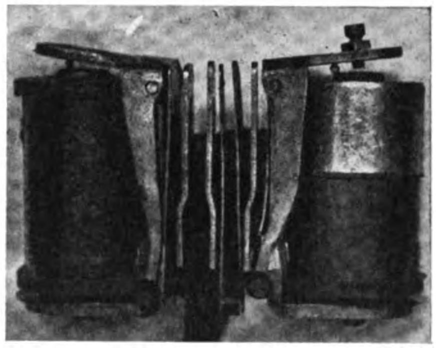


Figure 2—Simple form of the double contact key

The photograph shows such an arrangement as constructed by the author, using stock telephone relay parts, which was found to be entirely suitable. When sending at a speed of 20 words per minute, the speed of making dots varies from 8 to 12 per second; any variation of speed desired may be secured by adjusting the spring tension and the distance between the armatures and cores.

Figure 2 shows a simple form of double contact key to be used at AB. It consists of a steel corset stay rigidly fixed at one end, and making contact either with A for dots, or with B for dashes. Two key nobs are screwed to the other end for its manipulation, and it is operated just like the ordinary high-speed key. In using a key of this type, practice is required to get just the correct number of dots in each letter, but a few weeks are sufficient to make one fairly adept.



High-speed key apparatus constructed by using stock telephone relay parts

ARNO A. KLUGE—*Nebraska.*

A New Capacity Meter

THE objects of the apparatus herewith described are:

(1) To enable the capacity of a condenser to be very accurately and rapidly measured.

(2) To assist in the manufacture of condensers of a definite capacity.

(3) To enable variable condensers to be accurately and rapidly calibrated.

(4) It is intended as a useful instrument in the design of wireless apparatus.

The capacity meter depends for its action on the utilization of the phenomenon of "beating effects" produced by two sets of superimposed continuous oscillations. Continuous oscillations are set up in the grid and plate oscillating circuits of a vacuum tube by coupling the inductances. Another similar circuit is arranged with telephones included in the plate circuit.

If the frequency of the continuous oscillations in the first circuit A is made approximately equal to the frequency of the oscillations generated in the second valve circuit B, audible beats will be produced which will give a note in the telephones of the B circuit. The pitch of this note depends on the difference between the frequencies of the two sets of oscillations; that is, the note frequency heard is equal to the difference of frequency of the two sets of oscillations.

When the frequency of A is equal to the frequency of B, no beats will be produced, and therefore nothing will be heard in the telephones. The moment the frequency of A is altered, however minutely, by altering the inductance or capacity of its circuits, a note will be heard in the telephones of B. If the difference of frequency of the oscillations in A

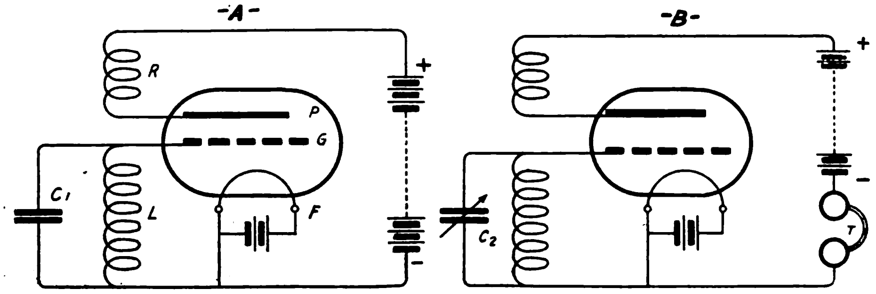


Figure 1—Diagram of two continuously oscillating circuits used in the capacity meter

and B exceeds about 14,000 per second, although beats are still produced, nothing will be heard in the telephones.

The invention uses the phenomenon of the beating effects to compare the capacities of condensers. Figure 1 shows two continuously oscillating circuits A and B. These circuits might be mounted in a box. The circuit A may conveniently be oscillating at, say approximately, a frequency of 500,000 per second.

C_1 is a very accurate standard condenser of, say, .002 mfd. capacity. By varying the variable condenser C_2 the frequency of the oscillations taking place in B circuit may be altered on either side of 500,000. If the oscillations in B are of a frequency of 400,000 nothing will be heard in the telephone. As the capacity of C_2 is gradually decreased, the frequency of the oscillations in B will increase and a very high note will be heard, owing to the establishment of audible beats which are rectified by the vacuum tube. This high note will gradually become lower as the frequency of B approaches the frequency of A, namely 500,000 per second. When the frequency of B equals that of A, no beats will be produced. The graduation of .002 mfd. should be made on the condenser C_2. On still further increasing the frequency of the oscillations in B, a note will be heard again which will rise higher and higher and finally die out.

Several different standard condensers should be substituted for the condenser C_1, and in each case a graduation should be marked on the condenser C_2 when it is adjusted to such a position that a variation to either side will cause a note to be heard in the telephones. Intermediate graduations are then marked on the scale of the condenser. When the condenser C_2 has been completely graduated by means of accurate standard condensers, the instrument may be used for a variety of purposes.

To measure the capacity of a condenser of uncertain capacity, the condenser should be connected in place of the C_1 condenser of the A circuit. The condenser C_2 is varied until a "chirp" is heard in the telephones. The middle of this chirp is found so that a variation to either side would give a note in the telephones. The calibration mark of the condenser C_2 will then register the capacity of the condenser under test. This result will be exceedingly accurate. Even the alteration of capacity by placing the hand near C_1 will be indicated by hearing a note in the telephones, since the balance of frequencies has been upset.

If a condenser of, say, .0005 mfd. is to be constructed, the condenser should be made approximately of the correct size. It is connected in place of the condenser C_1. Its capacity is then measured by turning the condenser C_2 until the middle of the chirp heard is obtained. If the capacity is too high, the plates of the condenser should be reduced, and tests made until the capacity is exactly .0005 mfd.

A variable condenser may be calibrated as follows:

Connect the variable condenser in the position of C_1. Make a number of calibrations by balancing C_1 and C_2 as described, calibrating C_1 with the readings given by C_2. The accuracy is exceedingly high since the slightest difference of capacity is indicated by an alteration of the note.

The procedure for measuring the capacity of large condensers is somewhat different. When the capacity of a large condenser is to be measured, a small standard condenser would be included in the instrument and would be connected in series with a large condenser. A separate calibration chart would be provided with the condenser C_2. When measuring small capacities the standard condenser would be connected in parallel.

LIEUT. J. SCOTT TAGGART—
Great Britain.

A Satisfactory Lead-In

THE following is a satisfactory method of bringing the aerial lead-in into the radio room where it is undesirable to drill through the window frame. A pane of glass is removed from one of the sashes and one corner is cut off; then it is replaced and a thin piece of either wood or fibre, drilled to pass a porcelain bushing, is fitted into this space in the corner of the sash. It is fastened in with brads and putty the same as the window pane. This bushing consists of two tubes placed inside of one another with pitch run in between. The wood or fibre corner should be well varnished to prevent warping. It will also be well to provide a small drip shield cut from sheet metal and soldered to the conductor near the point where it enters the bushing to prevent the beads of rain from following the lead-in into the room. Figures 1 and 2 are self-explanatory.

J. A. WEVER—*Maryland.*

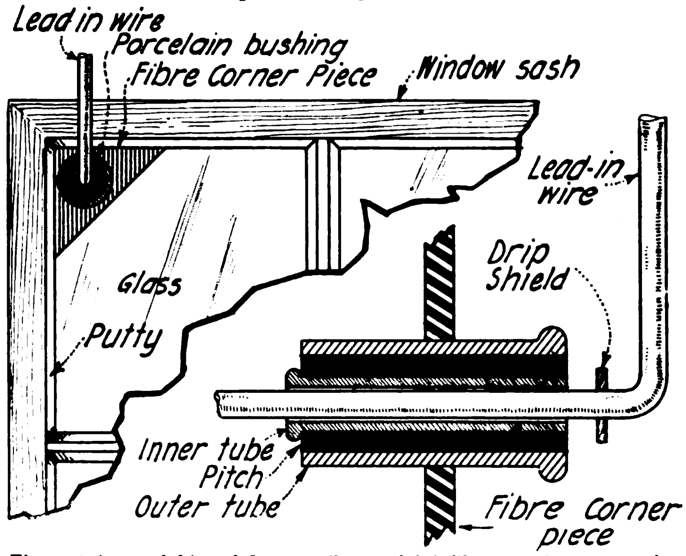


Figure 1 (upper left) and figure 2 (lower right) illustrate the construction and application of the aerial lead-in

A Unique Life Preserver

THE accompanying drawings and photographs show the use of a novel life preserver suit, which, in addition to the one wearing it, can support five others in the water. Never before in the history of the world's progress has there been such an imperative need for a life

High seas, cold weather, vast distances have no terrors for these men when protected by the safety-suit whose buoyancy is sufficient to support six persons in water

saving device that is thoroughly reliable. New dangers, added to the old, startle one daily with the toll taken of men, women, and children who travel by ship. Not alone the ocean, but coastwise waters, lakes, bays, and rivers are claiming an ever-increasing human price as boats multiply and high power and greater speed is developed, until many dread to plan a voyage or to think of loved ones and friends going on yachting cruises, motor boat trips, or even on river excursions.

The safety-suit illustrated is a self-guarantee against nautical disaster and accident. It makes drowning almost impossible and protects the wearer from exposure and its after effects. It keeps the shipwrecked traveler afloat for hours and days. It is a one-piece garment, perfect in workmanship and mate-

On land again after a sojourn in the cold waters of New York Bay in November

rial, and can be put on by man, woman, or child in less than a minute.

Little has been done to insure the safety of passengers in the event of disaster, during the hours which may elapse between the sinking of a ship and the arrival of assistance. The open boat, the life raft, and the primitive life preserver are the devices to which the traveler must turn when the ship fails him. The history of marine disasters has demonstrated that the launching of boats under stress is a hazardous undertaking at best and often is made impossible by the list of a sinking ship, a rough sea, or damage to the boats themselves. The life raft, washed by every sea, is a makeshift; and the final dependence of the passenger must be placed upon the individual life preserver.

It is often asked, "Has the life preserver made good?" Experience proves that it has not. Let us suppose that you are aboard a sinking ship. A wireless call for help has been sent broadcast over the ocean, and, a hundred miles away, a steamer turns about with smoke pouring from her funnels, while her wireless crackles a message of hope. There is barely time to adjust a life preserver, gather a few of the most precious possessions and scramble up to the tilted deck, when one finds oneself afloat—submerged to the neck in icy water. Before help can be secured several hours often elapse—several hours of exposure such as no human being can live through.

In addition to keeping one afloat, it is agreed that an effective life saving device must keep the body warm and dry in water for an indefinite length of time; it must keep the body upright with head well out of water; it must be quickly adjustable and proof against accident that might render it ineffective; and it should be compact, light and easy to carry. The safety-suit illustrated is a device which answers fully all of these requirements.

It enables the wearer to remain afloat for an indefinite length of time and to emerge warm and dry, notwithstanding cold water, rough sea, and strong wind. It contains a pocket large enough to carry a canteen and liquid food to last the shipwrecked 48 hours and more. It affords abundant space in which to carry valuables or papers, with the assurance that they will remain dry and safe, whether in the pockets of one's clothing or otherwise placed within the suit. It is equipped with a shrill whistle, readily accessible, with which to help attract the attention of rescuers. It embodies every device that human ingenuity can suggest to insure safety while in the water.

The suit is made in union style, with shoes and mittens, all in one piece, completely enclosing the body, excepting the head, in a water-tight garment.

Meters for Wireless and High-Frequency Work

A HIGH-GRADE, hot-wire measuring instrument designed particularly for wireless and other high-frequency work, depending for its operation upon the expansion of a

Switchboard ammeter

metal strip which is heated by the current to be measured has been developed by the Westinghouse Electric & Mfg. Co. The slight sag in the conducting strip is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring.

The conducting strip is made of special non-corrosive material. The separating posts have the same temperature co-efficient of expansion as the conducting strip, so that the changes in room temperature do not cause an error in the reading of the instrument.

The flush-mounting form, known as type EH is of the round open-face type. The face is 3 inches in diameter, and the diameter outside the flange is 3¾ inches. It has a black rubberoid case and rim, with white dial.

The portable form, known as type PH, is mounted in a Morocco leather-covered wooden case with heavy glass over the dial. The case is 3¾ inches by 4⅜ inches by 2 inches thick.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅜ inches long.

Portable ammeter

The type EH meters have a guaranteed accuracy of 2 per cent, while the type PH, with hand-marked scale, can be expected to show an accuracy within 1 per cent of full scale. Standard meters are for 1, 2 and 5 amperes. Care must be used not to subject the instrument to more than 200 per cent load.

The Monthly Service Bulletin of the
NATIONAL WIRELESS ASSOCIATION

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

A Recount of Past Performances of Amateur Stations

NEITHER the general technical public, nor even the average member of the Institute of Radio Engineers, knows what consistent long distance work was done by a number of amateurs throughout the United States, working under the double handicap of low power and short wave lengths.

During the 1916-1917 radio season the amateur field underwent some great changes, due partly to the adoption of the short wave regenerative sets, which for some reason had not up to that time come into general use.

The first amateur relay organization which pointed the way for the record breaking relays which developed throughout that season, was the American Radio Relay League. Trunk lines were organized through the larger cities of the United States for the purpose of establishing routes over which messages could be dispatched with regularity and rapidity. The main trunk line from New York City to Los Angeles, Cal., ran through Albany, N. Y., St. Marys, O., Chicago, and thence south via Nattoon, Ill., and branched to the coast either through trunk line "E": Little Rock, Ark., Dallas, Tex., Phoenix, Ariz., and Los Angeles—or trunk line "G": Jefferson City, Mo., Kansas City, Mo., Denver, Colo., and Los Angeles.

The relay station 2ZL (2LK) at New York handled some 1,300 messages during the season, most of which were messages over these lines. The Chicago 9ZN station handled 650 and 9ALM, his assistant, 425; station 6EA at Los Angeles relayed 520 messages; 99BD at Jefferson City, Mo., 300 messages; 1ZM at Hartford, Conn., 217 messages; 9EP, one of the Kansas City, Mo., stations 200 messages; 9ZK, another Kansas City station, 150 messages; station 8ASG, at Eaton, O., relayed 110, and so on down the line.

Probably the most efficient eastern station was station 2PM operated by Faraon and Grinan at New York City. On a wave of 200 meters with 450 watts input to the transmitter, 2PM repeatedly worked stations as far west as 8AEZ, 8NH, 99BD, 9ZN, 9ALM, 9XM, 9LR, 9GY, 9HQ.

Coming a little further west, station 2AGJ at Albany, N. Y., did remarkable work; using 750 watts input he worked with 9ABD, HCL, 9LR, 9ZK, 9ZN. Boats off Key West (9ZN) reported his signals audible often thirty feet from the phones.

Next 8AEZ and 8NH about share equally the honors—8AEZ at Lima, O., and 8NH at St. Marys, O., have both been reported at Phoenix, Ariz., a distance of about 1,600 miles. Few indeed are the amateurs east of the Rockies who have not heard both these stations.

Then 9ZN at Chicago, Ill., was heard quite regularly from the Atlantic Coast to the Rockies and one night worked with 7EG at Baker, Oregon. Mr. Matthews used a 1-kw. key set and at the time was working on 425 meters. The same night he was reported at 6F9 at Los Angeles, Cal.

Also 9ALM at Chicago, and 9AV at Maywood, Ill., did remarkable work.

Coming south, 9ABD at Jefferson City, Mo., probably leads. He was heard on the four boundaries of the country and worked boats off Key West. Ranking about with 9ABD, are 9LR at St. Louis, 9EP and 9ZK at Kansas City, and 9LQ at Lawrence, Kan.

9GY at Nattoon, Ill., has been heard on both the coasts. 9GY handled a very large amount of traffic from the west and southeast through 29GJ at Albany.

In Dallas, Tex., were two very efficient relay stations, SZC and 5DU. Both have been heard on all the boundaries of the country and have been responsible for the successful relaying of a large amount of traffic.

4AA at Athens, Ga., did very good long distance work on about 450 meters using very low power.

5ED at Houston, Tex., has been heard at Philadelphia and Albany, N. Y., and New York City. He was also heard at 6ZQ at Phoenix. 4CL at College Park, Ga., did very good work, working with stations far north.

Further east was the very efficient station at Denver, OZF, who was mainly responsible for the handling of transcontinental work. 9ZF often

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:

AT THE FINAL CONCLUSION OF PEACE NEGOTIATIONS, WHAT DO YOU CONSIDER TO BE THE MOST IMPORTANT REASONS FOR IMMEDIATE OPENING OF AMATEUR WIRELESS STATIONS?

This subject can be treated from the viewpoint of the beneficial services which trained amateurs gave to the government during the war or from any other logical, consistent standpoint.

Another suggestion for a forthcoming issue:

WHAT RESTRICTIONS SHOULD BE IMPOSED UPON AMATEUR TRANSMITTING SETS IN RESPECT TO POWER INPUT AND WAVE LENGTH?

Limit your manuscript to 800 words.

worked 8AEZ, 8NH, 9ZN, 9ABD and is reported as working 2PM at New York one night. Another good station at Denver was 9AMT who handled quite a few messages. 6ZQ (6DM) at Phoenix, Ariz., did fine work, having worked 9ALM and 9ZN at Chicago. He has reported also hearing thirty-one stations over 1,000 miles from him.

And last, but not least, comes 6EA at Los Angeles, which worked up and down the whole state of California, who was heard at Juneau, Alaska, 9ADL, Milwaukee, Wis., Houston, Tex., Little Rock, Ark., (1,800 miles) and by the SS D. G. Scofield (WDR) 1,289 miles out of San Francisco for Hong Kong.

There are numerous other amateurs who have piled up "records" of 1,000 miles transmission. Among this number are:

1ZL, Northampton, Mass.
1ZM, Hartford, Conn.
5ZM, Mobile, Ala.
8XA, Ann Arbor, Mich.
8U1, Pittsburgh, Pa.
8UL, Lima, O.
8YO, Columbus, O.
8ZJ, Buffalo, N. Y.
8XM, Madison, Wis.
9YG, State Agricultural College, N. Dak.
9Z1, Louisville, Ill.
3RO, Danville, Va.
4D1, Winston-Salem, N. C.
5AM, Birmingham, Ala.
5AX, Shreveport, La.
5BB, Franklinton, La.

8AAK-8CS, Saginaw, Wis., and many other 8th and 9th district stations.

These records have been due usually to the fact that the oscillatory circuits of the transmitter were correctly proportioned and carefully tuned. At the receiving end some form of the Armstrong circuit, either a Paragon, Grebe or home-made regenerative set was employed.

JOHN M. CLAYTON—*Arkansas.*

Spying on Germany in the Early Days

A RECENT article in THE WIRELESS AGE stated that wireless operators on American and other ships crossing the ocean, frequently pick up orders being sent by the German Admiralty to their submarines at sea, from the Nauen Station (POZ) in Germany. many.

For about a year before our stations were closed by the Government, I would hear every evening at 6:50 P.M. here (12:00 M. in Germany) the same messages, giving instructions to all of the submarines which came to the surface at that time in order to receive the signals. Their messages were all in cipher, different from our cipher, for they consisted of numerals and letters combined.

For the time signal, in place of the "ticks" sent out by Arlington (N A A) they used letters, G. G. G. O. O. O. X. X. X., etc. Just at 12:00 M. they gave a long dash similar to Arlington.

They evidently changed their cipher every few minutes, as they would say, Groupen 26, then Groupen 28 and so on.

WM. H. SEABURY—*Brookline, Mass.*

This is the first information we have received concerning the methods employed by the Germans in sending time signals. No transatlantic vessel could take down the signals from Nauen unless its equipment included an undamped wave receiver of some type. With a vacuum tube regenerative beat receiver, no difficulty would be experienced in copying signals from POZ, but it must be remembered that the average vessel is not equipped with a 10,000-meter tuner.

Results Obtained by Station "CV" (Houston, Texas) Before the War

THIS article I hope will renew pleasant memories of the hours spent by amateurs in long distance working just before their stations were closed down by government order.

Of course, most every amateur believes that he was doing the best work or had the best set at that time. I, for one, obtained most excellent results at my station and many were the nights that I closed "shop" at 4:30 A.M.

My station, being located at the extreme southern point of the United States, will no doubt make the results obtained in the South most interesting to those of the East, North and West who were also engaged in the same work.

As a whole I would say the conditions are most favorable to radio communication in the South; in fact I believe better conditions do not prevail anywhere. However, other locations may be equally good, but I doubt if it can be proven that the-so-much-thought-of Pacific Coast can equal Texas for favorable radio work.

The country is flat and a good portion is covered with trees, many towering seventy-five to ninety or even one hundred feet in height. The soil is of a somewhat sandy texture and is found to be damp about three feet below the surface, most any season.

It will be interesting for those who were in amateur work before the war, to review what was done at CV and to help keep the amateur radio spirit up so that when the war is over all the "old boys" may be able to lay aside war work and again plan to establish better records. I will record some of the best amateur transmitting and reception records together with a list of the stations heard during the period between January, 1917, and the date when my station was closed.

My very best working record made was by communicating directly with 9XN (University of North Dakota, Grand Forks, N. D.). This is a distance of 1,315 miles, air-line, and this station was worked twice within one week. No difficulty was experienced in holding conversations. On one occasion I worked both ways above five times. I hardly believe the operator in charge was aware he was working a station on the Gulf of Mexico, but if he reads this he will realize the fact. As I was not using a government call, his first inquiry after answering my call was Q R A (what station is that)? I answered back "Houston, Texas." He replied "only Houston, give me your address OM." I told him he was working with an amateur in Houston, Texas, and would give him my name if he cared for it. He would not believe this and finally quit, with the impression that someone was kidding him.

Other places where my signals have been heard are Albany, N. Y., 1,540 miles—a record distance. Superior Wis., Los Angeles and other southern places of California, Jacksonville, Fla., and Tampico, Mexico, were worked.

In amateur reception four different stations were heard that were over 1,600 miles distant (all of Northern California), and three of the four, namely, 6BY, 6KU and 6FG were heard a number of times, sometimes every night for a few nights and then only at intervals.

The amateurs of California were heard best from about 11.30 P. M. until about 3.30 A. M. There invariably seemed to be a marked "peak" in the strength of the signals from the California amateurs between 11.20 and 11.50 P. M., and again between 2.25 A. M. and 3.30 A. M.

One other thing was noted: the stations of the 6th district (California) were often heard at their twilight hours, but owing to the hubbub of Q R M it was never possible to listen to a given signal for any length of time, as someone invariably jammed it.

During the entire season five amateurs of Los Angeles were heard, some of them were heard with regularity, others just occasionally. 2AGT of Albany, N. Y., was heard twice during the season, but strange to state no other station of the second district was heard, and none of the first and none of the third.

At various times testing was carried on with other amateurs 600 to 900 miles distant, and interesting observations were made. For example, I was able to transmit 880 miles (9PI Indianapolis, Ind.) using but 106 watts input, or roughly speaking, 1/10 kw. power. On high power my input was 445 watts and on low power (used for local work) the transformer drew 106 watts. I was not the only one who could pull stunts like that, as I could hear 9ABD (Jefferson City, Mo., 650 miles distant) on his low power. I don't know his exact power consumption. Also I could hear 9PI when on his lowest power, as well as 9GY of Mattoon, Ill.

In receiving work, various apparatus was used at different times, but a regenerative hook-up, using a small sized home-made coupler that would tune to about 500 meters, with a variable condenser in series with the primary circuit, gave the best results. All connections were soldered, even the connections to the telephones, condensers, etc. This alone increased the signals. In the transmitting set all connections were soldered wherever possible and all conductors were of low resistance and sufficiently large to insure proper conductivity. The transformer used for this work was oil immersed and home-made, but of good construction and drawing 445 watts on *high power*.

The antenna mast was 76 feet high and constructed of 4 x 4's and 2 x 4's, and well guyed. The other end of the antenna was supported by a tree about 60 feet in height. The antenna was 90 feet long and consisted of seven No. 8 copper wires, with lead-in taken at the high end. The insulators used were 16 inches long and one inch in diameter, of hard rubber.

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.

R. M., Findlay, Ohio:

About one-half ampere of antenna current is all you may expect from the spark transmitter mentioned in your first query. Keep in mind that during the period of the war, amateurs cannot construct or experiment with wireless apparatus.

Regarding your query No. 2: The insulation of ordinary wood is sufficient for receiving aerials, but not feasible for transmitting apparatus on account of the high voltages involved.

In respect to the purchase of dead-end switches: We know of no manufacturer that can supply you with these switches for the time being, but they can be quite readily constructed.

* * *

A. T. H., Albert Lea, Minn.:

We have no information regarding the possibility of the reopening of amateur wireless stations after the close of the present war. As we have stated time and time again in these columns, amateurs cannot construct or experiment with radio apparatus during this period.

Regarding your third and fourth queries: We know of no manufacturer that will supply you with end turn switches for receiving tuners.

In reply to your fifth query: It makes no difference how the coupling is varied between primary and secondary circuits of the receiving tuner. Any feasible mechanical construction can be employed.

* * *

H. H., Atlantic City, N. J.:

Any of the text-books on radio telegraphy issued by the Wireless Press will show you how to connect a stopping condenser in a receiving circuit. In the usual receiving circuit, a crystal detector and a head telephone are connected in series, and in shunt to the terminals of the secondary condenser. In this case the stopping condenser is in reality a telephone condenser being placed in shunt, in order to obtain an accumulative effect of the rectified current.

On the other hand, in the old carborundum hook-up, as shown in figure 153-A of "Practical Wireless Telegraphy," it is necessary to insert a condenser in series with the crystal detector to prevent the battery being short-circuited by the secondary windings of the receiving transformer. This condenser is of fixed capacity. On the other hand, the diagram in figure 153-B of "Practical Wireless Telegraphy," when used in connection with the crystaloi detector, gives satisfactory results only by providing a telephone condenser of very large capacity. There is nothing unusual about the construction of this condenser. It may either be adjustable by steps or continuously variable. It can be made of a number of interleaved sheets of tin foil separated by paraffine paper. By the use of a multi-point switch, taps can be taken so as to vary its capacity.

The most effective results are obtained from dry batteries for the operation of a spark coil when a series parallel connection is employed. Connect up enough series cells to provide the requisite voltage for operation of the induction coil. Then make up another group with the same voltage as the first and connect them in parallel with the first group. This connection will tend to prolong the life of the batteries.

No advantage is derived in the use of a rotary gap in connection with the spark coil, for the note of the spark discharge is already governed by the frequency of the interrupter. The only advantage that could possibly be derived from a rotary gap would be to mount it on the shaft of a mechanical interrupter and operate it in synchrony therewith. Such a method has already been described in an issue of THE WIRELESS AGE.

It would be well for you to keep in mind that amateurs are not permitted to experiment with or construct wireless apparatus during the period of the war. They will open themselves to suspicion by so doing and are subject to a penalty for any violation of the President's executive order.

* * *

G. E. W., San Francisco, Cal.:

We are unable to give you a satisfactory explanation to account for the burning out of your high voltage transformer. It may be that one of the secondary coils was too close to the iron case and, in consequence, an arc was set up on account of the difference of potential between the frame and the windings. If we were on the ground and could make an examination of the general conditions surrounding your apparatus, we would be able to give a satisfactory explanation. However, the inspector in your home port will solve your problems for you.

The burning of the collector rings on the generator probably is due to the fact that the rings are bent so that the brushes arc as the collector rings rotate.

* * *

A. B. D., Boston, Mass.:

The grid and plate circuits of a cascade vacuum tube amplifying system can be coupled through a resistance, an inductance or condenser. Satisfactory circuits have been evolved for all three methods of coupling. The plate circuit resistance for coupling is usually of the order of 20,000 ohms, more or less, depending upon the resistance of the vacuum tube.

A. F. S., Radio School, Harvard University:

You will find on page 198 of the book, "Radio Instruments and Measurements," issued by the Bureau of Standards, a decrement scale which can be trimmed off and applied to any variable condenser with semi-circular plates, which is an element of a wave meter circuit.

In contrast to the simple variable condenser whose capacity increases linearly with the rotation in the movable plates, the condenser in the Kolster decremeter is designed so that the per cent. change of capacity is the same throughout the entire range of the condenser and equal angular rotations on any part of the scale correspond to the same decrement. This is obtained from special design of the moving plates.

In the Kolster decremeter, the decrement scale is geared to the movable plates of the variable condenser. The decrement is measured as follows: The wave meter is first tuned to resonance by observing the maximum reading of the ammeter. Then the capacity of the wave meter condenser is increased to some value above resonance where the reading of the hot-wire ammeter is one-half of that obtained at resonance. A sliding ring encircling the decrement scale is then turned so that its zero point coincides with the zero point on the decrement scale. The capacity of the wave meter condenser is then decreased to some value below resonance where the reading of the ammeter is again one-half of that obtained at resonance. The notation on the decrement scale underneath the pointer (which has now turned through a certain number of degrees) gives the combined decrement of the wave meter and that of the circuit under measurement. The decrement of the decremeter being known, it is subtracted from the reading obtained as just described.

Electrical Digest

The Improvement of Power Factor by Use of Static Condenser—A Novel Method for Illustrating Electric Phenomena—Research on Searchlights

The Improvement of Power Factor by Use of the Static Condenser

MEANS for improving the low power factor encountered in alternating current power circuits have been given more and more consideration as the use of alternating current power machinery expands. The wattless current resulting therefrom is by no means wattless when figured back to the coal pile, for in such circuits the consumption of coal is required even though no power is derived from the wattless component. War-time economy demands the adoption of devices for improving the power-factor to as near unity as possible.

The lagging phase in alternating current circuits has heretofore been corrected through the use of the so-called synchronous condenser—a machine admirably adapted to this work on power lines in which the conditions are constantly changing, but in many small installations the first cost of such a machine is prohibitive.

Extensive use has been made, of late, particularly in Europe, of the static condenser, which has proved a boon to small power installations where the character of the load is more or less constant. The principal disadvantage of the static condenser compared with the synchronous condenser, is its lack of flexibility, but it possesses several real advantages, chief among these being its efficiency, which approximates 99 per cent. Again, its first cost is low; it occupies less space than the synchronous condenser; there is a complete absence of vibrating and rotating parts, and when once installed it requires little or no attention. The reduction of the output of generators, transformer and distributing feeders, as well as the increase in heating losses and bad voltage regulation resulting from low power factor loads, have been experienced by all central alternating current power stations.

The static condenser manufactured by the General Electric Company in the United States consists of a

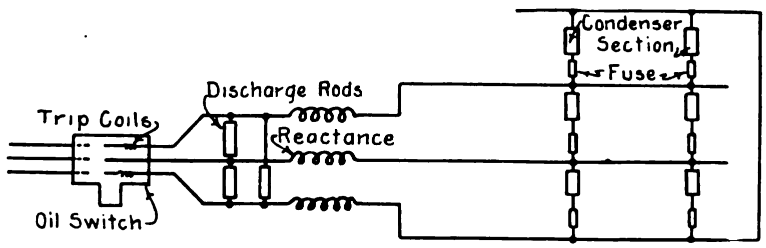


Figure 1—Schematic diagram of static condenser, showing control, discharge rods, reactance, fuse and condensers

number of condensers mounted closely together to form a compact unit. Each condenser is composed of paper and metal foil submerged in oil and assembled in metal containers.

We are indebted to a recent issue of the Electrical Review for a wiring diagram and data on the static condenser as used in typical installations. The accompanying diagram shows the three-phase installation designed by the General Electric Company.

It is pointed out that if a static condenser be connected directly across the power line, it will generally be found that instead of raising the power factor, it lowers it. This is due to the fact that a condenser tends to amplify the harmonics in the voltage wave so as to interfere with the expected increase in power factor. To overcome this and to damp out objectionable harmonics, the reactance coils shown in the diagram are connected in each phase.

The resistance or discharge rods shown in the diagram serve to discharge the condensers immediately they are disconnected from the line. As a prevention against short circuits, fuses are connected in the circuit. The trip coils controlling the circuit breaker are installed to permit disconnection of the condenser should anything occur to make it advisable for the units to clear themselves from the line.

The effect of low lagging power factors on power lines are aptly illustrated by the following example:

A 100-kva. transformer will deliver 100 kw. at unity power factor. Assuming, however, that the power factor should lag .60, then the rated energy output of the transformer would be but 60 kw. and yet the current and consequently the heating would be approximately the same as when delivering 100 kw. at unity power factor.

The ill effects of low power factor loads on alternating current generators are more striking than on transformers, for they have decreased kilowatt capacity, decreased efficiency, impaired voltage regulation and, in addition, call for increased exciter capacity. In the case of a 200-kva. dynamo designed for .08 power factor (160 kw. output), if the power factor in the circuit is but .60 it is probable that the normal voltage could be obtained only with difficulty even though at this power factor the generator would deliver but 120 kw., and beyond this the lagging or current in the armature sets up a flux which opposes the flux set up by the fields tending to demagnetize them and thereby decreasing the armature voltage. In such circuits it is often necessary to install new exciters to supply an increased exciting voltage to the field coils. The field losses and therefore the field heating are greater at lagging power factor than at unity.

The Electrical Review offers a concrete example of the effects of low power factor in a circuit. Assume that a two-mile power line is to carry a 3-phase 60-cycle load of 160 kw. at 2,300 volts; sections of 25,000 circular mils at 100 per cent. power factor, 30,820 circular mils at 90 per cent. power factor and 69,500 circular mils at 60 per cent. power factor. It is, therefore, evident that the investment in copper must necessarily be 2.8 times as great for a power factor of 60 per cent. as for a 100 per cent. power factor. Also the energy losses will be 2.8 times greater, being actually 28 per cent. instead of 10 per cent. at unity power factor. This simple problem emphasizes the necessity for a high power factor in order to attain an economical investment in materials.

Before undertaking the installation of a static condenser for increasing the power factor a complete survey of conditions should be made to determine to what extent the problem of lagging current could be remedied by it. It is desirable, for example, to locate the static condenser as near the source of the inductive load as possible in order to avoid the transmission of wattless current. It is more economical to install a number of relatively small condensers rather than a single large one. It is for this class of service that the static condenser is especially suited. Just how the size of the condenser may be determined on a given line to raise the power factor to a given value is illustrated by the following example given in the Electrical Review. Reference is made to the curve in figure 2.

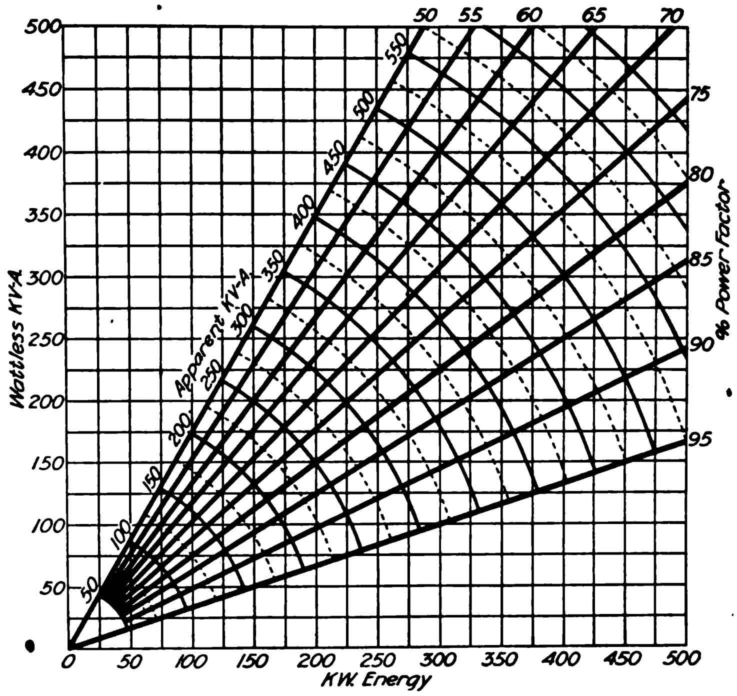


Figure 2—Curve showing relation of energy load to apparent load and wattless components at different power-factors

Assume a 250-kw. load at 0.60 power-factor, and that it is desired to raise to 0.90 power-factor.

A 250-kw. load at 0.6 is 250 ÷ 0.60 or 416 kva. apparent load which has a wattless component lagging of $\sqrt{416^2 - 250^2} = 332$ kva. A 250-kw. load at 0.90 = 250 ÷ 0.9 or 279 kva. apparent load that may be expected when the condition of 0.90 power-factor is realized. This has a wattless component lagging of $\sqrt{279^2 - 250^2} = 123$ kva. The difference 332 — 123 = 209 is the leading kva. that will be necessary to raise to 0.90 power-factor.

This may be read directly from the accompanying curve. Read up the vertical line at 250 kw. energy to the point where it crosses the 0.60 power-factor line. The apparent load may be read as 415 kva. approximately. Reading from this point to the left margin the wattless component will be found to be 330 kva. Then in the same manner the apparent load at 0.90 power-factor will be found to be 280 kva. and the wattless component read at 125 kva. The difference or 330 — 125 = 205 kva. which is close enough for all practical purposes to a 200-kva. condenser, the nearest standard size.

It will also be found in this case that using a 200-kva. static condenser will make it possible to take on an additional load at 87 kw. at 60 per cent. power-factor and still have the same total apparent load while the resulting power-factor would be 81 per cent. In other words, the possible income from the particular feeder in question may be increased 87 ÷ 250 or approximately 35 per cent.

The success with which the static condenser can be used to correct low power-factor conditions, on even most extensive distribution systems, or on shorter lines and isolated plants should appeal strongly to every central-station manager, and to those in charge of isolated plants having inductive loads. Their use may in many cases obviate the necessity for additional generator, transformer, and line capacity and will always conduce to maintenance at the highest possible efficiency the generating plant and distribution system.

A Novel Method for Illustrating Electric Phenomena

C. H. BISHOP, of Rochester, N. Y., is the originator of several novel ideas for demonstrating the general phenomena of the electrical circuit. For example, he pictures a flow of current in parallel conductors by partly filling in the space between the wires. Different degrees of magnetization, for example, are indicated by parallel lines of varying density.

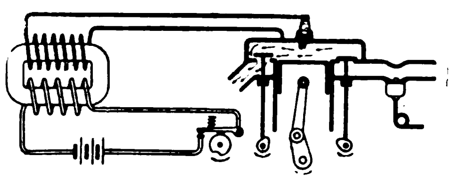


Figure 1—Ignition circuit of internal combustion engine

An example of his work is shown in the accompanying diagrams, which indicate the ignition circuit of a gas engine and the functions performed during a complete cycle.

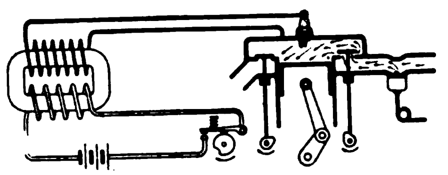


Figure 2—Circuit during intake of engine

Thus in figure 1, the engine is exhausting, the intake valve being closed. The circuit breaker of the primary of the induction coil is open. In figure 2, the engine is on the intake stroke, the exhaust valve being closed, and the circuit breaker of the induction coil is still open. In figure 3, the intake valve and exhaust valve of the engine are closed and the charge taken in on the intake stroke is now being compressed. It is to be noticed that the primary circuit of the induction coil

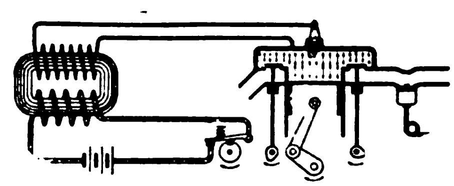


Figure 3—Battery circuit closed

is closed as indicated by the darkened line.

In figure 4, the piston is nearing the dead center, the circuit breaker on the primary of the induction coil is open, the magnetic lines of force in the core of the coil are collapsing and the high voltage current flows through the secondary coil as shown by the darkened line. A

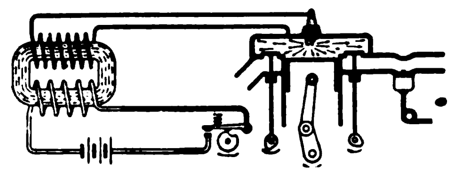


Figure 4—Secondary circuit discharged through spark plug

spark is now discharging across the spark plug and a moment later complete combustion will take place in the cylinder. Afterward the cycle of operation will be repeated.

The diagrams should be of particular interest to aviation students.

Research on Searchlights

LABORATORIES having proper facilities to carry on extensive research with arc searchlights are urged by the Corps of Engineers, United States Army, to make investigation of the following problems and present solutions. The results of such investigations should be sent to the Officer in Charge, Searchlight Investigation, General Engineer Depot, Corps of Engineers, United States Army, Washington, D. C.

Data is desired on the following:

(a) Means for determining the finding power of a searchlight which will take into account the color of the light, the nature and color of the target, the condition of the atmosphere, and the distance between the searchlight, the target, and the observer.

(b) Means for **rapidly** determining the intrinsic brilliancy of a searchlight light source.

(c) A **simple** system of remotely controlling the operation of a searchlight in azimuth and elevation. The present or proposed systems require from five to fifteen or more wires, and are too complicated.

(d) A mirror design which shall be more efficient for anti-aircraft service than the standard parabolic mirror.

(e) A light source which shall be more efficient than a high-intensity carbon arc. A thallium arc has been suggested because it has only one line (green) in the spectrum.

(f) A mirror material which shall have the reflecting and longevity properties of silver-backed glass. without the fragility of glass mirrors.

Progress in Radio Science

(*Continued from page* 14)

separate lead 5′ sealed into the stem 6 of the device. By this construction the starting filament is located a greater distance from the anode 9 than the arcing tip of the cathode, in order to guard against the arc deserting the tip 3 and running to the starting filament either entirely or in part.

The anode 9 may have any convenient shape and may consist of refractory material such as tungsten or carbon, or volatilizable material such as mercury, as shown at 10 in figure 3. In a rectifier the anode should have a materially greater

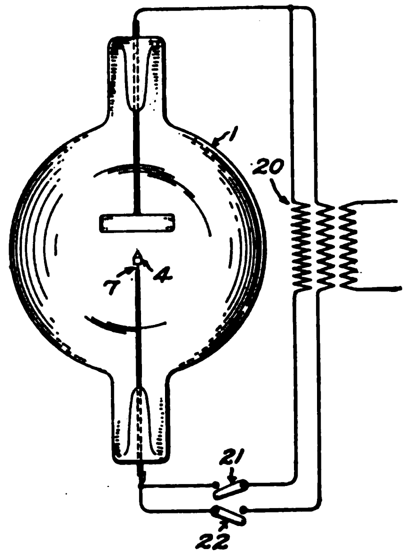


Figure 2—Modification of figure 1, with standing filament omitted and arc started by high-voltage discharge from a pointed cathode

heat dissipating capacity than the cathode, to enable it to remain below a temperature of about 700° C. at the normal operating current of the device.

In the preparation of the rectifying tube, the space within the envelop should be carefully exhausted of all gases and vapors, care being taken to remove electro-negative gases, such as oxygen or chlorin, or substances yielding electro negative gases, such as water vapor. A trace of oxygen does little harm when the electrodes consist of oxidizable metal, such as tungsten or molybdenum, as the oxygen combines chemically with the heated electrodes to form non-volatile oxids. The envelop is filled with a gas inert to the electrodes, as, for example, argon, nitrogen cryptom, neon, hydrogen, at a pressure which may be between several millimeters and atmospheric pressure, or more. These gases should be substantially free from electro-negative gaseous impurities. For low voltage rectifiers a gaseous pressure of 5 to 12 millimeters of mercury is desirable, but no definite limit of gas pressure can be given, as it will in general vary with the voltage upon which the device is operated and the character of the service required of the device. In some cases the gaseous filling may be constituted by the vapor of a material ordinarily a liquid; mercury for example. The envelop should be properly proportioned with respect to the energy consumed during the operation of the device to dissipate heat at a rate which will result in an operating temperature at which the vaporizable material has the desired vapor pressure.

The arc is started by heating the filament 8 to incandescence by suitable current introduced through the leads 5, 5′ by the conductors 11, 12, from a convenient source, such, for example, as the secondary 13 of a transformer 14. When the filament has been heated to incandescence, a current of suitable voltage is impressed between cathode and anode. As shown in the drawing, the device may be used to rectify alternating current supplied from the transformer secondary winding 15 through conductors 16, 17. The arc initially runs from the incandescent filament 8 to the anode and serves to heat the starting tip 3 to incandescence, both by heat conduction

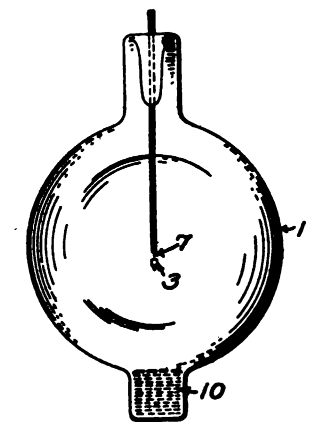


Figure 3—Tube having a mercury anode

from the filament which is connected to the tip, and by reason of the proximity of the tip of the arc as well as the heated filament. The circuit of the starting filament may then be opened by a switch 18. The arc will continue to operate from the incandescent tip 3 to the anode, only half waves of current being conducted by the device illustrated. The rectified current may be used for any desired purpose; for instance, to charge the storage battery 19.

As the arcing tip 3 has a relatively greater mass than the filament, electrical erosion or disintegration will have but very little deleterious effect. The filament 8 is used only for a very short time when the device is started, hence the electrical disintegration of the filament is negligible. For these reasons the device will have a commercially long life.

In some cases, as shown in figure 2, the starting filament may be entirely dispensed with when the device is to be used only for relatively high voltages. In that case the arcing tip 3 is made sharp or pointed to such an extent that the arc will be certain to start from the point of the electrode as cathode when a relatively high voltage is applied to the terminals of the device; for example, by means of an auxiliary transformer winding 20. After the main cathode has been heated to incandescence, the switch 21 may be again opened and the switch 22 closed. Mr. Ferguson has found that by thus using a pointed electrode an arc may be started at a potential of about 60%, as great as the voltage required to start with a large surface as cathode. In other respects the device shown in figure 2 is the same as that already described in connection with figure 1.

A Ventilated Spark Discharge Gap

When high frequency apparatus is employed in medical treatment, it is essential that spark discharge gaps be muffled for the patient's ease.

Former types of muffling proved unsatisfactory because of lack of ventilation, resulting in an irregular spark discharge and an output of gradually decreasing intensity. A discharge gap has been designed by H. G. Fischer which is substantially silent in operation and can be relied upon to maintain a predetermined operating characteristic.

Figure 1 is a side elevation of the Fischer spark gap, parts being broken away to disclose the internal construction. Figure 2 is an end view of the same; and figure 3 is a section taken transversely.

In figures 1, 2 and 3, reference characters 4 represent what may be termed end holding plates which carry three side bars 5, preferably of glass, fitting in sockets 6 appropriately arranged in the end plates 4. The spark gaps indicated at 7 occur between units 8. These units are arranged in alignment and the adjacent ones of two adjacent gaps are connected together by screws 9, the end ones being connected by screws 10 with transverse plates 11 of current conducting material. A similar plate 12 is located upon each screw9 which connects the adjacent gap elements 8 of adjacent spark gaps. Each gap 7 is inclosed in a two-part housing 13, 13, each part 13 being fastened by screw 9 between the element and the adjacent plate 11 or 12. These housing parts 13 may also be of current conducting material. They are insulated from each other by a mica plate 14 forming a partition in the housing. Each plate 14 is provided with a restricted opening 15 about the spark gap proper. The plates 11 and 12 are recessed at two points at 16 to be engaged by appropriate glass connectors 5, and are of dimensions causing them to engage the other glass connector 5 at 17 so that the glass connectors hold them in place.

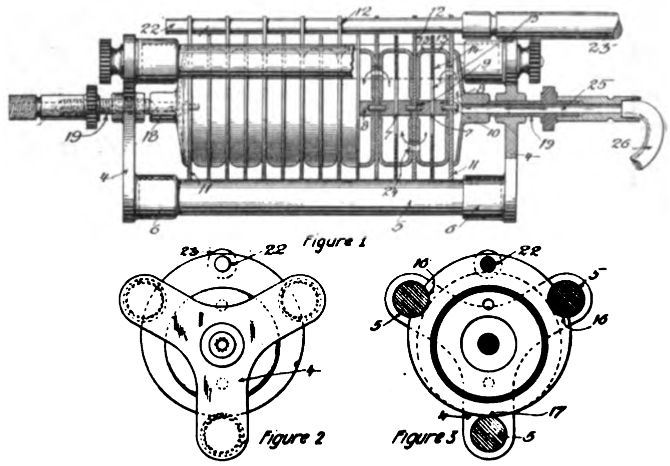


Figure 1—Showing side elevation of the Fischer spark gap with internal construction disclosed
Figure 2—End view. Figure 3—A transverse section

An end clamp 18 presses against each end plate 11, holding the parts tightly together through a screw post 19 in threaded engagement with an end plate or member 4. All of the plates 11 and 12 are perforated at 21 for engagement by a connecting rod 22 having an insulated handle 23, this handle permitting the rod to be pulled in and out to govern the number of spark gaps actually in operation, it being shown in figure 1 as having them all inoperative by reason of the passage of current through the rod 22 instead of across the gaps. So much of the multiple spark gap described has been tested and employed prior to this design, and it has been air confined in the housings formed by the housing parts 13, 13 that has in the past interfered with the prolonged efficient operation of the device. In accordance with Fischer's design, apertures or openings 24 are provided between succeeding housings and stagger these successive apertures with respect to each other. There is provided an opening 25 through the screw posts 19, which, in the present instance, constitute the binding posts to which connection can be made to the rest of the circuit. Air is admitted from the right, viewing figure 1, and passes along the path defined by the arrows and out at the left. In order that this action may be positive in operation, a tube 26 is provided for the introduction of compressed air continuously through the tubes. In the devices formerly in use the current has dropped within a period of, say, an hour and a half, from 700 milliamperes to approximately 200. When air has been forced through in the manner described, the efficiency has been unimpaired over a run of several hours, no variation in the current being shown.

Former Assistant Editor Wounded

On the eve of the cessation of hostilities, word reached The Wireless Age that Captain Richard Douglas, formerly an editorial assistant, had been wounded in action. The injury is in his left foot, the heel being torn away and some doubt existing as to whether the foot can be saved.

Captain Douglas, 28 years old, secured leave of absence from editorial duties to attend the Massachusetts militia maneuvers, later entering Plattsburg with the outbreak of the war and receiving a commission as lieutenant. He was then sent to Camp Gordon and, in August, 1917, was promoted to captaincy and almost immediately embarked for overseas. Word has been received that he took part in the major engagements at Château-Thierry and St. Mihiel and was wounded during the week of October 21. As we go to press it is learned that he is in a base hospital at Baunedor.

Captain Richard Douglas, a former Wireless Age assistant editor, wounded in action

Conditions on the firing line were word-painted in characteristically broad strokes by the captain. In a recent letter he notes: "I haven't had my clothes off in ten days. I'm covered with fleas as big as grasshoppers; in more than a week the only sleep I've had has been in a sitting position in trenches filled with mud. It rains constantly. We've lived on bully beef, bread and coffee—and glad to get that—but we are going *forward!*"

A letter written a week before he was wounded depicts the bloody horrors of the war for democracy; how men were blown to pieces at his side, heads being severed from their trunks, and a battle fought in streams of blood. The war work auxiliaries come in for generous praise in this letter. Conditions which provided but two day nurses and one night nurse for some hundred-odd patients are spoken of, with the observation that these women and the head nurse "are splendid beyond praise, indefatigable, kind, gentle and cheery Ours just about fills my ideal of the holy woman of the Red Cross." This tribute to the Salvation Army is paid: "I've seen the Salvation Army girls serving rations and tending store with their masks on during a gas alarm. Coming out of the trenches, we often find them at hand with piping hot coffee and crullers."

Throughout, his letters have reflected that noble spirit of generosity which has made the American soldier so welcome and efficient abroad. As in his editorial work, Captain Douglas has recorded in military life the effectiveness of sincerity and earnest, upright effort, and The Wireless Age is proud to number him among those stalwart civilians who made material personal sacrifices to lead our troops to victory.

Book Reviews

Practical Aviation for Military Airmen. By Major J. Andrew White. Cloth binding. 6¼x9½ inches; 208 pages. Wireless Press. Price $1.75.

Although the literature on aviation is extensive it is not exhaustive. A particular place therefore awaits Major White's textbook, for in its pages is found the first complete presentation of the varied knowledge required by the military aviator.

In fifteen chapters he has covered the subject in its entirety. The reader is first made acquainted with the theory and principles of flight and types of airplanes; this knowledge is then applied to consideration of the elements of airplane design, followed by a chapter which discusses how stability in flight is gained and how the machine is controlled. The necessary knowledge of materials, stresses and strains is then given, so the aviator may realize the importance of thoroughly assimilating the succeeding chapter which explains in detail how airplanes are erected and assembled, how controls are rigged and wires tensioned, and stabilizers and wing surfaces aligned.

Unlike most aviation books, this volume does not ignore the important subject of engines or refer the reader elsewhere for enlightenment; four chapters are given to aeronautical motors, beginning with fundamentals of motive power and continuing through study of pistons, valves and carburetors, ignition, cooling and lubrication, to types of motors, and the operation and care of engines. The subject is so clearly presented that an absolute novice may acquire within a few hours a fair knowledge of the functioning of each part of a high-powered aero engine.

Instruments and equipment for flight is the next chapter's subject, profusely illustrated with the various devices and descriptions of their use and operation. Then the practical aspects of flight are discussed, beginning with the exact manipulation of controls for simple take-offs and landings, straightaway flights and turns. Cross-country flight and air navigation by instruments is then explained in detail and the problems of night flying carefully reviewed. Air acrobacy, upon which all fighting depends, is made clear by diagrams of the evolutions and full explanation of how the controls are manipulated to produce these amazing dips and dives, loops and turns. Meteorology has a separate chapter, this vital subject being considered in the practical applications of the science to flight conditions. Treacherous wind eddies and currents and the unfavorable conditions which are revealed by cloud formations are made known to prospective aviators and the effect of obstructions on air currents graphically described.

The two final chapters have no parallel in the literature on aviation. One discusses aerial gunnery and combat, bombs and bombing; the other deals with reconnaissance and fire spotting for artillery. Not only has the author in both cases pictured and described the armament and devices, but he has exhaustively gone into aerial tactics, anti-aircraft fire, bombing air raids, estimating enemy strength, code telegraphing, airplane radio apparatus and reconnaissance photography. The highest commendation is due for this portion of the volume, for the material here has evidently been laboriously compiled by searching investigation into actual warfare occurrences, analysis of principles and conditions affecting success in military airmanship being thereafter defined for the first time.

The volume concludes with an appendix containing conversion tables and mensuration rules, together with a nomenclature of aeronautical terms and their French equivalents, the phonetic pronunciation of the latter being given to facilitate intercourse with Allied aviators.

On the whole, the designation "Practical" in the book's title is entirely justified. The illustrations—200 or more—have been prepared with care and tell a story in themselves. The supporting text, however, will perhaps excite the principal comment. Major White has departed from usual textbook arrangement and has so prepared his material that the descriptive matter in every case is directly under or facing the illustration with which it deals. In no instance is the reader required to turn the page. This feature's value is further emphasized by the use of relative sizes and boldness of type to value the importance of each statement as it is made.

While the book is less a treatise on aeronautical engineering than a fully practical text for men who expect to fly and want to learn in the shortest possible time, the mass of data contained in the volume will insure it a place on the bookshelves of even those whose interest in aviation is purely on the theoretical side. Certain it is that this latest contribution to the literature of the aeronautic field will receive a hearty welcome wherever it goes.

Obtainable through the Book Dept., The Wireless Age.

A Dictionary of Military Terms. (Revised Edition.) By Edwin S. Farrow. Cloth binding. 5x7 inches; 682 pages. Crowell. Price $2.50 net.

Nothing is more disconcerting to the newly commissioned officer than to hear military terms in common usage which army manuals do not mention. Many an uncomfortable moment will be spared those to whom Tactical Instructor Farrow's dictionary is available for ready reference. While the compiler's primary purpose seems to have been to include the many specialized terms used in modern warfare, the work has been made sufficiently exhaustive to stand by itself as a ready reference for determining the exact meaning of both ancient and modern works on military subjects.

The value of a work of this character is perhaps best instanced by quoting a few examples from its nomenclature, words which are familiar to experienced officers but are seldom comprehended by the novice. For instance: buzzacot, dixie, revetment, logistics, indirect laying, full sap, terrain, enfilade, bracketing, chevaux-de-frise, are terms which may be heard any day about a cantonment but are likely to be meaningless to the officer from civilian life. Another glance through the volume discloses these, of which the same may be said: deflection, whippet, martinet, line of investment, kitchen police, parados, elan, allowance of quarters, aparejo, camion, barbette, ballistics, double sap, striker, ricochet, oriented—and so on. There are 12,000 definitions in the volume, a fairly large percentage of which will appear entirely new to the officers' camp graduate, yet are in daily use by officers of the regular army.