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THE WIRELESS AGE

An Illustrated Monthly Magazine of RADIO COMMUNICATION

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

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THE ACTIVITIES OF ALIEN ENEMIES

THE arrest of Professor Jonathan Zenneck by order of the Department of Justice is an event of the month that holds significance beyond its surface indications. Nothing made public thus far has disclosed any definite German spy activities attributed directly to this scientist whose name has become a by-word in the radio art, but it is strongly intimated that the Government looks upon him as one of the most dangerous German subjects in this country. His internment at Ellis Island for the duration of the war is a proper measure.

It is difficult—and no one knows it better than the writer—for the American mind to cut off instanter from the fraternal spirit which scientific investigation fosters among men of all races and nationalities. Yet that this must be done answers itself in the fact that we are at war; undeniably active already in the greatest conflict the world has ever known; and our personal liking or affection for a kindred scientific worker must not be permitted to cloud our sense of duty in silencing the activities of enemy aliens. It is certain that communication of some sort is established between Germany and her agents in this country; it is a reasonable certainty also that radio figures in the communication scheme. Professor Zenneck, being one of our enemy's most skilled wireless experts, must have restricted the freedom hitherto allowed him.

One cannot forget the lesson of Germany's publication of our torpedo flotilla's arrival four days in advance of its appearance in foreign waters, despite the fact that the vessels sailed under sealed orders and not a line concerning their departure was published in any American journal. When our enemy's agents can penetrate the innermost portals of the Navy Department, secure information presumably known to but the two high officials concerned, and then transmit the details right under our very noses, so to speak, it is time for us to wake up.

Who can doubt that at this very instant German agents in this country are receiving instructions from Nauen or Hanover by wireless? It is a simple and safe task to establish a receiving station of the portable type most anywhere in this nation. The Secret Service is well nigh helpless in locating plants of this character, for their detection is more a matter of skillful engineering than sleuthing of the conventional type. The day is not far distant when the Government will realize the tremendous value of amateur skill in this connection.

Meanwhile the nation must, we expect, resign itself to waiting for the catastrophe which will rouse the officials to action. While the lay public rests in fancied security now that all wireless plants are shut down, the wireless men know that hundreds of American experimenters could, if they so willed, operate for a considerable period without detection. Loyally, they have obeyed the law, and will still continue to obey. But the ease with which the enemy alien can keep in touch with German wireless across the water is common knowledge and a matter for grave concern.

The secrecy which surrounds events since our entrance into the war prohibits illustrating this point by specific instances. But an incident of the days of our neutrality will serve.

It will be remembered that when the submarine Bremen arrived in New London, moorings for the vessel had been prepared in advance by German agents. Presumably, Germany was then, as now, without communication with this country, other than the Sayville wireless. Yet neither Government nor commercial stations had intercepted any message relating to the submarine's arrival. Secret stations, working on unusual wave-lengths, apparently had no difficulty, however, in keeping in touch with enemy equipments outside this country; and that these stations are inoperative now is a proposition that even the most guillible cannot credit.

Thus we return to a consideration of the Zenneck arrest. This type of expert is an undeniable menace to the safety of our merchant vessels and troop ships when given unrestricted freedom. His prominence as a radio scientist made certain his apprehension, but little seems to have been done with the many lesser lights whose familiarity with the methods of superimposing a number of oscillation circuits one upon the other gives German agents on these shores unlimited opportunities for secret communication.

The use of advanced amateurs for detection of these men seems inevitable. Some suspects have already been informally reported and action taken, but the radio field still awaits establishment by the Government of a comprehensive plan. A board capable of creating a system of spy station detection can be quickly assembled from competent experts in the experimental field, and it is to be hoped that the Government will not postpone the execution of this obviously necessary measure until our transports are reached through a death-dealing message.

Meanwhile, every radio man must realize his duty to report any definite suspicions he may entertain. We have reached the point where apparent friendships must not prejudice our judgment. For instance, though a large measure of Professor Zenneck's popularity may be deserved, he is the expert who for a time was in charge of Sayville and he has served in the German army. It is said also that before coming to this country he participated in the German drive through Belgium and later by falsifying his passports gained admission to the United States. His scientific standing is of the highest; he has been professor of physics in Danzig and has the D. Sc. degree from the University of Tübingen, besides being the author of several standard works on electricity and magnetism and wireless telegraphy. It is therefore obvious that no good end is served by allowing him liberty under which he very readily could direct a well organized group of less skilled men resident in this country to serve Germany's ends.

Americans with unbounded faith in German acquaintances who have through naturalization declared themselves loyal to the United States will do well to consider the possible operation of the infamous Delbrück law passed by Germany in 1913. Under this law Germans who have been naturalized in foreign countries, or their descendants, are still considered to be German subjects provided they register with local German Consuls. Could anything be devised which puts a higher premium upon dishonor than this? Can we doubt that possibly thousands have taken out their papers and so registered? One such case known to the Secret Service concerns a reservist in the German army, who, having taken out his first papers, openly boasts that it was done for business purposes. He says that he still considers himself a German subject while posing as an American.

This type of information, particularly if the one concerned is a skilled wireless man, often results in the apprehension of a menace to the safety of American fighting forces going abroad. Until the Government realizes the value of a system of espionage for spy wireless stations and lays out a plan for utilizing amateurs in their detection, the experimental field can be of service by separating sentiment from loyalty in their associations with possible enemies and not hesitating to report to the police any well-founded suspicions.

JACK BINNS' PARTING MESSAGE

JUST before leaving New York to join the British Royal Flying Corps, Jack Binns, the famous C. Q. D. operator of Republic fame, told the English recruiting officers that he knew that Germany was preparing for war against Great Britain years ago, because from April, 1905, to July of 1908 he had been a wireless operator on German ships. He told them that the wireless apparatus on the German ships was controlled by a Belgian concern, and that there were ten English, two Italian, one Belgian, one Icelander, and a number of Danish wireless men employed on German ships. In 1908 at the time of the Morocco crisis, Binns said, the Germans asked the Belgian concern to discharge the British, Italian, and Belgian operators, stating that in the event of war between Great Britain and Germany the British operators would refuse to tell the German Captains when war was declared, if they received the information at sea, and that consequently the German ships would be captured by British warships.

In this incident is once again illustrated how the mailed hand of the Hun has been ready to strike for years. Can it be doubted that the same thoroughgoing consideration has been given to the eventual engagement in war with the United States? America must awake; eternal vigilance is the price of safety.

THE NEW FACTOR IN WARFARE

BOUNDLESS opportunities are daily revealed for the wireless man whose knowledge of electricity and magnetism is of the practical order. Electricity, child of peace, has been adopted by war as its own especial ward. Without electricity this war could never have reached the proportions which it has; perhaps could never have been fought at all. Every Big Bertha is fired by an electric spark. Every order from headquarters reaches the trenches, not by courier as in days of old, but by telephone. The wireless crackles a staccato accompaniment to every sailing of ship and submarine. The torpedo itself is propelled by electric motors.

Invention has been stimulated almost hysterically by the demands of war. Armies on the march or in the field have now a hundred conveniences which were not known last year. There is a radio telephone and telegraph equipment, for instance, which can be attached to a motorcycle. Current for this compact field set is supplied to the telephone or telegraph by a high voltage direct current generator connected directly to an independent motorcycle engine connected with the side car. For the equipment is contained in a small metal side car attached to the cycle.

The wireless equipment comprises a completely independent unit, which can easily be detached and pushed by hand or loaded on a wagon and transported over rough ground. An extra wheel is provided which can be attached to either hub of the side car or to the front or rear of the motorcycle. The antenna is supported by a light-weight metal mast of tubular construction. The telescopic form of it makes it possible to collapse the mast and to strap it out of the way on the car's side.

It is said that the French are using a detector so small that it can be carried in the soldier's breast pocket. To use it, a knife is planted in a tree and the wire attached by metal clip to this "antenna," another clip and stake serving for the ground wire. The entire receiver weighs but thirteen ounces, and yet, in spite of its size, it is meticulously made and is a most accurate apparatus.

For long distances, for instance, to the extreme borders of France, one clip is joined to a telephone line which serves as an antenna, and the other goes to gas or water pipes for the ground. But at a smaller distance there can be a wider choice for antennæ: a kitchen stove, a balcony, a metal bed or the like, or even a bicycle or an automobile. The operator may use his own body for the ground by attaching the metal clip to his finger, while the other clip goes to the telephone wire.

We have termed these things "stunts" up to now; perhaps we have considered them both foolish and useless forms of pastime. Yet, on good authority, it is reported that these former toys are carrying on important work.

ALLEGIANCE AS VIEWED BY A WORLD-CITIZEN

THE Italian Mission had been formally received at the City Hall in New York. The ceremonies were ended for the day. "The cordiality of our reception," said Mr. Marconi, "was most marked. It has been very different from the reception given to me here twenty years ago this month, when I first came with my poor wireless inventions."

In these few phrases lie a world of encouragement for inventors the world over. Cold, callous, self-centered and satisfied New York turning out by the tens of thousands to cheer the inventor of wireless made a spectacle never to be forgotten. At every turn Marconi was met with wild and enthusiastic acclaim and, most significant of all, his popularity did not rest alone on gratitude for his humanitarian invention—everywhere was manifest recognition that he stands for the true adjustment of nationality and world-relationship.

The straightforward simplicity of character which has endeared him to men of all nationalities was made evident in his every official act while the guest of Americans. The inventor has long been looked upon as a citizen of the world, Italian by circumstance of birth, but somehow belonging to all nations. It required a slight readjustment of habitual thought to recognize him as the official representative of Italy, but it was obvious that by being a good citizen of Italy he was best serving America. At a public school in the poorer section of the city—a school which has honored him by adopting his name—he spoke in Italian to those of a quarter occupied largely by those who were originally his countrymen. Here his sincerity of purpose to make these schoolboys good Americans was eloquently revealed.

"You boys represent the future of this great country," he said, "and it is the vitality, enthusiasm and patriotism that you show which give to your elders who are now engaged in actual war increased courage to carry on their work. Nothing could please me more than to see children who are preparing to become citizens of the great ally of Italy at such time. We are living in stern times and we must do all in our power to prepare not only to end this terrible struggle victoriously, but also to prepare for the new conditions which are bound to arise when peace finally comes.

"Our countrymen are giving their heart's blood, not for themselves, but to obtain a better world for you. I therefore exhort you to remember that this struggle is for democracy, liberty and mankind."

How different is this spirit from that shown by the scientific men of our enemy country! Propaganda designed to demolish America's traditions and continuous efforts to make naturalized citizenship but a blind to cover allegiance to their fatherland is Germany's contribution for years antedating the war. It is cause for general thankfulness that fate selected as the benefactor of humanity, Marconi—a Man.

—THE EDITOR.

Multiplying Wireless by Magic

How the Call of the Nation for Vast Quantities of New Sets for the Army and the Navy Expanded the Marconi Factory

By JOHN WALKER HARRINGTON

THE magic flutes of today are the wireless sets. With them men fend themselves from harm in peace and outwit their foes in war. A modern magician gave them to us that we might sing across the liquid leagues and span the continents with voices which are silent melodies save to those whose ears are attuned to the hidden minstrelsy.

When war came, the United States Government took from the Marconi Wireless Telegraph Company of America all those magic flutes, both large and small, and said, "Make for the Army and Navy a thousand or so more." How the Company's plant in Aldene, New Jersey, was to put through this rush order was a problem which required considerable planning. To make appliances in a leisurely way for one's own use is one thing, but to manufacture them commercially is another. It would have been impossible to have risen to this great national need, had not the Company called to its aid that which works so many wonders in this world—the wizardy of efficiency.

There was no time to be lost. The erection of additions to the factory; the perfection of new machines and new jigs and models; the training of artisans to a new and highly specialized calling—all had to be carried on at once. "Business as unusual" from May 1st until now has been the slogan at the Aldene plant.

Cartloads of brick, piles of lumber, barricades of cement bags, appeared overnight. Carpenters, masons, machinists, engineers, electricians, arrived from all parts of the compass. On the first of May there was a lawn and on the second something that looked like a shell crater. The foundations of the big one-story extensions were spun rather than dug and built, and the brick walls were reared on them by workmen who turned night into day. The progress photographs of the addition could be built into a movie and sped up into a two-reel production. No construction contract was ever carried through on quicker schedules than was the one which gave the needed room to Aldene. The buildings which have been added cover 40,000 feet more of ground space. They are of the saw-tooth type on top, which gives them the appearance of a series of studios such as are let out to artists and sculptors. They are dedicated to the art which in these days is so all important—that of swift communication. Now that everything is done, those who watched the bewildering swiftness of the operations wonder how such order was brought out of all this hectic haste. It is an apt illustration of what men can do when they have to.

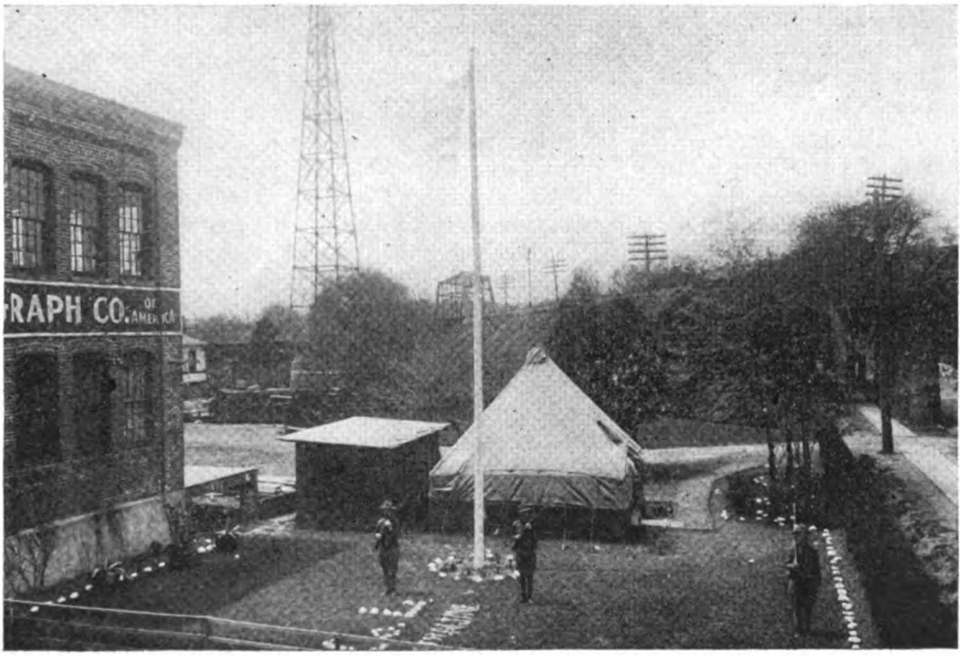
Some of the seasoned old lathe hands, recruited from all parts of the country, were jarred a little when they started. To see a group of carpenters nailing down a floor as though they were mad hatters rather than respectable craftsmen; then to see another frenzied crew slide a lathe upon the freshly-planed surface, while others were rigging up belts, caused those aristocrats of labor to rub their eyes in a bewildered kind of way.

"All right, there's your lathe, man, get to work," roared the superintendent in their ears, for there has not been any silence on tap at the Marconi factory for months, and before they realized what they were about they themselves were seized with the spirit of rush.

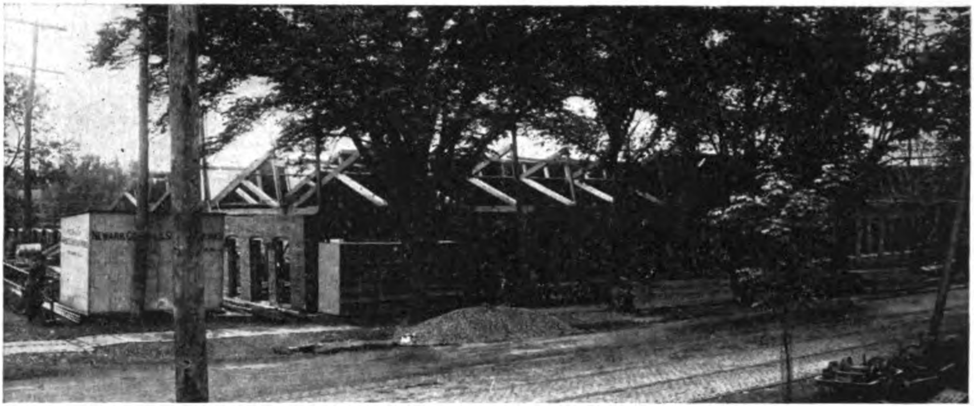
The installation of instruments of precision, such as required for the making of the thousands of parts which enter into a wireless set, be it little or big, requires meticulous care. The marvel of it all is that these appliances which are used in such delicate operations seemed to be veritably thrown into position and yet they are as right as trivets.

One of the reasons for this is that the United States brand of workman is one of the ablest and most adaptable human beings under the sun. He is as fit to do a thousand things well as is his prototype of the machinery world, the great American lathe. The men at Aldene are putting into their daily tasks the zeal of patriots. There are more than 700 of them working in two shifts in the new plant. Some were once making gauges and calliphers; others were adepts in fashioning automobiles or sewing machines; many were making brass work or working over hard rubber. There is no better example of the way in which a group of ingenious Americans can be drilled in difficult and highly specialized trades than is shown at the benches at Aldene.

First of all, there had to come into being certain jigs and templets and many other appliances such as only skilled die makers and tool experts can fashion from the designs of the engineers. The Marconi Company had for years been making apparatus for its own use both on land and sea. The Federal authori-



The Aldene plant of the Marconi Company where, on the first of May, there was a lawn, a few piles of lumber and soldiers on guard, harbingers of the reconstruction to meet a national emergency



A view of the work dedicated to the art of swift communication; note on the left the depth of the partially roofed building, extending beyond the third telegraph pole

ties wanted apparatus adapted to different wave-lengths than those sets in ordinary commercial use and that meant all kinds of changes. There had to be sets for aeroplanes, for destroyers, for submarines, for battleships and for colliers, all of which had to have their own patterns and jigs before a single one could be turned out from the works. The way these skilled workers, brought into the "Valley" from all parts of the United States, go about interpreting a blue print as though Marconi, and Hertz and Sir Oliver Lodge were everything in their lives, was a sight which made one think of automatic efficiency. And mind you, they were doing all this while carpenters were sawing and ripping along side, while masons were rattling their trowels in the next unit, and roofers were hammering and stamping overhead, as though trying to show that each and every one of them was the most important in putting wireless sets together.

Probably there is not a reader of THE WIRELESS AGE who has not seen radio apparatus both stripped and mounted in ebon panels hurling its shocks into the ether, but few who have not watched wireless sets being machined and assembled can realize what an intricate task it is to build them. Of the thousands of parts, tiny and big, which go into the make-up of the sets, scarcely any can be bought in the open market. Screws and nuts, and bolts and all the bits of copper and aluminum and iron and steel and wire which enter into the composition are all made according to the Government standards, and the process of standardization itself was one which might have taken months had there been time to wait. Brass and silver and bakelite-dilecto enter into the making of these magic flutes of earth and sea with which brave men may be called to fight or warned of the coming of the foe.

The steps in the making of the wireless sets are numerous and intricate. Practically everything which comes in at the receiving end of the great plant is raw material. This makes its way through many operations into a delicately adjusted instrument which can make the earth a whispering gallery at the touch of a brazen key. Everything looks pretty much alike at the start. The tyro cannot distinguish whether all the material piled so high in the storeroom or being shoved in from the freight cars on the siding is going to come out as commercial ½ K. W. sets or the great twenty kilowatters which can jar the ether into vibrations from Sandy Hook to Lands End. The operations are literally legion and by the time a 5 K. W. apparatus has emerged at the discharging end of the factory from four to six months will have elapsed. All the time, however, there is so much action that the metals which are the makings of the sets have hardly time to get cool from the constant handling of hundreds of toilers carried on all day and almost around the clock.

Some of the types of wireless sets which are being developed at Aldene are, to the visitor, unlike anything which has ever been fashioned before. That is evident in the dexterous manipulation of strange tools which are everywhere seen in the plant and in the array of weird jigs which are being carried about the long rows of benches and lathes.

Here is a skilled artificer bending steel angle bars into the frame for a new type of aeroplane set, surely one of the most compact contrivances which ever saw the light of invention. Other types for the submarine chaser, the destroyer and the submarine are being sent through the works at top speed. Side by side with the small set may loom a black paneled contrivance which before long may be talking from the wireless cabin of a dreadnaught

In order to manufacture all these varieties it was necessary to convert many of the standard machines to unaccustomed uses. The turning out of copper plates on the lathe, for instance, where iron castings or such materials were machined, is a very difficult job but it is being admirably and effectively done at the Aldene plant. End to end, there are sixteen machines on which are being turned the finely-threaded screws which are used in the precise adjustments of tuning the wireless to wave-lengths of other instruments. Turret lathes just placed in commission are performing their ingenious tasks so deftly that they seem even to ignore the guidance of the skillful hands which direct them.

Everywhere are bundles of rods of brass, sheets of aluminum, and foil of copper, emerging from machines as parts of the instruments which are to make vibrant the air above the warfare of the seas. Into every piece there is put the conscientious work of a spirit which transcends the machine. Wonderful as is the mechanical ingenuity here displayed, there is nothing of the automaton in the way in which these able artificers go about their toil, as the processes grow step by step more complicated.

There is the same alert enthusiasm shown by the girls and women who are winding the miles and miles of fine wire for the coils, for there is about them just such an unconscious air of consecration that one observes on the faces of the women who are learning the technique of the Red Cross nurse. Side by side are girls just out of school and gray-haired mothers who are doing their bit in this factory while husbands or sons are enlisted in the service of the country.

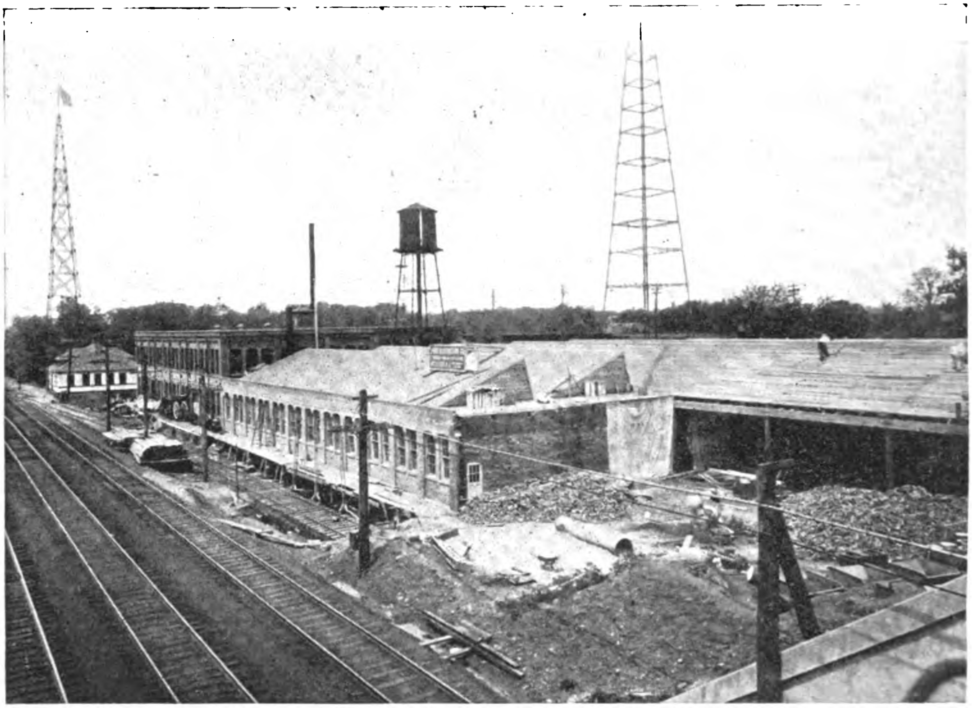
The expansion of the manufacture of wireless sets has brought into play all manner of factory efficiency methods. They apply especially to the great stockrooms where in hundreds of separate compartments are piled the different sections of the various sets. Motor-generators, transformers, starters, gap switches, aerial indicators, rheostats, are waiting in their stations, ready to go out into the world of adventure.

Owing to the highly developed system in the assembling room, the widely separated fractions are joined with a rapidity which is startling to the uninitiated.

When the sets are finally articulated they are taken to the testing room, where they are tried under what are practically service conditions which have been ingeniously simulated. "Birds may be singing in the trees" from which the wooden ships are to be built to carry food for France, but the wireless sets which are to be on board of some of those craft are already giving voice to their lays at this factory. If Rembrandt were back again on earth, he would like nothing better than to paint the lights and the shadows which play about a youth in one corner of the testing room bending intently over the new appliance which is being practiced to in its notes as though it were some sable-hued bird trying to attune its unaccustomed throat to a mighty lilt.

The plotting room, from which has been directed so much of the plant strategy, is a one-story wooden building from which the engineering force was in transit when I visited the works a few days since. The engineers are now quartered in the remodeled part of the factory which was the old building. The men who have done so much to meet the sudden emergency which confronted them are of that keen witted, capable breed which are coming these days from American schools of technology and also from the drafting rooms of the great manufacturing plants. Among them I noticed one who only a few months ago had been a wireless operator, but by intensive study had fitted himself for one of the best positions in the employ of the company. He is among the able staff which, through its adaptation of shop practice to the demands of these days of stress, has made possible such an achievement of human resourcefulness and skill as one sees everywhere about him in this plant.

The laboratory and the drafting rooms seem to be a busy plant in themselves. Indeed they might have well suited the purposes of Guglielmo Marconi in the early days of wireless.



Cartloads of brick, piles of lumber, barricades of cement bags, appeared overnight at Aldene and were as quickly absorbed into buildings, which, in seven weeks, covered 40,000 feet more of ground space.

One of the strongest features of the development of the factory is that despite the drive for efficiency, nothing has been neglected which makes for the well-being and the comfort of every employee, be he engineer, a winder of coils or a clipper of copper.

There are commodious quarters for the men with plenty of locker space and suitable washing facilities, and there is also a well appointed rest room for the women and girls. Everything which can make for the best environment of the worker is at hand.

The soul of the task reigns in this realm of the busy machines where a spirit of work for work's sake seems to prevail and the results obtained speak convincingly of the power of individual co-operation,

Under Fire With an Amateur On the Silver Shell

The Sinking of a German Submarine by an American Ship as Seen From the latter Vessel's Wireless Cabin

By HAROLD T. MAPES.

EDITOR'S NOTE.—In this recital of an amateur wireless operator who obtained an assignment in the radio cabin of a ship that sank a German submarine by which she was attacked, is contained a vivid picture of sea warfare. The author is a mining engineer and assistant general manager of a mining company in Mexico. Having obtained a Government first-grade commercial operator's license, he sought a place in the commercial field with the aim of gaining experience, and was assigned as first Marconi operator on the American oil tank steamship Silver Shell. What he saw from the radio cabin while the vessel was engaged with the undersea craft is graphically related in the following article:

Harold T. Mapes, the author of this article

AS I sat in the wireless cabin of the Silver Shell, sending out frantic calls for protection against the German submarine which was bombarding us even as she steamed closer to the stern of her prospective victim, my position might be likened somewhat to that of the blackfaced man at the Coney Island amusement places who exposes himself as a target for the missiles hurled by visitors.

On a tanker, it should be explained, the boiler, engines and wireless cabin, forming the vital parts of the ship, are in the stern. So I had, as it were, a

For three days the Silver Shell was tossed about on turbulent waters

grand stand seat, rather too close to the bullseye to be comfortable. Add to this description of my position the fact that the Silver Shell was laden with more than a million gallons of gasolene, which was almost sure to explode when the first shell hits its mark, and you can comprehend without difficulty the perils with which I was surrounded.

But I had embarked on the Silver Shell for experience and experience I got.

During the earlier stage of the vessel's voyage from New York to Marseilles, France, our port of destination, we weathered a storm of no mean force, being tossed about on turbulent waters for three days. A short time afterward we passed within 100 feet of a submarine that was on the surface of the water, going through the process of having her storage batteries charged for the next day's run. It was three o'clock in the morning, in mid-Atlantic, when she was sighted. So close did the Silver Shell pass to the craft that she could be plainly seen from the deck and the throb of her engines was heard after she had been swallowed up in the darkness. Her lookouts were asleep evidently, for she made no attempt to attack us and she had passed out of sight before the after-guns of the Silver Shell could be trained on her.

Although every one on the tanker realized fully the danger of traveling through the war zone, the proximity of the submarine made us more alert to avoid peril. The fact that the crew of a submarine, on a dark night, can see a large steamship with considerable less difficulty than those on the latter would have in locating the U-boat had been thoroughly impressed on the minds of all on the Silver Shell. Still more forcibly was the destroying-power of the submarine brought to our attention when the Silver Shell passed the wreck of a wooden ship. She floated bottom up, the large wound in her side providing grim evidence of the torpedo's ravages. Tossed about by the waves nearby were a few life preservers and a lifeboat. All of which bears out my statement that the Mediterranean is a mecca for U-boats. Twelve out of the sixteen submarines reported to me by wireless were found in the Mediterranean.

Our next and more thrilling encounter with a submarine occurred when a day and half more of steaming would have brought us to Marseilles. It was early in the afternoon of May 30th when she was sighted. She was then off our starboard bow and the alarm blast was sounded immediately.

The course of the Silver Shell was changed to the west, lifeboats were made ready for lowering into the water and the ship's company buckled lifebelts about their waists. We had just thrown the bundles containing our valuables into the boats when the submarine, which was one of the largest type of U-boats, being about 300 feet in length, gave unmistakable notice that she was an enemy craft by firing a shell. The latter exploded about 100 yards away from the American vessel. Almost before we had time to realize our situation another shell was fired. It just missed the wireless cabin, finding a resting-place in the water 100 yards away from the ship.

Meanwhile the Silver Shell's men had been preparing to defend themselves.

Seated, from left to right, are shown L. D. Higgins, third assistant engineer of the Silver Shell, Operator Mapes and G. S. Adams, first assistant engineer. Standing are the members of the gun crew which did such effective work

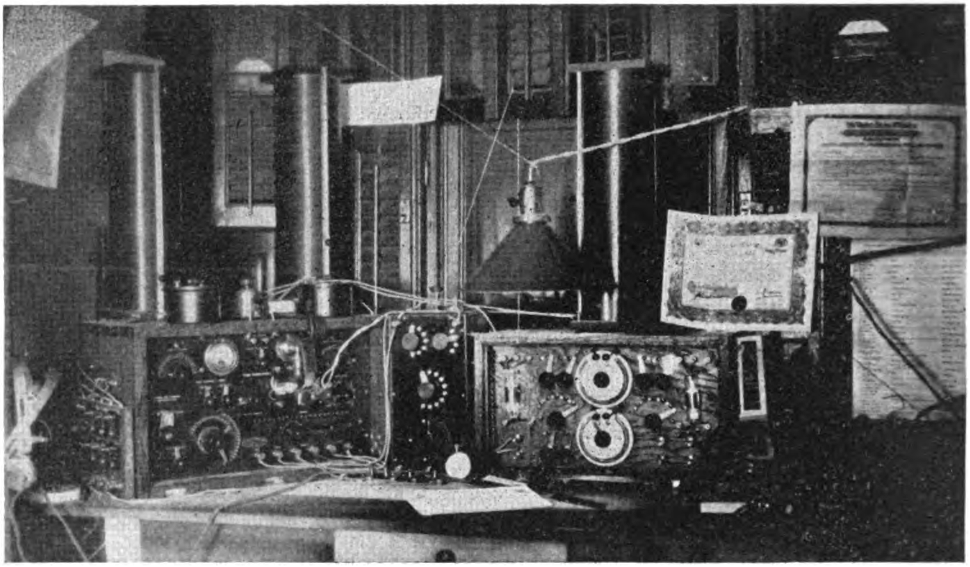
They opened fire on the Germans with our four-inch after gun, but the first seven shots missed their target by about 1,000 yards. This fault was soon remedied by Chief Petty Officer Clark who knocked out the extreme elevation pin, which gave the gun about forty degrees. The improvement in marksmanship was at once evident. On all sides of the submarine the shells from our vessel dropped, giving preliminary notice of what our fire was to accomplish later.

But we did not have the fighting all our own way by any means, for the Germans had two five-inch guns as compared to our four-inch ones and at the beginning of the engagement were outshooting us. Their shells passed in alarming proximity to our heads and burst on both sides and at the bow and the stern of the ship. I recall that one shell bounded over the wireless cabin, just missing that structure by a couple of feet.

There was no lack of activity in the radio room while we were being shelled. Even while I was flashing the S O S, giving our position, course and rate of speed, Second Operator Douglas was adjusting my life preserver.

Listening in for the response to my appeals for aid was not without its problems. Our after-gun was only twenty-five feet away from the wireless cabin and every time it was fired the concussion knocked the radio apparatus out of adjustment. Then, too, the roar of the gun and the bursting of the German shells were deafening.

Algiers was the first to answer my call. The handicaps in receiving were so great, however, that it was necessary to ask for a repetition of the message several times. To add to my difficulties a Spanish ship interfered by repeatedly asking in Spanish: "What ship is that asking for help?" She did not sign off



A view of the amateur set operated by Mr. Mapes

and the circumstances made the incident appear like deliberate interference. However, I finally succeeded in receiving the Algiers message which was as follows: "Help thirty-five miles northwest gunboat FQ." Getting into communication with gunboat FQ, I received this response: "Coming as fast as possible."

This was reassuring news, indeed, for from my position in the cabin I could see the submarine steaming along in our wake like a hound after a hare. She was astern of us about 3,000 yards, the head seas washing over her deck as she breasted the waves and compelling the members of her gun crew to stand waist-deep in the water. They would fire between the intervals of the boat's plunges through the waves. From the Silver Shell could be seen the flash of their guns. Then would follow an interval of about ten seconds before those on the tanker could determine whether the shot would hit its mark. The emotions which filled the men on the American tanker during these periods were not the most comfortable, I can assure you. As for myself, I sat with strained nerves, at the head phones, listening for word that might be of value.

The Silver Shell was speeding through the water at the rate of fourteen knots an hour although she had never made more than eleven before. The safety valves were screwed down and the engineers and firemen were bending every effort to get all possible speed out of her. Their position was by no means enviable as a shell was likely to strike the boilers and cause an explosion.

Under a high pressure of steam the U-boat was gaining on us and finally she reached a point about 2,300 yards away. She was using a shrapnel to sweep our decks; the shells continued to burst on all sides of us and it seemed that some of them must take disastrous effect. Then, as suddenly as she had begun the attack on us, she was vanquished. For one of our shots struck her just aft of her conning tower, inflicting a wound which caused her bow to rise high in the air. Immediately she began to sink, stern first, with her crew still on deck.

It was a dramatic finish of a dramatic fight, for she would, it is likely, have cleared our decks in fifteen minutes and then turned her fire on our lifeboats in the event that we tried to escape in them.

The Germans did not abandon their attempts to sink the Pearl Shell, following the sending to the bottom of the submarine. Soon after the engagement was ended I received the following message: "If possible steer south, I will meet you in an hour." This message, which came in very weak, was a decoy communication sent out by another submarine to lure us into her path. We had already been instructed to disregard messages sent by ships that were not authorized, or confirmed by a Government land station. It was impossible for me to confirm the "steer south" message.

Gunboat FQ asked me for the Silver Shell's new position at five minutes after seven o'clock that evening. This I wirelessed, as well as details concerning the sinking of the submarine. She flashed back, "Good work!" and at eleven o'clock had approached so close to us that the two vessels were able to exchange messages by Morse lamp signals.

Or arrival at Marseilles the next afternoon had in a measure the significance of an important event, for the Silver Shell was the first American ship to enter that port since the United States had declared war with Germany. The uniforms of the bluejackets, of course, attracted considerable attention and the fact that we would probably receive prize money from the French Government for sinking the U-boat added to the interest displayed in the Americans.

The engagement with the submarine lasted more than an hour and a half, but fortunately no one on the Silver Shell was seriously injured. As I look back on the engagement now that it is ended I can even see a humorous side to some of the incidents. For instance, the bos'n, who had donned his three suits of clothes when preparations were made to take to the lifeboats, did not neglect to take a pinch of snuff and express his feelings with considerable force every time a shot was fired from the submarine. He was an active figure in the fighting as were also Petty Officer Clark, who showed excellent judgment in handling the guns and gunners, and Captain J. Charlton. Despite the fact that Captain Charlton was suffering from rheumatism, he remained on the bridge to navigate the ship. G. S. Adams, J. J. Prescott and L. D. Higgins, respectively first, second and third assistant engineers, also deserve mention for their efforts in speeding up the Silver Shell at a time when speed was sorely needed.

And that is the story of how an amateur got an insight into the life of a commercial operator at sea. When this article appears in THE WIRELESS AGE I shall be on by way to Mexico to resume my mining work, but the memories of my voyage on the Silver Shell will remain with me for years to come.

CIVIL SERVICE EXAMINATIONS

The United States Civil Service Commission announces open competitive examinations for auditing clerk (radio) and bookkeeper and accountant (radio), for men only, on July 25th. Five vacancies in the position of auditing clerk at entrance salaries ranging from $1,000 to $1,400 a year; one vacancy in the position of bookkeeper and accountant at $1,500 a year; two vacancies in the position of assistant bookkeeper and accountant at $1,000 a year, all in the office of Naval Communication Service, Washington, D. C., and future vacancies requiring similar qualifications, will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

DAVID SARNOFF WEDS

David Sarnoff, commercial manager of the Marconi Wireless Telegraph Company of America, and secretary of the Institute of Radio Engineers, was married to Miss Lizette Hermant of New York City, in the Broadway Central Hotel, New York, at six o'clock in the evening of July 4th. The Rev. S. Privin, the bridegroom's grandfather, performed the ceremony.

Radio Science

STATIC ELIMINATION WITH UNDAMPED WAVES

THE pressing problem in long distance wireless telegraphy and telephony is the prevention of static or impulsive currents which may be induced in a receiving telephone either by atmospheric discharges or earth disturbances.

In collaboration, H. D. Arnold and H. W. Nichols, have evolved a method whereby a transient atmospheric discharge may be eliminated when the receiving apparatus is adjusted to an undamped or sustained oscillation transmitter.

The proposed method of obtaining selectivity by the use of a number of resonant circuits in series between the antenna and oscillation detector, while thoroughly efficient, gives rise, on account of the number of coupling coils in use, to considerable energy losses. Beyond this, a static discharge striking the antenna system produces a loud response in the receiver even though the circuits are sharply resonant.

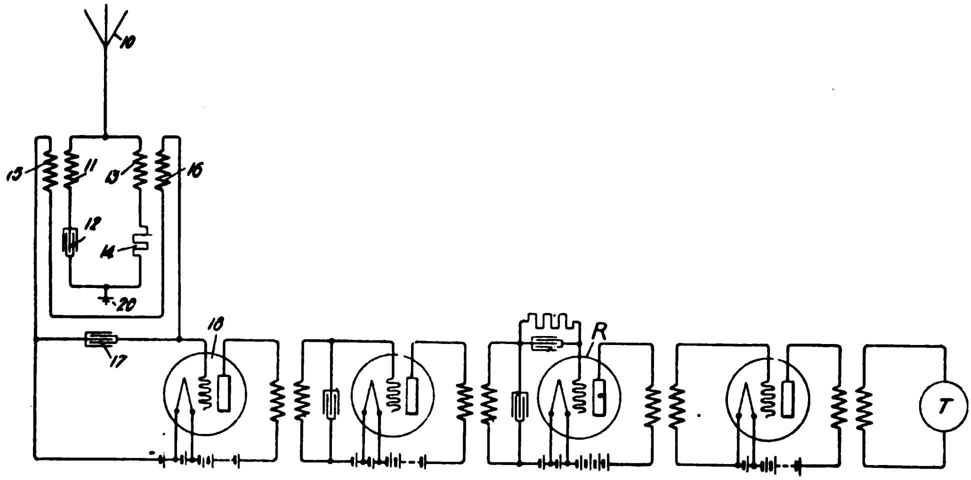


Fig. 1—Arnold-Nichols circuit for static elimination

The fundamental principle of the apparatus is as follows: Under the impressed electromotive force of an impulsive disturbance, the initial rush of current in a receiving circuit is inversely proportional to its inductance, but the final current during the flow of undamped or sustained oscillations is dependent solely upon the resistance of the circuit. Following out this principle, if two parallel circuits have impressed upon them an electric impulse, the initial rush of current in each will be inversely proportional to the inductances, and if the inductances are made equal, they may be connected in a circuit to annul each other's effects. This will be the case even though the resistance and capacity in the two parallel circuits are widely different.

If, however, the impressed electromotive force on the two parallel circuits has a sustained oscillatory character, the current which will finally be built up will depend upon all the constants of the circuit, and in the case of a tuned circuit, it will depend upon the resistance, being inversely proportional thereto.

If the one circuit is tuned to the frequency of the received electromotive force and has a low resistance while the other circuit has equal inductance but a higher resistance, the current flow in the first will be much larger than in the second. In order to obtain discrimination between impulsive electromotive forces and sustained oscillations, it is therefore necessary to give one circuit a large damping constant. This is most easily accomplished by increasing the resistance or decreasing the inductance. By using a third circuit inductively connected to both of the primary circuits, the effect of an impulsive current may be neutralized, but the effect of the sustained oscillations will be transferred to the detector circuit.

Like all devices of this kind where discrimination between two incoming signals is obtained, there will be some loss of energy, and in general, it is necessary to amplify the desired oscillations, after which they may be detected. In other words, however large the loss of energy may be in the initial weeding out circuit this can be properly compensated for by amplifying the desired signal through a number of three electrode vacuum valves or thermionic amplifiers connected in cascade.

One method of applying this principle is shown in Figure 1 where it will be noted that two branch circuits 11 and 12, 13 and 14 are connected in parallel between the antenna and the earth. In the right hand branch the resistance 14 is large in order that the damping constant $\frac{R}{L}$ of that branch shall be large compared to that of the left hand branch. Coils 11 and 13 are inductively coupled to coils 15 and 16, which are connected in series and the final terminals to the grid and filament of a vacuum valve. As is usual in circuits of this kind, a source of electromotive force, 22, is connected in series with the grid to maintain a strongly negative potential with respect to the heated filament. It will further be noted that a number of valves are connected in cascade, transformers being employed in the local circuit of the one circuit to the next one, and so on throughout the series. These circuits may be tuned or untuned at the discretion of the experimenter.

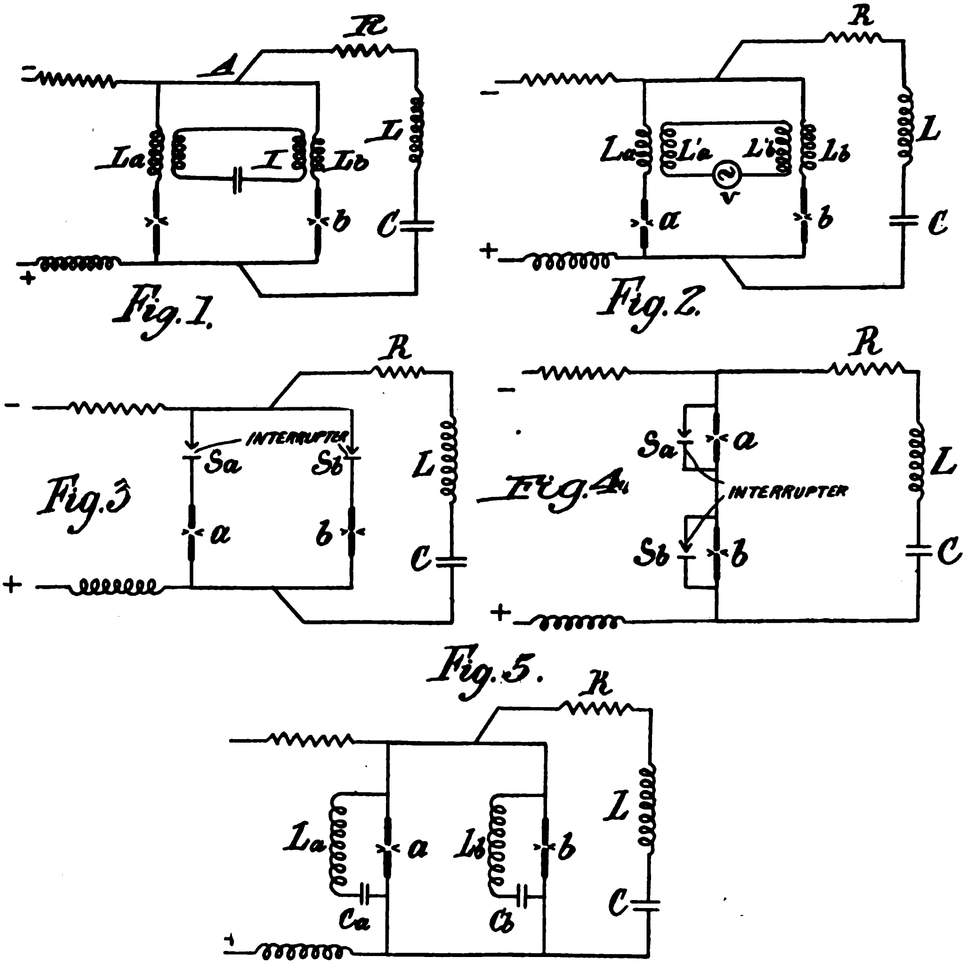
The action of the apparatus in Figure 1 is as follows: If sustained waves of desired frequency are impressed upon the antenna of the receiving station, the current in the tuned branch 11 and 12 is large, while that in the branch 13 and 14 is very small. Energy is therefore transferred to the circuit 15, 17 and 16 and from there on to the oscillation detector, but if static or impulsive disturbances are impressed upon the antenna, the current in the two branches will neutralize each other's effects in circuits 15, 17 and 16.

In practice, inductances 11 and 13 are made approximately equal in order that the currents will be equal, but this is by no means necessary, for any difference in the inductance of 11 and 13 can be compensated for by changing the coupling or inductive relation between 11 and 15 or 13 and 16.

HIGH FREQUENCIES FROM DIRECT CURRENT ARCS

Circuits through which extremely high frequencies can be obtained from the direct current arc are accredited to P. O. Pedersen of Frederiksberg, Denmark. Heretofore the maximum frequency obtainable from arc systems has been limited, owing to the difficulty of cooling the anode, a limitation which Mr. Pedersen seeks to overcome by providing a number of arcs which are so arranged that the current impulses pass through the arcs alternately. For example, if three arcs are employed only each third current impulse passes through a single arc, and this arc remains inactive for two entire periods, allowing the gap sufficient time to cool. If the shiftings are promptly timed this will not affect the period of the alternating currents which pass through the circuit containing the inductance L and the condenser C. This contribution to the art is important in that it provides a sufficiently long time for each arc to cool and deionize, no special methods for cooling the arc being needed. Another interesting feature is that the discharge loses the character of an arc, since so long a time elapses between the passage of single current impulses through one of the discharge spaces, the discharges therefore becoming in effect a series of non-oscillating sparks.

In Figure 1, between the cathode and the feed conductor are inserted inductance coils L-a and L-b, which are inductively coupled to a third circuit I, containing two coils and a condenser in series. The condenser C, the induc-



Pederson circuits for obtaining high frequencies from the direct current arc

tance L and rheostat R constitute an oscillation circuit. The period of circuit I is twice the period of R, L, C. If a current impulse passes through the discharge space A, a free oscillation is induced in circuit I, but a period later the oscillations in this circuit will again counteract through the inductance L-a. so that a current impulse again passes the discharge space A, but at the same time it will permit the passage of a current impulse through the discharge space B. It is important that the damping of the circuit I be as small as possible.

A somewhat different arrangement is shown in Figure 2, where an alternating current from a generator V is passed through the coils L*a* and L*b* and the period of the alternating current is twice that of the circuit R, L, C. Each second discharge passes through the discharge space A, and then through the discharge space B. If the period of the alternating current is four times that of R, L, C, two discharges will pass through the discharge space A and thereafter two discharges from the discharge space B, and so on.

Figures 3 and 4 show the apparatus employing interrupters which alternatively close and interrupt the connection between the cathodes and the source of direct current. The contact period of the interrupters should be in the neighborhood of the period of the oscillation circuit or some sub-multiple or multiple thereof. By proper design of these circuits the interrupters S-a and S-b will work without sparking, and if at the same time the sparking distances are chosen so that the potential between the electrodes during the passage of the current is small, while the ignition tension is relatively high, a very high efficiency is obtained, practically all the energy of the direct current being transformed into radio-frequency oscillations.

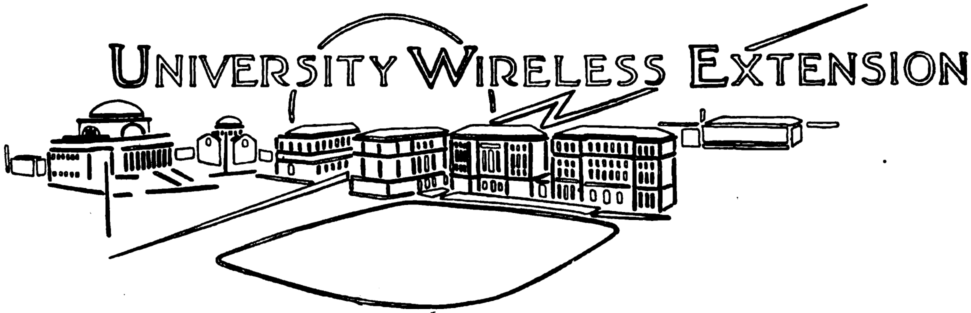
Figure 4 shows the interrupters and arcs connected in series, and in Figure 5 the arcs are in parallel, shunted by the circuits L-a, C-a and L-b C-b. The discharges of this circuit are incurred by the sudden high tension currents being alternatively induced in the inductances L-a and L-b, which cause sparks to jump through the discharge space A and the discharge space B, respectively. The sparks follow each other with an interval of nT where T as usual indicates the natural period of the oscillation circuit.

Items of Varying Interest

The peroxide of lead detector consists of a pressed pellet of peroxide of lead placed between a blunt lead point and a platinum plate. The pressure of the lead point is varied by an adjustable spring tension. The device is in reality an electrolytic cell and when it is connected in series with the local battery and head telephones, it exerts a back pressure upon the voltage of the cell. If these two E. M. F.'s nearly balance and the detector is connected directly in series with the antenna circuit, the incoming signal will destroy the balance of the opposing E. M. F.'s and cause an audio-frequent current to flow through the head telephone. This variation of current has been found to be of sufficient amplitude in many cases to operate a recording instrument direct without the use of an intermediate relay.

One of the earliest efforts toward establishing a commercial service on the American continent was undertaken by the United States Army between Nome and St. Michaels, Alaska, across Norton Sound, a distance of 107 miles. These stations were put into successful operation as early as August, 1903.

A synthetic crystal rectifier may be prepared as follows: Take one part by weight of powdered sulphur and four parts of finely divided lead, both of which should be chemically pure to secure the maximum sensibility. Mix these elements thoroughly and place them in a test tube, but, in order to allow for expansion, do not fill more than half of the tube. Hold the tip of the tube in the flame of a Bunsen burner or an alcohol lamp. The mixture will soon become incandescent and as soon as this comes about, remove the tube from the flame and allow the incandescence to spread through the mass. Keep the open end of the tube away from the flames in order that the gases generated may not ignite, although no serious harm will result from their doing so. Allow the tube to cool, then break it away from the crystaline mass inside. Break this into convenient pieces and mount in a crystal cup or in some other approved fashion..



Radio Telephony

By ALFRED N. GOLDSMITH, PH.D.

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

ARTICLE VIII

PRIOR to the consideration in detail of the Goldschmidt radio frequency alternator and internal frequency changer, we desire to establish a principle of interest in connection therewith. This principle can be rendered clear from a simple analogy. Imagine a circular platform of moderate dimensions rotating once per minute, somewhat in the fashion of the carousels used in amusement resorts. Suppose, further, that the attendant elects to walk back and forth along a *diameter* of the rotating platform while it is in motion, and that he makes one to-and-fro trip in one minute, that is, in the same length of time as that required for one complete rotation of the platform. It is required to find his path as viewed from an external stationary point, or, otherwise stated, with reference to the fixed ground under the platform.

Figure 91 shows a series of successive positions of the diametral line along which he walks, each position being 45 degrees further advanced than the preceding (that is, one-eighth revolution). The dotted line with the reference dotted arrow at one end indicates this diameter which, as will be seen, has reversed its direction in the half-revolution between positions 1 and 5. The position of the man on the diametral line is indicated in each case by the cross. It will be seen that the man never succeeds in getting to the left of the center of the platform because, as position 3 is passed, he comes to the reversed end of the diametral line, that is, the end away from the arrow.

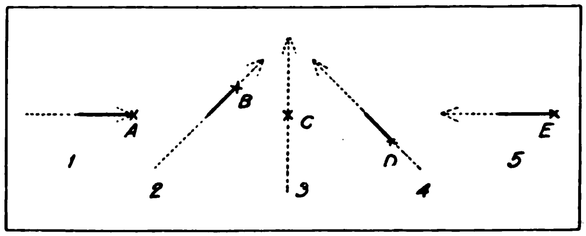


Figure 91—To-and-fro motion on rotating platform with equal periods of oscillation and rotation

The important point is that the path of the man relative to the ground (that is, the curve *ABCDE*) is a closed curve, and that he has returned to his original position in a *half-revolution* of the platform. In other words, relative to the ground, he moves in a closed curve at twice the speed or double the frequency that the platform rotates.

We establish then the principle that an oscillatory movement of frequency n taking place on a system rotating with frequency n is equivalent relative to fixed external points to an oscillation of half the amplitude or width of swing and of *double* frequency. The mathematical proof of this principle for simple harmonic (sinusoidal) vibrations is of the utmost simplicity, but need not here be given.

The diagrammatic wiring plan of the Goldschmidt alternator is given in Figure 92. The following description is based on an earlier explanation of this device by the Author. In the figure, the battery, B, supplies the direct current whereby the stator winding, S, becomes the field magnet of the alternator. L is a large inductance intended to prevent the flow of alternating currents through the battery circuit. In the field of the stator, S, is a rotor, R, which is short-circuited (that is, tuned to resonance) for the fundamental frequency produced when the rotor is revolved. The tuning of the rotor circuit is accomplished by means of the capacities, C_3 and C_4, and the inductance, L_2. It is to be noted that R and C_3 alone would be in resonance to the fundamental frequency, as also would L_2 and C_4. The complete circuit, $R\ C_3\ L_2\ C_4$, therefore contains approximately twice the inductance and half the capacity of either $R\ C_3$ or $L_2\ C_4$. Its period, therefore, is the same as that of either of these, and even if $L_2\ C_4$ were to be short-circuited, the rotor would still be resonant to the fundamental frequency. This permits shunting the condenser, C_5, across the circuit, L_2-C_4, without disturbing the tuning. A perfectly similar arrangement is adopted for the stator by the use of the circuit, $S\ C_1\ L_1\ C_2$, except that the circuit in question is tuned to *twice* the fundamental frequency. It will be seen that as the rotor revolves in the field of the stator, powerful currents of the fundamental frequency will flow through it. The great magnitude of these currents is due to the fact that the rotor is itself part of a circuit resonant to the fundamental frequency. If we consider the field of the rotor, we see that it is a field produced by an alternating current of fundamental frequency n itself rotating with a frequency, n. Therefore, by the principle established at the beginning of this discussion, we may regard it as containing a component field of constant magnitude, but rotating with a doubled frequency, $2n$, relative to the stator. A further study of the phenomena would show that there was also present a constant field rotating with velocity 0. The rotor fields will therefore induce in the stator electromotive forces of twice the fundamental frequency (and zero frequency); and since a circuit resonant to the double frequency is provided, powerful currents

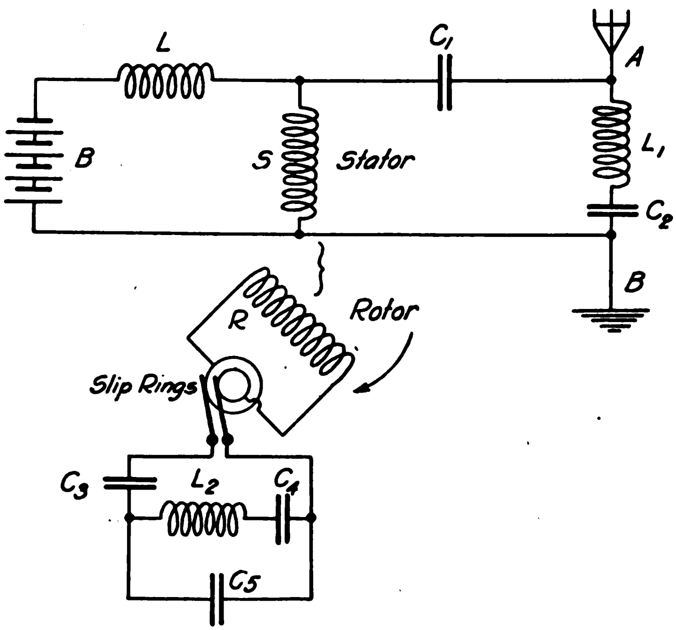


Figure 92—Winding of Goldschmidt alternator

of that frequency will flow through the stator. These alternating currents in the stator will induce in the rotor electromotive forces of frequencies, *n*, (from the steady field) and 3*n* (from the field of the current of frequency 2*n*). By means of the condenser, C_5, a path resonant to the frequency, 3*n* is provided in the rotor. By properly choosing the constants of the rotor circuits, the current of frequency *n* just mentioned can be made nearly to neutralise the current of frequency *n* first mentioned. The reason for this is that these currents can be brought to nearly complete opposition in phase and equal amplitude. There will be left then in the rotor a powerful current of triple frequency. Its field may be regarded by a process of reasoning quite similar to that originally employed as equivalent to two constant and equal rotating fields, revolving in opposite directions, with speeds of rotation corresponding to 2*n* and 4*n*. There will, therefore, be induced in the stator currents of frequency 2*n* and 4*n*. Of these, the current of frequency 2*n* will nearly completely neutralise the current of frequency 2*n* mentioned previously if the stator constants are properly chosen. The outstanding current of frequency 4*n* is shown in the figure as flowing into the capacity and inductance formed by the antenna, *A*, and the ground, *B*. We have, therefore, by "internal reflection" of energy, quadrupled the original frequency of the machine before using it for antenna excitation.

In the actual Goldschmidt installations (at Tuckerton, New Jersey, and Eilvese, Germany,) the motor drive of the alternator is accomplished by a 220-volt, direct current, 250-horse power motor having a speed of 4,000 R. P. M. For constant speed, a special form of sending key is used. This is shown in Figure 93. This key automatically inserts (by opening the back stop circuit) the resistance, *R'*, in the motor field circuit just before the load is thrown on by closing the exciter circuit of the alternator (by the front contact of the key). In this way the motor tends to speed up just as load is thrown on, and the speed actually remains constant. In addition, the inertia of the heavy armature helps greatly.

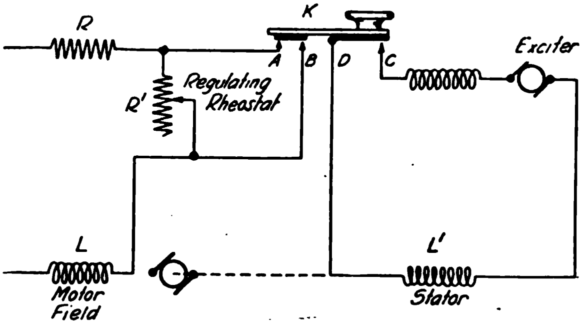


Figure 93—Goldschmidt alternator speed constancy system

The alternator itself is a 360-pole machine having a pole pitch or distance between windings of 7.5 mm. (0.3 inch), the slots in which the insulation and wire are placed being circular and of cross sectional diameter of 5 mm. (0.2 inch). The rotor diameter is, therefore, about 90 cm. (3 feet) and the rotor weighs about 5 tons (4,500 kg.). The direct current power required for field excitation is about 5 per cent. the rated output of the machine.

The winding of the machine is one conductor per pole, being a simple wave winding indicated in Figure 94. *AB* and *CD* are typical separate sections of the winding so arranged that they may be connected in series or parallel, depending on the electrical requirements. There are twenty-four such sections on the total circumference. Both rotor and stator are wound in the same way. The wire itself is very finely stranded, and made of No. 40 Brown and Sharpe gauge individual enamelled wires suitably twisted. The iron in the machine is very

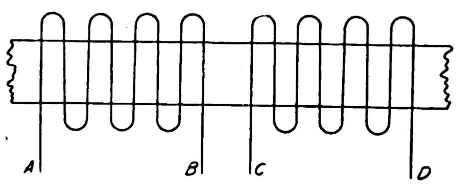


Figure 94—Position of rotor or stator winding of Goldschmidt alternator (developed)

finely laminated, the sheets being only 0.05 mm. (0.002 inch) thick, insulated by paper between, 0.03 mm. (0.001 inch) thick. The rotor is more than one-third paper, which is a most unusual proportion. Such construction is particularly noteworthy in view of the high speed of peripheral rotation, namely 200 meters (600 feet) per second. The design of the brushes bearing on the rotor slip rings and the connection to these brushes required careful consideration, especially in view of the danger of burning the slip rings of any brush that was connected to an output circuit of greater or less impedance than the remainder. In this connection, it must be mentioned that there were really more than one pair of slip ring connections to the rotor since a number of the rotor sections were placed in parallel outside the machine.

Some difficulty was experienced in preventing the currents which were generated from escaping to ground through the capacity (in air) between the conducting wires and the ground. In addition, there was always the danger that this air capacity would, in conjunction with one or more of the machine windings, produce a circuit resonant to one of the frequencies generated whereupon dangerously high voltages and currents would have arisen, and the output have disappeared.

The accuracy of construction of such machines is extreme. Since the air gap clearance between rotor and stator is 0.8 mm. (about 0.03 inch), very accurate centering of the rotor was necessary. In addition, very strict parallelism of the armature and stator slots was required, a deviation from parallelism of one part in a thousand causing a fifth of the output of the machine to disappear!

One of the Goldschmidt alternators in use at Eilvese (Hanover, Germany,) is shown in Figure 95. The machine is to the right, the driving motor to the left.

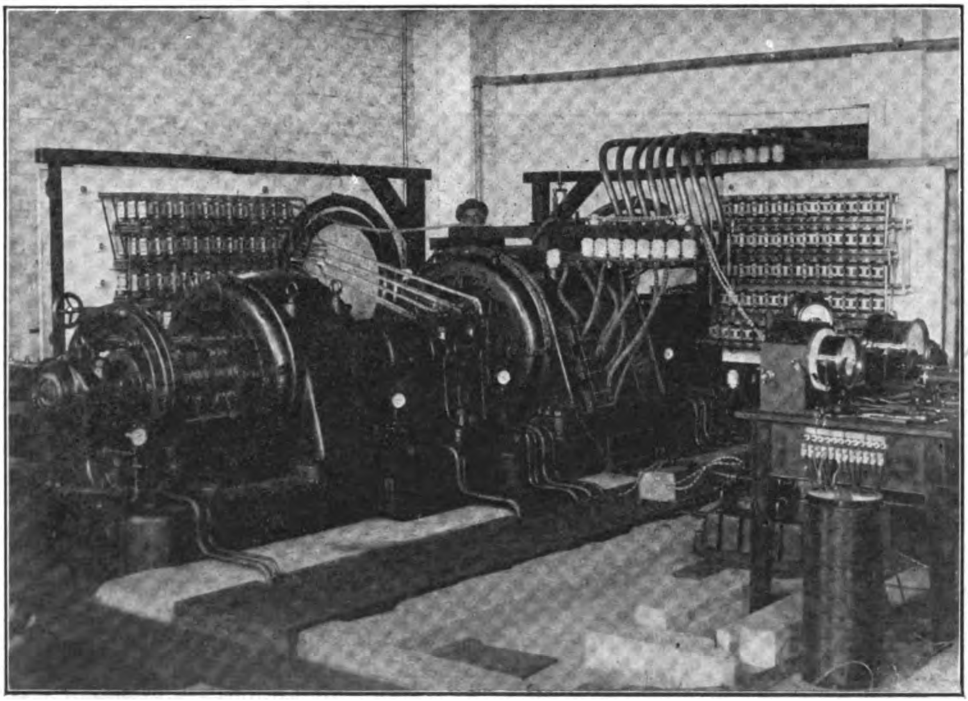


Figure 95—Goldschmidt alternator, motor, and reflection circuits at Eilvese, Germany

The large brush surface chosen for the high-speed driving motor is obvious. The condenser banks for tuning the various rotor and stator circuits are mounted on the walls, and are typical mica condensers. Some idea of the difficulty of leading the radio frequency currents into and out of the machine may be gained from the leads which are visible. The ingenious fashion in which the difficulties have been overcome is worthy of comment.

At the present time (January, 1917) two such alternators are being used in parallel when necessary, and put 275 amperes into the Eilvese antenna. Rapid telegraphy has been accomplished by their use at a rate of 200 letters per minute.

As has been previously stated, the second method of securing considerable amounts of sustained energy at radio frequencies when using alternators is that wherein an alternator of moderately high frequency is employed and the frequency is multiplied by external frequency changers and not, as in the Goldschmidt machine, by reflection of the energy in the machine itself. Most of the external frequency changers employed at the present time, particularly for considerable energy, are based on the properties of iron. Before explaining them in detail, it is desirable to quote from a paper by the Author on the subject of "Radio Frequency Changers."

In Figure 96 is shown a typical "B-H" curve for iron. This is the curve which shows the connection between the magnetising force (e. g., expressed in ampere-turns or product of current flowing through the magnetising winding by the number of turns of winding) and resulting magnetisation or magnetic flux through the iron core (referred to as the "induction"). "Let us suppose that the magnetisation of the iron has been brought to the point, *x*. If now, by means of a superposed alternating magnetising force, (such as may be produced by having around the iron core an auxiliary winding through which flows alternating current), equal increments and decrements be added to the magnetising force, the magnetic induction will increase during the positive half of the cycle by the small amount, *ef*. On the other hand, during the negative half of the cycle, the induction will diminish by the considerably larger amount, *xd*. The explanation of this phenomenon is found in the well-known magnetic saturation qualities of iron, whence it results that for high magnetising forces the iron becomes saturated and the bend or "knee" of the curve which is shown at *x* results. It will be seen, then, that though a sine-wave alternating current may be flowing through the auxiliary winding, the variation in the magnetic flux through the iron core will not be sinusoidal but distorted, the upper halves of the curve being flattened. Such a deformation of the flux variation always occurs when nearly saturated iron cores are used under the conditions mentioned. However, such a deformation of a sine curve always leads to the production of upper harmonics (i. e., high frequencies in a secondary circuit wound around the same iron core), and it is upon this principle that the entire series of frequency changers employing iron is based."

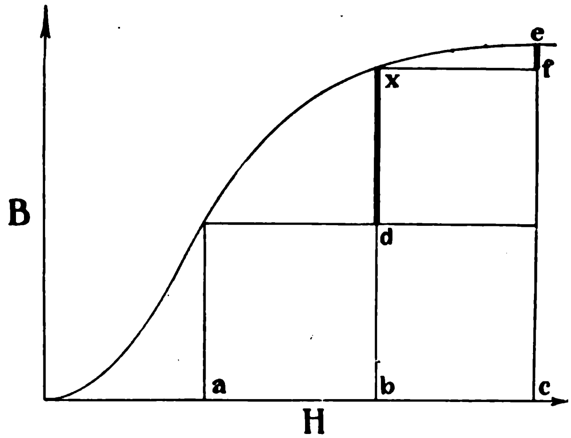


Figure 96—Magnetising force and magnetic induction curve for iron

An application of the principle just stated was shown by Epstein in 1902 (German patent 149,761) and has since been worked out and amplified in detail by Joly in 1910 and Vallauri in 1911. It is now extensively employed in various forms by the Telefunken Company under the patents of Count von Arco and Dr. A. Meissner. The circuit arrangement in a simple form is shown in Figure 97. As will be seen, an alternating current source, *A*, sends its current through the primaries, P_1 and P_2, of each of two transformers having iron cores. These primaries may be connected in series or in parallel according to the secondary voltage and primary current which may be desired. They are wound oppositely relative to each other. A direct current source, *B*, e. g., a storage battery or small direct current generator, supplies the two auxiliary coils, M_1 and M_2, which coils are also wound on the same transformer cores. The direct current coils are wound oppositely. The secondaries of the two transformers, S_1 and S_2, are wound in the same direction, and connected as indicated in the figure.

The operation of the device is in the main as follows: The direct current flowing through M_1 and M_2 is so chosen that the iron is brought to the knee of the magnetisation curve, i. e., the point, *x*, in Figure 96. In consequence, during half the alternating current cycle, each of the transformers has a flattened addition to its iron magnetisation due to the iron saturation, while during the other half of the cycle it has a peaked diminution in its iron magnetisation due to the rapid drop of the iron curve below the point, *x*.

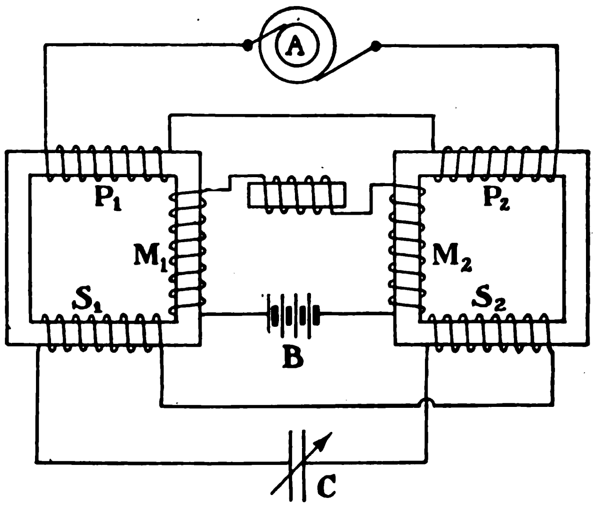


Figure 97—Telefunken Company frequency doubler

This effect is shown graphically in Figure 98. In curve *a* of the figure, the fine horizontal line represents the constant magnetisation produced by the direct current which flows continuously. The curved line shows the actual magnetisation which results when the alternating current also flows in the winding, P_1. It will be seen that during the positive half of the alternating current cycle, there is only a small increase in the iron magnetisation, whereas during the negative half cycle, there is a large diminution in the iron magnetisation. It will further be noticed that the direct current coils and the alternating current coils on the two transformers are wound so that during the positive half cycle they assist each other on

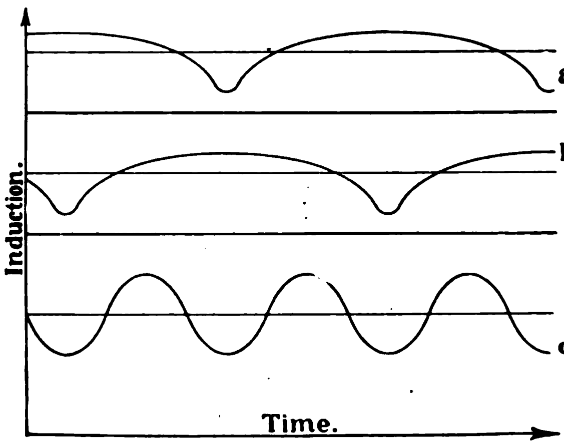


Figure 98—Iron magnetisation curves for frequency doublers

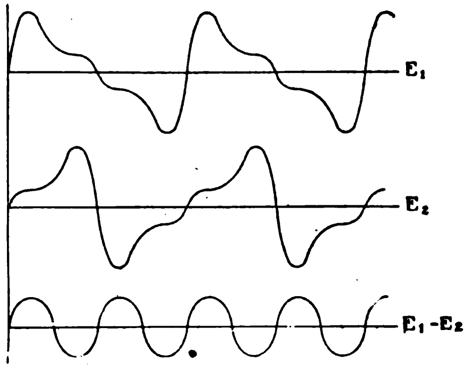


Figure 99—Induced voltages in secondarys of Telefunken Company frequency doubler

one transformer and that they simultaneously oppose each other on the other transformer. From this it follows that the induction in the second transformer is given by curve *b*, which lags practically a half cycle behind curve *a*. The resulting total magnetisation is given by curve *c* and is seen to contain a double frequency. Oscillograms of the voltages induced at the secondary terminals of each of the transformers are represented in Figure 99. The voltage at the terminal of one of the transformers is given by the curve E_1; that at the terminals of the secondary of the other transformer by E_2, and there is also shown the resultant voltage, namely E_1-E_2. The voltage curves are easily explicable on the ground that the voltage magnitude is proportional to the rate of change of the primary current so that it is only at times when the primary current is changing from the flat portion to the peaked portion that the large secondary voltages are induced. The resultant voltage is seen to be of double frequency."

Of course, the phenomena shown are for the frequency doubler with no load on the secondary, and these are to some degree modified when the double frequency energy is withdrawn. However, by secondary tuning and appropriate design, the same results as outlined can be obtained. A more detailed diagram, showing something of the actual practce with the frequency doublers, is given in Figure 100. It will be noted that the primary circuit of the alternator *A* is tuned by the inductances L_1, P_1, and P_2 and by the condensers C_1 and C_2. It will also be seen that there is a choke coil L_2 inserted in the direct current magnetising circuit of the frequency changers to prevent injuriously large radio frequency currents from being induced in this circuit.

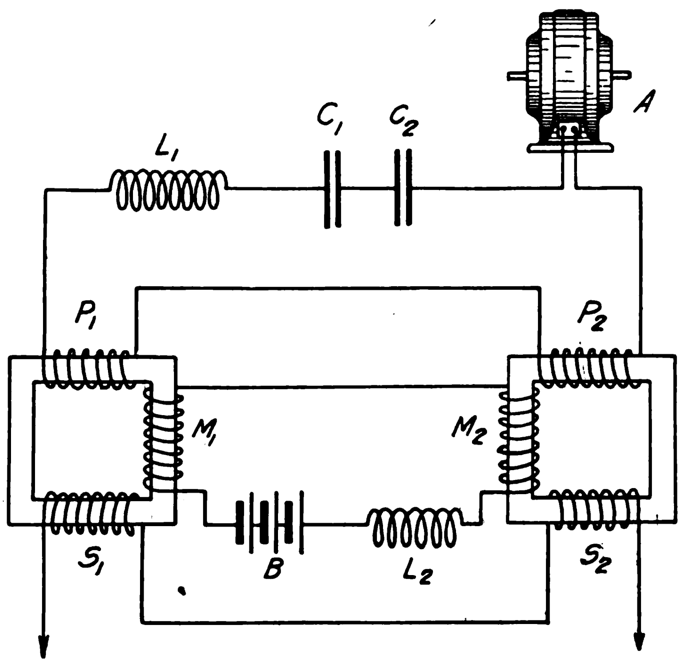


Figure 100—Frequency doublers used in actual practice

It can further be shown, both theoretically and practically, that if the secondaries of the frequency changer, S_1 and S_2 are connected assisting instead of opposing each other, there will be produced in the secondary circuit an electromotive force of *triple* frequency. Thus the same equipment can be readily used either as a doubler or a tripler.

A clear idea of the interior construction of the Telefunken radio frequency alternators can be obtained from Figure 101. The left hand portion of the figure gives a vertical cross section of half of the machine. Here *A* is the shaft to which the driving motor or engine is attached either directly or through appropriate gearing. *R* is the inductor or rotor, a rotating mass of steel, on the outer surface of which are cut a great number of grooves parallel to *A* thus producing the longitudinal teeth and slots indicated in cross section at *R* in the right hand portion of the figure. The constant direct current passing through the field winding, *F*, (which is an ordinary circular coil or ring of square cross section) produces a field the lines of force of which take the path indicated by the dashed line, *P*. It will be seen that this path is suitably interlinked with the coil, *F*, and passes through the yoke, *Y*, the stator slot supports *W*, and the rotor, *R*. The armature, which is in two portions, one on each side of the field coil consists of to-and-fro windings in longitudinal slots parallel to those of the rotor. The portions of the armature can be placed in series or parallel in accord-

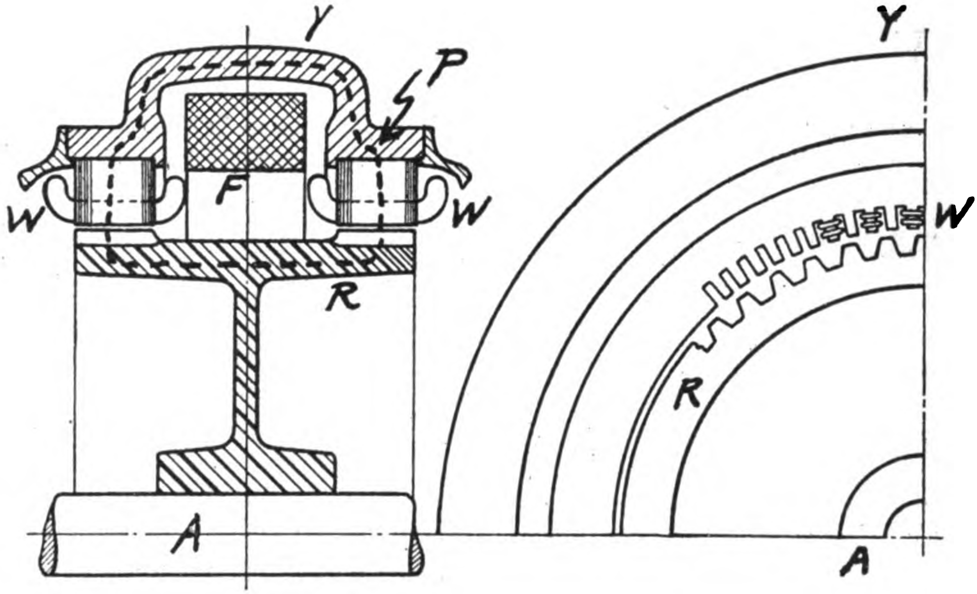


Figure 101—*General arrangement of Telefunken radio frequency alternator*

ance with the characteristics of the circuit to which the machine is connected. The mode of winding the armature is indicated at *W* in the right hand portion of the figure. It is evident that as the rotor revolves, the field passing through the armature turns, *W* pulsates back and forth with a frequency corresponding to the product of the number of rotor slots and the rotor revolutions per second. The advantage of this (inductor) type of machine as compared to those with wound armatures is that the rotating portion consists of a solid steel mass and is consequently much more sturdy than a normal armature carrying wire windings on a laminated support.

The appearance of a small (10 K. W.) machine of this type is indicated in Figure 102. The motor is mounted at the front of the base plate and the alternator at the rear. The housing between them contains the multiplying gear.

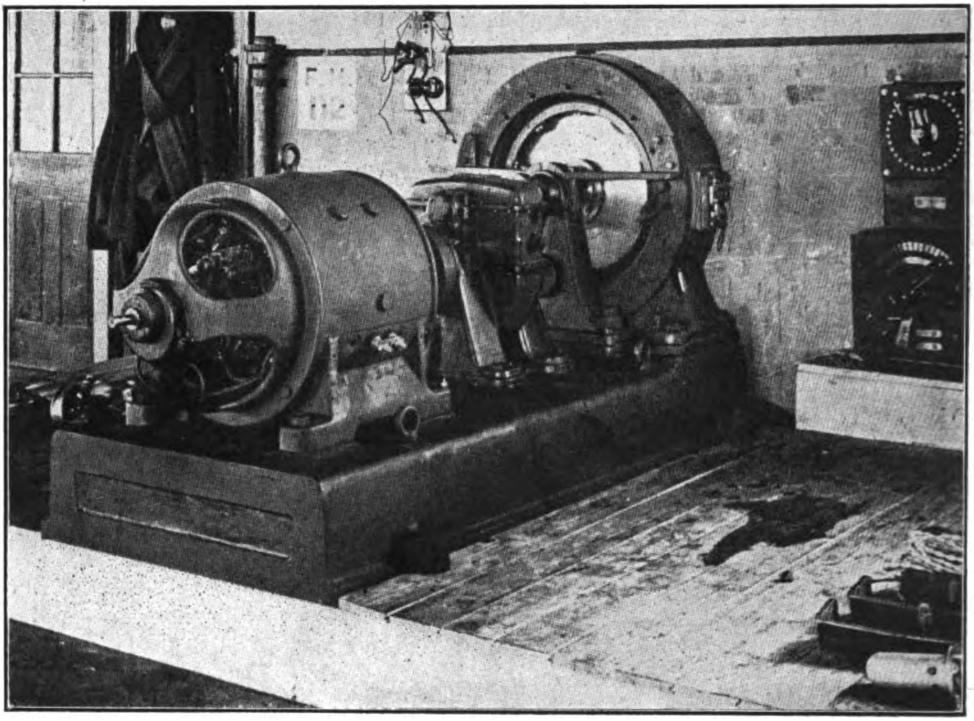


Figure 102—Telefunken Company 10 K. W. 10,000 cycle alternator

The motor starter, and the speed controlling rheostat are mounted on the wall at the rear. The machine shown produced 10,000 cycles per second directly. Its use in radio telephony, together with the other portions of a frequency changer set of which it was a part, will be described under "Control Systems."

This is the eighth article of a series on "Radio Telephony" by Dr. Goldsmith. In Article IX, continuing the consideration of generating radio frequent currents by alternators, an interesting and important form of alternator, largely developed by E. F. W. Alexanderson, is taken up.

Signal Officers' Training Course

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

THIRD ARTICLE

By MAJOR J. ANDREW WHITE

Chief Signal Officer, Junior American Guard

WIRELESS men training for army war service show a natural impatience to begin study of the tactical employment of technical apparatus with which they are already familiar in great or lesser degree. That this seeking for knowledge is premature is best explained in the words of Brigadier General George O. Squier, Chief Signal Officer of the United States Army: "History shows that wars are usualy won by new devices. Frederick the Great was the first to employ the principle of drill, and won his battles by that agency. Until this time armies had been formless crowds of men which could not be quickly handled and manoeuvred. Frederick the Great was the first drill master. He saw the possibilities in having men trained to march and halt and wheel and countermarch and so on, automatically like a great machine, in response to a word of command. He made an army a co-ordinate, coherent thing, capable of quickly responding to meet every emergency as the emergency was seen and understood by a man in supreme command. And his success was based on that.

"This now seems a very simple, matter-of-course thing, but it was unheard of before Frederick the Great introduced it into warfare as his new contribution."

It is now recognized that the principle of drill—the marching, halting, wheeling and turning in unison—is the first essential for mastery by soldiers. So, while it is true, as General Squier says, that "wars are usually won by new devices," and wireless experimenters of America may yet develop a new agency in scientific practice, familiarity with military principles must be gained before the experimenter is of value as a Signal Corps member.

In the preceding article, an outline of the recruit instruction was included in the form of extracts from the book, "Military Signal Corps Manual." From the same source the following extracts are made, carrying the drill instruction one step further: the School of the Squad, the smallest military unit, consisting of eight men—seven privates and a corporal.

THE SQUAD

As soon as the recruits are sufficiently instructed for the purpose, they are formed into squads of convenient size in order to teach them the principles of the alignments, taking intervals, and the marchings.

For this instruction, the recruits are formed in double rank. The files on the right and left of the squad are always complete; if there be an incomplete file, it will be the second from the left. The rear-rank men cover their file leaders accurately at 1 yard distance.

In the case of a small number of recruits, they may be formed in single rank. The movements described for the double rank formation apply equally well to the single rank, omitting the explanations for the rear-rank men.

TO FORM THE SQUAD

To form the squad, the instructor designates a recruit as the front-rank man of the right file and indicates to him where the right of the squad is to rest; he then places himself about 3 yards in front of where the center is to be formed, and commands: FALL IN.

How the squad is formed is illustrated in this photograph, showing the rear rank with proper distance. The position illustrates the action immediately after the command "Fall in"

The men form on the designated recruit, in two ranks facing to the front, as nearly as practicable in order of height from right to left.

The rear rank forms with distance of 40 inches.

The instructor then commands: COUNT OFF.

At this command, all except the right file execute *eyes right,* and beginning on the right, the men in each rank count *one, two, three, four;* each man turns his head and eyes to the front as he counts.

The squad executes *the rests;* resumes *the attention; marks time;* and executes *the facings,* the *setting-up exercises, the step,* and *the halt,* and is dismissed by the same commands and means as explained for the recruit in the preceding article.

ALIGNMENTS

The alignments are first taught by requiring the recruits to align themselves upon two files established as a base.

Being at a halt, the instructor causes the first two files on the flank toward which the alignment is to be made to move forward a few paces, and establishes them as a base; he then commands: 1. Right (left), 2. DRESS, 3. FRONT.

At the command DRESS, all men place the left hand upon the hip (whether dressing to the right or left); each man, except the base file, when on or near the new line executes *eyes right,* and, taking steps of 2 or 3 inches, places himself so that his right arm rests lightly against the arm of the man on his right, and so that his eyes and shoulders are in line with those of the men on his right; the rear rank men cover in file.

The instructor verifies the alignment of both ranks from the right flank and orders up or back such men as may be in rear, or in advance, of the line; only the men designated move.

At the command *front,* given when the ranks are aligned, each man turns his head and eyes to the front and drops his left hand by his side.

In the first drills the basis of the alignment is established on, or parallel to, the front of the squad; afterwards, in oblique directions.

Whenever the position of the base file or files necessitates a considerable movement by the squad, such movement is executed by marching to the front or oblique, to the flank or backward, as the case may be, without other command.

To preserve the alignment when marching: GUIDE RIGHT (LEFT).

The men preserve their intervals from the side of the guide, yielding to pressure from that side and resisting pressure from the opposite direction; they recover intervals, if lost, by gradually opening out or closing in; they recover alignment by slightly lengthening or shortening the step; the rear-rank men cover their file leaders at 40 inches.

In double rank, the front-rank man on the right, or designated flank, conducts the march; when marching faced to the flank, the leading man of the front rank is the guide.

TO TAKE INTERVALS

Being in line at a halt: 1. Take interval. 2. To the right (left). 3. MARCH. 4. Squad. 5. HALT.

At the first command, the rear rank steps back 4 steps and halt; at the command MARCH, all face to the right and the leading man of each rank steps off; the other men step off in succession so as to follow the preceding man at 4 paces, rear-rank men marching abreast of their file leaders.

At the command HALT, given when all have their intervals, all halt and face to the front.

TO ASSEMBLE

1. Assemble, to the right (left). 2. MARCH.

The front-rank man on the right stands fast, the rear-rank man on the right closes to 40 inches. The other men face to the right, close by the shortest line, and face to the front.

MARCHINGS

During the marchings the guide conducts the march, preserving with great care the direction, length, and cadence of the step and selecting points on which to march.

TO MARCH TO THE FRONT

Being at a halt: 1. Forward. 2. MARCH.

The men step off and march straight to the front.

If in line, the rear-rank men follow their file leaders accurately. The instructor sees that the ranks preserve the alignment and the intervals toward the side of the guide. The men yield to pressure from that side and resist pressure from the opposite side; by slightly shortening or lengthening the step they gradually recover the alignment, and by slightly opening out or closing in they gradually recover the interval, if lost; while habitually keeping the head to the front, they may occasionally glance toward the side of the guide to assure themselves of the alignment and interval, but the head is turned as little as possible for this purpose.

If in flank column, the men of the leading file step off at full step; the leading rear-rank man marches abreast of his file leader at 26 inches interval. The other files march at the half step, each taking the full step when at 1 yard distance.

Being in march: 1. To the rear. 2. MARCH.

At the command *march,* given as the right foot strikes the ground, advance and plant the left foot; turn to the right about on the balls of both feet and immediately step off with the left foot.

In marching in double time, turn to the right about, taking four steps in place, keeping the cadence, and then step off with the left foot.

If at a halt, the squad may be faced about and then moved forward, as explained in the preceding paragraph; or, without facing about, it may be marched a short distance to the rear by the command; 1. Backward. 2. MARCH.

Whenever the squad in line is faced about or marched to the rear, all men in the front rank not covered step into the new front rank.

TO MARCH BY THE FLANK

Being in line; 1. By the right (left) flank. 2. MARCH.

At the command *march,* given as the right foot strikes the ground, advance and plant the left foot, then face to the right in marching and step off in the new direction with the right foot. The march is continued as described in the preceding paragraph, "March to the Front."

The formation obtained by marching by the flank from line is called a *flank column.*

If at a halt, the squad may be marched by the flank by first facing it in the desired direction and then moving it forward, as explained.

When the march by the flank is executed from flank column while at 1 yard distance, the files close in gradually toward the guide until they have the prescribed interval.

Whenever the flank column is halted while marching at 1 yard distance, the leading file halts at the command; the others close to facing distance before halting.

To close up in flank column without halting: 1. Close. 2. MARCH.

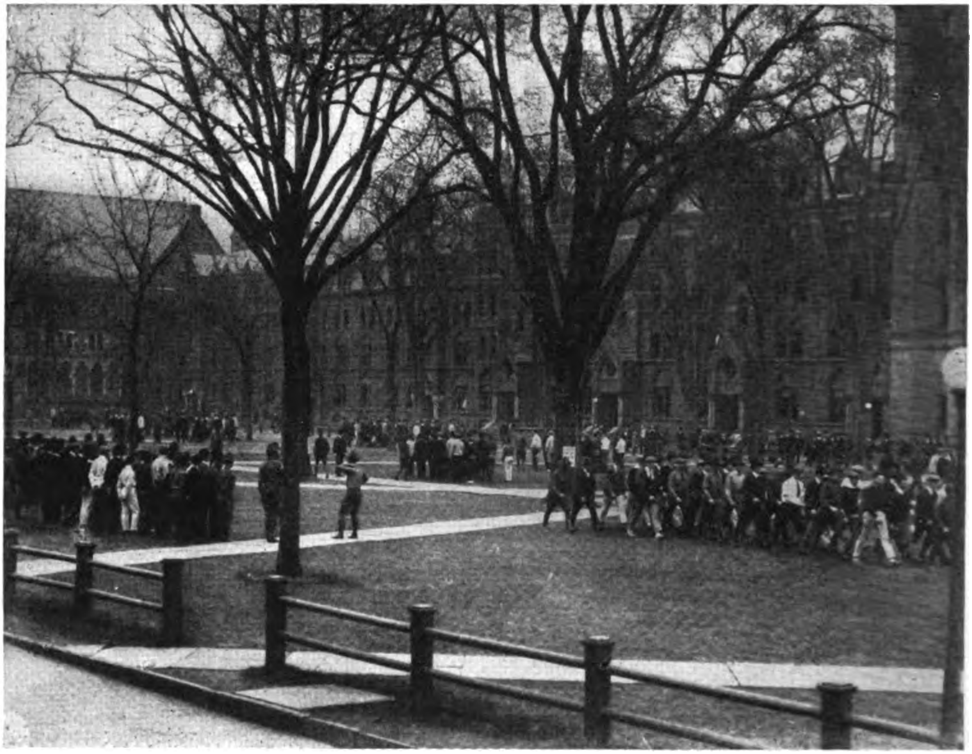
The leading file takes the half step; the other files close to facing distance and take the half step; all the files having closed to facing distance, the column is halted or marched by the flank as previously explained.

To halt the flank column without closing up: 1. In place. 2. HALT.

TO MARCH OBLIQUELY

For the instruction of recruits, the squad being correctly aligned, the instructor causes the squad to face half right or half left, points out to the men their relative positions, and explains that these are to be maintained in the oblique march.

1. Right (left) oblique. 2. MARCH.



A view of Yale campus, showing the students, not yet in uniform, receiving elementary instruction in close-order drill

Each man steps off in a direction 45 degrees to the right of his former front. He preserves his relative position, keeping his shoulders parallel to those of the guide, and so regulates his step as to keep the ranks parallel to their original direction.

If the command HALT be given while marching obliquely, the men halt faced to the original front.

To resume the original direction: 1. Forward. 2. MARCH. 3. Guide (right or left).

At *half step* or *mark time*, while obliquing, the oblique march is resumed by the commands: 1. Oblique. 2. MARCH.

TO CHANGE DIRECTION IN FLANK COLUMN

1. Column right (left). 2. MARCH.

The movement is executed by each rank successively and on the same ground. At the second command, the pivot man of the front-rank faces to the right in marching and takes the half step; the other men of the rank oblique to the right until opposite their places in line, then execute a second right-oblique and take the half step on arriving abreast of the pivot man. All glance toward the marching flank while at half step and take the full step without command as the last man arrives on the line.

Wireless Instruction for Military Preparedness

A Practical Course for Radio Operators

ARTICLE IV

By Elmer E. Bucher

Instructing Engineer, Marconi School of Instruction

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

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

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

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

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

THE ELECTRICAL UNITS

(1) We have stated the unit of **electromotive force** to be the **volt, the unit of current strength,** the **ampere** and the **unit of resistance,** the **ohm.**

(2) The student should understand that a **difference of potential** in an electrical circuit causes **electromotive force** and electromotive force will cause the flow of an **electric current** provided the proper conducting **path** is afforded.

(3) The distinction between the unit of current quantity and of current strength should be clear. The quantity of electricity flowing in a given circuit is expressed by the unit termed the **coulomb,** which is analogous in hydraulic systems to the term, the gallon. The strength of an electrical current should be described as the **rate of the flow of electricity** through a circuit per second of time, and this rate is expressed by the unit, the **ampere,** the physical standard for which has already been mentioned.

(4) We may define the **coulomb** as that amount of electricity which would pass in one second through a given circuit in which the strength of the current is one ampere.

(5) If a current of one ampere flows every three seconds, the quantity of electricity delivered is three coulombs, or if three amperes of current flow for one second the quantity is also three coulombs.

(6) From this it is clear that the quantity of electricity flowing in any circuit in coulombs is equal to the current strength in amperes multiplied by the time it flows in seconds or——

$$Q = I \times T;$$

where Q = the quantity of current in coulombs;
I = the current in amperes;
T = the time in seconds.

(7) Hence, in a circuit carrying 15 amperes of current for ten minutes, the quantity of electricity flowing equals $10\times60\times15=9{,}000$ coulombs. In such a circuit, current flows at the rate of 15 amperes per second, but the quantity of current flowing for ten minutes equals 9,000 coulombs.

(8) As it is more convenient in electrical practice to measure the strength of the current in amperes than to compute the total quantity of electricity flowing, we express the rate at which it flows, i. e., employ the unit, the ampere.

(9) In electrical equations the ampere is represented by the letter I. Instruments for measuring the strength of current in electrical circuits are called **ampere meters** or **ammeters.**

ELECTRICAL RESISTANCE

(1) **Resistance** in electrical circuits is that property of bodies which oppose the flow of electric current, the spent energy being manifested in the form of heat.

(2) All substances are found to resist the passage of electricity, but the resistance of metals is the least.

(3) **Silver** is found to be the **best conductor** and offers less resistance than copper; in fact, the ability of silver to conduct electricity is taken as the base from which the **specific resistance** of other metals is computed. German silver, for example, has a relative resistance of 13.92 and silver 1; hence a cubic inch of German silver, for instance, has a little more than thirteen times the specific resistance of a cubic inch of pure silver. Lead may also be classed among the poorer conductors of electric currents.

(4) Since resistance opposes the flow of an electrical current, it reduces the energy of the current. A resistance coil of variable value may be employed in any circuit to regulate the flow of current. Such a resistance unit is termed a **rheostat.**

(5) The resistance of metals is effected by temperature. The majority of metals increase their electrical resistance with increase of temperature, but certain substances decrease their resistance under rise of temperature, an example being carbon filaments and certain electrolytic conductors, such as battery solutions.

(6) The resistance of a conductor is always constant if its temperature remains constant, irrespective of the strength of current flowing through it. If the conductor offers unit resistance to a current of one ampere, it offers the same resistance to a current of 20 amperes, provided the temperature does not change appreciably.

(7) The **unit of resistance** is called the **ohm,** the physical standard for the ohm has been previously noted.

OHM'S LAW

(1) There is a distinct relation between electromotive force, current strength and the resistance of an electrical circuit. This is disclosed by **Ohm's law,** which states that the strength of the current in amperes in any given circuit is directly proportional to the E. M. F. and inversely proportional to the resistance.

This may be written—

$$I = \frac{E}{R};$$

where I = the current in amperes;
E = the electromotive force in volts;
R = the resistance in ohms.

(2) This law shows that an electrical circuit in which the condition of the circuit does not change during the flow of the current, i. e., the circuit remains of constant resistance, the current flow in amperes will increase directly in proportion to the E. M. F. Hence if an E. M. F. of 10 volts is applied to any circuit, the resistance of which is 5 ohms, the current strength in amperes will be——

$$I = \frac{10}{5} = 2 \text{ amperes}$$

and if the E. M. F. were increased to 20 volts then

$$I = \frac{20}{5} = 4 \text{ amperes.}$$

This formula may be transposed to read:

$$E = I \times R \text{ or}$$
$$R = \frac{E}{I}$$

(3) Thus if we know any two of the quantities involved in this expression, the third can be readily determined. For example, if an electrical circuit had resistance of 10 ohms and the current as measured by an ammeter is found to be 11 amperes, then the electromotive force applied to this circuit must have been——

$$11 \times 10 = 110 \text{ volts.}$$

ELECTRICAL POWER

(1) The relation between electrical and mechanical power is determined by the unit, the **watt,** and the watt is the unit to express the **rate of doing work** per unit of time. The energy expended in an electrical circuit is expressed by the unit, **the joule,** and the joule occupies the same relation to the watt as the coulomb to the ampere.

(2) In an electrical circuit, the electrical energy expended in the form of heat in joules is expressed:

$$J = I^2 \times R \times T;$$

where I = the current in amperes;
R = the resistance in ohms;
T = the time the current flows.

(3) It should be thoroughly understood that the **joule per second** is called the **watt** and the watt is **the unit of electrical power.**

(4) The **power** in watts in a given circuit in which direct current is flowing is equal to the result obtained **by multiplying the current in amperes by the electromotive force in volts** or

$$W = I \times E.$$

Hence if a current of 10 amperes flows in a circuit to which is applied an E. M. F. of 100 volts, the power of the current = 10 × 100 = 1,000 watts and since 1,000 watts = 1 K. W. (abbreviation for kilowatt), the power of the current is said to be 1 K. W.

(5) **One mechanical horsepower** is the work done at a rate equal to raising 550 lbs. per second through a distance of one foot against the force of gravity.

(6) It can also be shown that 746 watts = 1 mechanical horsepower, hence 1,000 watts = approximately 1 1-3 horsepower.

GROUPING OF ELECTRICAL CELLS

(1) The grouping of electrical cells in various ways effects the current and pressure available for a given external circuit. The following diagrams will illustrate the point:

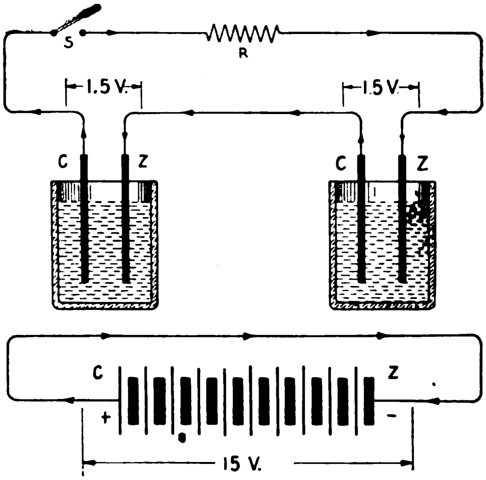


Figure 13

OBJECT OF THE DIAGRAM

To show how electrochemical cells are connected in series.

PRINCIPLE

If a number of electrochemical cells are connected in series, the electromotive force is increased and the resultant E. M. F. is the sum of the individual E. M. F.'s.

DESCRIPTION OF THE APPARATUS

In the upper diagram of Figure 13, two cells are connected in series, the zinc terminal of one cell being joined to the carbon terminal of the next cell. In the lower part of the diagram 10 cells connected in series are shown as they would be represented in electrical diagrams.

SPECIAL REMARKS

(1) If the E. M. F. of all cells is identical, the final E. M. F. will be that of one cell multiplied by the number of cells in the group.

(2) The strength of the current will not exceed that of a single cell and due to the internal resistance of all cells, it will be somewhat less.

(3) A series connection is employed when the resistance of the external circuit is large compared to the internal resistance of the cells.

QUES.—What is the total E. M. F. of 10 average dry cells connected in series?

ANS.—The average voltage per cell = 1.5 volts. Hence the voltage of 10 cells in series = 10 × 1.5 = 15 volts.

QUES.—What is the total E. M. F. of 10 lead plate storage cells connected in series?

ANS.—The E. M. F. of the average lead plate cell is 2.1 volts. Hence 10 cells in series would have an E. M. F. of 10 × 2.1 = 21 volts.

QUES.—If the resistance, R, in the upper part of the diagram (Figure 13) has resistance of 6 ohms and the E. M. F. of the two cells is 3 volts, what current will flow (ignoring the internal resistance of the cells)?

ANS.—According to Ohm's law, $I = \frac{E}{R}$ hence, the current in amperes = $\frac{2}{6}$ = 0.33 amperes.

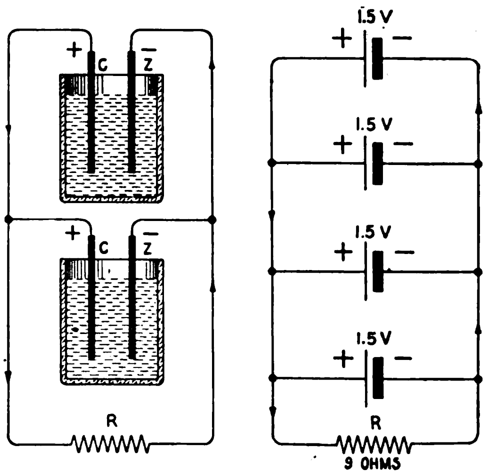


Figure 14

OBJECT OF THE DIAGRAM

To show how electrochemical cells are connected in parallel.

PRINCIPLE

The total E. M. F. of a bank of cells connected in parallel is that of a single cell provided the E. M. F.'s of all are equal, but the current output is that available from one cell multiplied by the number of cells in the group.

DESCRIPTION OF THE APPARATUS

In the left hand part of the diagram (Figure 14) two electrochemical cells are connected in parallel, and the positive and negative terminals joined together through the resistance, R.

In the right hand part of the diagram four electrochemical cells are connected in parallel and their positive and negative terminals are joined together through the resistance R. This diagram shows electrical cells in parallel as they would be represented in wiring diagrams.

SPECIAL REMARKS

(1) Electric cells should be joined in parallel when the resistance of the external circuit is small in comparison with the internal resistance of the cell.

QUES.—If the four cells in the right hand part of Figure 14 *have, individually, normal current output of* 15 *amperes, what would be the current available at the negative and positive terminals of the group?*

ANS.—The four cells in parallel would furnish current of 4 × 15 or 60 amperes.

QUES.—If in the right hand part of Figure 14, *the resistance R has* 9 *ohms and the E. M. F. of the bank is* 1.5 *volts, what value of current will flow?*

ANS.—Current $= \frac{1.5}{9} =$ **0.166 amperes.**

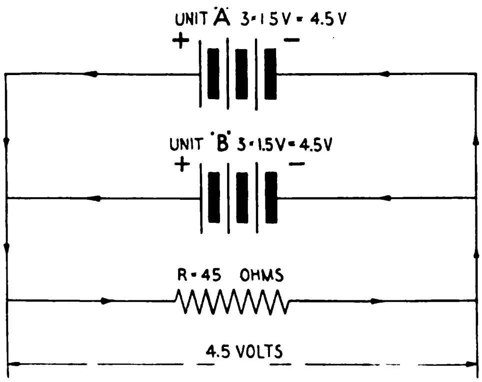


Figure 15

OBJECT OF THE DIAGRAM

To show a series parallel connection of electrochemical cells.

PRINCIPLE

Cells may be grouped in series and several units connected in parallel in order to increase the supply of current.

DESCRIPTION OF THE APPARATUS

In the diagram (Figure 15) two battery groups, A and B, consisting of three cells connected in series, are connected in parallel and their positive and negative terminals joined through the resistance, R, of 45 ohms. By this connection, the E. M. F. at the terminals is that of either group A or B, but the current supply is that available from the two groups.

SPECIAL REMARKS

(1) In connecting groups of cells in parallel, as shown in Figure 15, care must be taken to have like E. M. F.'s in each group, otherwise the weaker cells will absorb current from the stronger cells.

QUES.—If the current output of each cell of Figure 15 is 15 amperes, what will be the current available at the terminals of the external circuit?

ANS.—Unit A would have a current output of approximately 15 amperes, likewise unit B, hence the two units connected in parallel would produce a curr.nt of approximately 30 amperes.

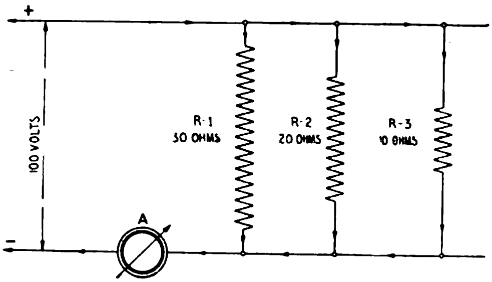


Figure 16

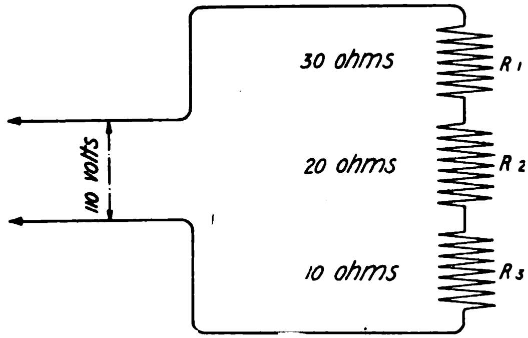


Figure 17

OBJECT OF THE DIAGRAM

To show an electrical circuit of several branches.

To show the effect of connecting several resistance coils in series or in parallel.

PRINCIPLE

The joint resistance of several unequal resistances connected in parallel will be less than that of the smaller resistance.

The joint resistance of several equal branches in parallel will be that of the resistance of the one branch divided by the number of branches.

The joint resistance of several resistances in series is equal to their sum.

DESCRIPTION OF THE CIRCUIT

In Figure 16 three resistance coils, R-1, R-2 and R-3 of 30, 20 and 10 ohms resistance respectively, are connected in shunt to a power line to which is applied an E. M. F. of 100 volts.

Three paths are thus afforded for the flow of current.

In Figure 17 three resistance coils are connected in series.

SPECIAL REMARKS

(1) The joint resistance of several resistances connected in parallel is found as follows:

$$R = \frac{1}{\frac{1}{R\text{-}1} + \frac{1}{R\text{-}2} + \frac{1}{R\text{-}3}}$$

Example:—In the circuit of Figure 15, the joint resistance of the three elements

$$= \frac{1}{\frac{1}{30} + \frac{1}{20} + \frac{1}{10}} = \frac{1}{\frac{11}{60}} = 5.4 \text{ ohms.}$$

(2) When a number of resistances are connected in series, their joint resistance is the sum of several resistances taken separately.

Example:—In the circuit of Figure 16, the total resistance of the three coils = R-1 + R-2 + R-3 or 30 + 20 + 10 = 60 ohms.

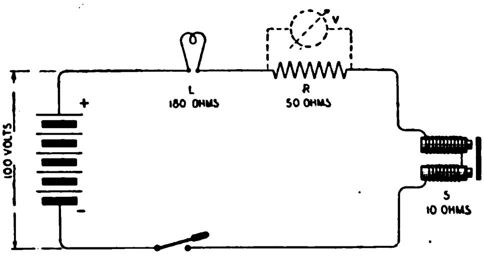


Figure 18

OBJECT OF THE DIAGRAM

To show a complete electrical circuit with a number of electrical devices connected in series.

PRINCIPLE

Irrespective of the resistance of each element in Figure 18, the current flow through each is the same.

DESCRIPTION OF THE APPARATUS

An incandescent lamp L of 180 ohms, a resistance coil, R, of 50 ohms and a telegraph sounder of 10 ohms are connected in series and in series with a battery of 100 volts.

SPECIAL REMARKS

(1) The total resistance of the external circuit is 180 + 50 + 10 = 240 ohms.

(2) According to Ohm's law $I = \frac{E}{R}$; then the flow of current (through the circuit) must equal $\frac{100}{240} = 0.41$ amperes.

DEFINITION OF PRACTICAL ELECTRICAL UNITS

The practical units of electrical measurements may be defined as follows:

(1) The practical unit of **electromotive force** is the **volt,** and by definition the volt is that E. M. F. required to maintain the flow of current of one ampere through a resistance of one ohm.

(2) The practical unit of **current strength** is the **ampere,** and it is that strength of current maintained by an E. M. F. of one volt through a resistance of one ohm.

(3) The **ohm** is the **unit of resistance** and is such resistance of conductor or circuit that permits the passage of a current of one ampere under an E. M. F. of one volt.

(4) The unit of **current quantity** is the **coulomb** which is the quantity of electricity flowing in a circuit when one ampere passes a given point during one second of time.

(5) The **watt** is the unit of **electrical power** and is equal to **one joule per second.** It is the power of a current of one ampere flowing under electric pressure of one volt.

(6) In connection with these units, the prefixes kilo, micro and milli are employed, meaning respectively 1,000 times, $\frac{1}{1,000,000}$ of, and $\frac{1}{1,000}$ of. Thus a kilo-volt=1,000 volts; a micro-ampere = $\frac{1}{1,000,000}$ ampere; and a milli-volt = $\frac{1}{1,000}$ of a volt.

QUES.—What voltage is to be expected from the average primary cell?

ANS.—It varies according to the type of construction from 0.6 to 1.75 volts.

QUES.—What is the current output of the average open circuit primary cell?

ANS.—From 5 to 30 amperes.

QUES.—What is the voltage of the average lead plate storage cell?

ANS.—From 2.08 to 2.6 volts.

QUES.—What voltage is generally used in the lighting circuits of house wiring?

ANS.—110 volts.

QUES.—What voltage is generally used on the trolley wires of the street car service?

ANS.—550 volts.

QUES.—In what branches of electrical work are extremely high voltages used?

ANS.—Voltages up to 200,000 volts are employed for the transmission of power over great distances and up to 50,000 volts for exciting the condenser circuit of a wireless telegraph transmitter.

QUES.—How is the safe current carrying capacity of a copper wire determined?

ANS.—A complete table of the current carrying capacity of various sized wires in the B. & S. gauge, is contained in the instructions issued by the National Board of Electrical Inspectors, and also in the Underwriters booklet, copies of which can be obtained in any city in the United States.

QUES.—What precaution must be taken in the installation of a power circuit?

ANS.—Care should be taken that such installations conform thoroughly with the Underwriters Rules in each city. The circuits must be insulated and in the majority of cases low voltage circuits are installed in armored cable, lead covered copper conductor or in iron conduit. Circuits carrying current at a pressure of several thousand volts must have special insulation in order to prevent breakdown.

(To be continued)

How to Become An Aviator

The First Article of a Series for Wireless Men in the Service of the U. S. Government Giving the Elements of Aeroplane Design, Power, Equipment and Military Tactics

By HENRY WOODHOUSE

Author of "Text Book of Naval Aeronautics"

UNTIL the beginning of the war we marveled at a small aeroplane radio set transmitting one mile per pound weight, but the progress made in the past two years has been extensive and at present we get three miles per pound weight.

The wireless equipped aeroplane was, at the outbreak of the war, something of a novelty; today it is an accepted factor in both military and naval aeronautics and aviator-operators are in ever increasing demand. An indication of the place occupied by the wireless operators of aircraft is disclosed in the four general rules recently defined by a British authority:

(1) See before starting that the wireless instrument is properly adjusted to send strong signals.

(2) Don't send when turning; always send when the nose of the machine is towards the receiving station.

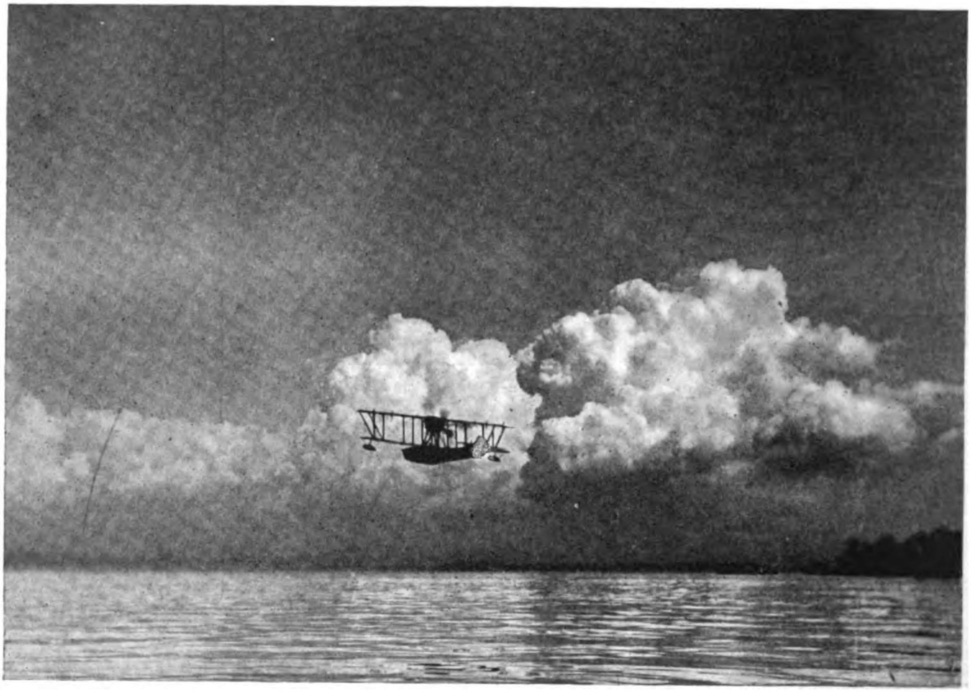
(3) Don't send too near the receiving station; a minimum distance of from 2,000 to 3,000 yards gives better results.

(4) Don't send jerkily; send evenly and remember that slow, bad sending is quite as undesirable as quick, bad sending. In sending slowly, don't stop in the middle of a word, a set of code letters, figures or coordinates.

These practical suggestions are of value, of course, only to the qualified aviator; they are given here, however, to point out to readers of THE WIRELESS AGE the definite place in aeronautics assigned to the wireless operator and to acquaint the field with the fact that many wireless men will be needed and developed when the new national program of military aviation is completed. It may be well to note also that the greatest percentage of flying men are former civilians. General W. S. Brancker, R.A., Director of the British Air Organization, has stated officially in an explanation of civilian training that the British practice is to place the candidate through a course in the cadets' school, after which "he goes through a course in the care of engines and rigging, is given some ideas of the theory of flight, and is taught wireless signaling and receiving."

This article will consider some aspects of our naval requirements, in which connection it is interesting to know that under the heading "Advanced Flying," the United States Navy requires instruction in the Flying School to include "sending and receiving radio messages in the air."

The practical application of this instruction may be instanced in the present war. Spotting the fall of shots was one of the first recognized uses for naval aeroplanes. The employment of aeroplanes for this purpose greatly extended

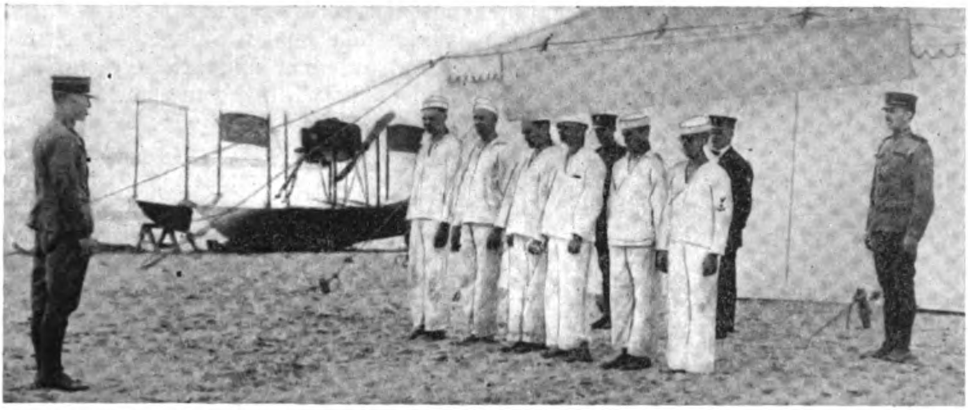


It was a seaplane of a type similar to the one here illustrated which directed by wireless the fire of the British monitors which destroyed the German cruiser Konigsberg

the range of vision of ships and became invaluable in long range, indirect, high-angle firing. The following extract from the "Text Book of Naval Aeronautics" deals with an important test of the seaplane's value in spotting gunfire. "At first this work was hampered by the lack of efficient wireless sets to be carried on seaplanes, to make it possible to the aviators to communicate with the man behind the gun. The weight of wireless sets up to 1914 was between three and five pounds per mile of transmission, which was almost prohibitive, as the seaplanes at the time had a small margin of carrying capacity. By 1916, weight of sets was cut down to one pound per mile of transmission, and the margin of carrying capacity was increased through general improvements in the construction of seaplanes.

"The first actual tests of seaplanes to spot the fall of shots took place in July, 1915, when British seaplanes were used to direct the guns of monitors to attack the German cruiser Konigsberg, which was hidden up the Rufigi River, in East Africa. The writer is fortunate in being able to present herewith the first complete report of this historic event.

"The wrecking of the German by two British monitors, one of the most remarkable events of the war, was made possible by seaplanes. Following is a letter written home by an English naval officer, which describes the aid rendered by the two aeroplanes, and shows how closely the gunners of the sea, as well as the gunners of the land, have been working as a team with the air scouts. The action described was the attack by monitors upon the German cruiser Konigsberg. It may be remembered she took refuge up the river on the east coast of Central Africa and was a menace to British interests. She was found after many months up the river where she was hidden from the monitors by palm trees.



A squad of naval aviators undergoing instruction which will insure them active service within six months

A typical aeronautical school, where instruction begins with shopwork and includes lectures, flying lessons, elementary and advanced, and aircraft station administration

Aeroplanes were procured after many weeks, and action started. The officer of the monitor Savern writes:

"We went on higher up the river, and finally anchored. Two shells fell within eight feet of the side and drenched the quarterdeck. It was a very critical time. If she hit us we were probably finished.

"We had no sooner anchored than the aeroplane signaled she was ready to spot. Our first four salvos, at about one minute intervals, were all signaled as, 'Did not observe fall of shot.' We came down 400, then another 400 and more to the left. The next was spotted at 200 yards over and about 200 to the right. The next 150 short and 100 to the left. At the seventh salvo we hit with one and were just over with the other. We hit eight times in the next twelve shots. It was frightfully exciting. The Konigsberg was now firing salvos of three only. The aeroplanes signaled all hits were forward, so we came a little left to get her amidships. The aeroplane suddenly signaled, 'Am hit; coming down;

send a boat.' As they fell they continued to signal our shots, we, of course, kept on firing. The aeroplane fell in the water about 150 yards from the Mersey; one man was thrown clear, but the other had a struggle to get free. Finally both got away and were swimming for ten minutes before the Mersey's motor boat reached them—beating ours by a short head. They were uninjured and as merry as crickets."

From this incident the prospective operator-aviator may gain some understanding of the importance of the radio man in the air service. While it is purposed in this series to outline the duties and knowledge of aircraft required in both branches of military service, this article will consider only the aeronautics of the Navy and state something of the qualifications and training. Later, descriptions of the apparatus will be included and practical suggestions given for supplementary study for those who expect to qualify for the flying service in the Signal Corps of the Army.

The regulations governing the classes for the Air Service of the United States Navy place the maximum period of courses of instruction at two years for officers and eighteen months for enlisted men. Under the present war conditions the maximum training period will not be over six months. Many aviators will be trained in considerably less time and there is no question that wireless operators will be given special consideration when applying for the aviation service, appropriations for which will be more than one billion dollars this year. Officers detailed for aeronautic duty are classed as student naval aviators, naval aviators, naval air pilots, aeroplane and dirigible, and military aviators. Enlisted men are classed as student airmen, airmen, quartermasters, aeroplane and dirigible, and aeronautic machinists.

Upon arriving at the aeronautic training station students supply themselves with the volumes prescribed by the commandant for text book study. The course of instruction begins with shopwork, and includes lectures, flying lessons, elementary and advanced flying and aircraft station administration. As far as possible, the shopwork is practical, students doing actual disassembly, reassembly, installation and adjustment of all parts of each type of machinery at the station. The same applies to the various types of aerodynamic instruments, following which weekly lectures are given to stimulate original thought and development. Meanwhile flying lessons are begun and continued until the student airman is qualified for high altitude and rough weather flying, to make spirals and steer an air course by compass.

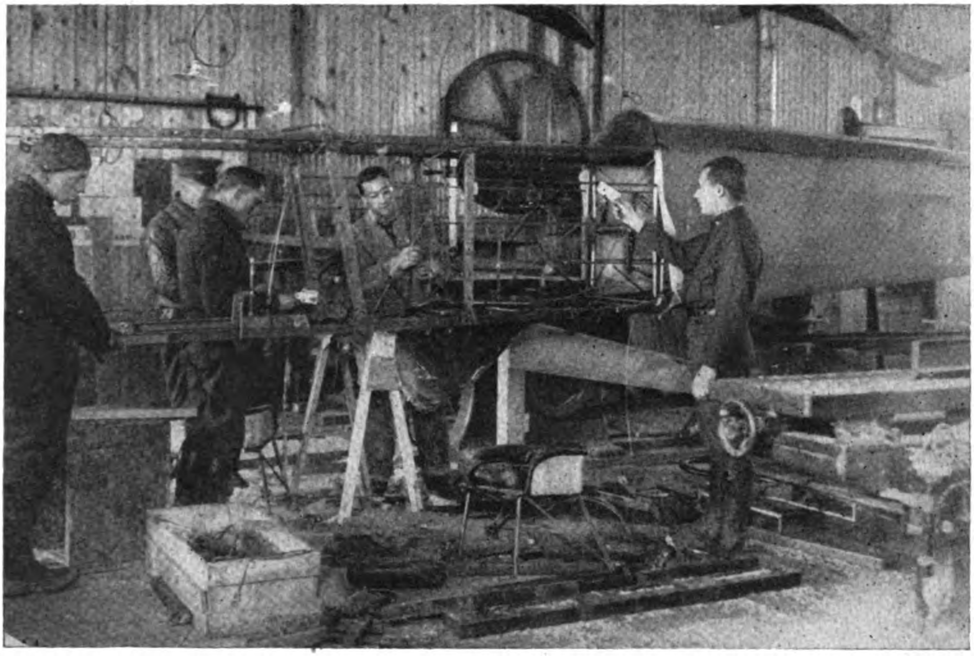
When sufficiently advanced in the shop course, the student has an aeroplane assigned to him for care, preservation and keeping its logs and records. His instruction in advanced flying then begins, under the supervision of the officer in charge of the Flying School. By actual experience he learns then to start from a catapult, to land in deep-sea waves, drop bombs, fly in formation and send and receive radio messages in the air.

While qualifying as an advanced flyer, the student is appointed a sub-inspector of machinery and aeroplane work and assistant planning superintendent. Monthly written examinations are held during the entire period, students being rated in adaptability, bearing and conduct, flying, practical knowledge and written examination. A rating equal to 62½ per cent is required in all subjects, any average below this mark being reported to the department and the student may be recommended for detachment.

To become a naval aviator the student must demonstrate ability to climb to an altitude of 6,000 feet and glide with motor idling to a normal landing within 200 feet of a designated mark; horizontal flights must be resumed twice during the descent at altitudes above 1,000 feet. Under the same landing conditions, a spiral glide must then be made from an altitude of 3,000 feet, with the motor stopped. Landings must also be made in waves at least three feet high, without damage to any part of the aeroplane. Flying in 20-mile winds or better over a prescribed course, demonstrating flying ability in very bad weather, and starting a flight from a catapult, after personally making all adjustments, are the remaining tests.

Scouting, taking sights while flying, solution of scouting problems and controlling the fire of the guns of an aeroplane must be mastered by those who, having qualified as aviators, seek the rating Navy Air Pilot.

It is obvious that these matters cannot be covered in a practical manner in



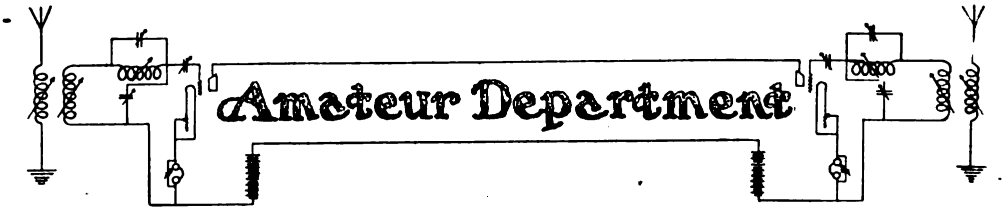
The Government requires its student aviators to do practical shopwork, actual disassembly, reassembly, installation and adjustment of all parts being part of the instruction

a series of magazine articles. A substantial amount of instruction can be included, however, and the series, of which this is the first article, will be of considerable value to wireless men who are specializing in naval communication and studying for commissions in the Signal Corps. Used in conjunction with the other two instructional courses appearing in this magazine, it is expected that valuable highly trained specialists will be made available for Uncle Sam's fighting forces from among the thousands of men engaged in the experimental field of radio.

FOR MEN WITH RADIO EXPERIENCE

Uncle Sam offers any American citizen from 18 to 35 years, with radio experience, an opportunity to see the world. Class 2 of the Naval Reserve is open for enrollment.

As this is for the period of the war, the opportunity should appeal strongly to the imagination of men of spirit who wish adventure, ever changing scenes, new countries and people. In addition to clothing outfit he is furnished excellent food and the pay is good.



Taking U. S. Government License Examinations

Hints to Candidates for Wireless Operators' Certificates

BEFORE taking the Government examination for a wireless operator's certificate, the examinee will do well to heed the following suggestions:

In complying with the request for a diagram of a standard radio transmitting and receiving set he should not fail to include the motor-generator and the motor starter. He should bear in mind that two types of hand starters are employed on Marconi commercial sets, namely, the Cutler Hammer and the General Electric Company's starter.

There is a slight difference between these two types in their construction: in the Cutler Hammer starter the release magnet is connected in series with the shunt field winding of the motor, whereas in the General Electric Company's starter, the release magnet is shunted across the D. C. line and has a small resistance coil connected in series.

In drawing the diagrams of the motor-generator, properly located field rheostats should be inserted in both the motor and generator field circuits. If the examinee elects to show the circuits of an automatic starter, he should draw one of the three types in use in the Marconi system.

The ½ K. W. 120-cycle panel transmitter is fitted with a single step starter, the ½ K. W. 500-cycle set with a two-step automatic starter and the 2 K. W. 500-cycle set with the Industrial Controller Company's multi-point automatic starter. The circuits for this last-named starter are completely shown in the book, "How to Pass U. S. License Examinations." It will be observed from the diagram in that volume that the starter not only performs this function, but assisted by an overload relay switch, it acts as a circuit breaker as well. In addition, it is fitted with a special set of contacts so that when the motor-generator D. C. line is opened, a resistance is thrown in shunt to the motor armature, thus giving a powerful braking action on the machine and bringing it to a quick stop.

In answering all questions pertaining to storage batteries or to auxiliary emergency apparatus, the student sitting for examination should bear in mind that two types of emergency transmitters are in use. On many ships the 2 K. W. 500-cycle set is operated by a 60-cell battery, but if such a battery is not in use, the auxiliary set will comprise a 10-inch induction coil set operated by a small battery varying in capacity from 16 to 30 volts. In the event that this emergency set is used, the induction coil is employed in place of the high voltage alternating current transformer, and its secondary winding is connected to the high potential condenser of the standard power set. With this type of apparatus, the length of the spark gap, of course, must be shortened and other adjustments made commensurate with the reduced power of the coil.

In drawing diagrams of both the transmitting and receiving apparatus, the student should aim for clearness and should adopt a standard method such as is shown in many textbooks; that is to say, he

(Continued on page 845)

Announcement

THE EDITOR has decided to extend the scope of this department to include general electrical experimental apparatus as well as radio telegraph equipment.

Readers who have made exceptional and unusual experimental apparatus for use in the workshop or in the home are invited to send in a complete and brief description of its construction and working, accompanied by clear drawings. Articles from amateur electricians and wireless operators who have developed devices of particular merit both in and outside of the radio telegraph field will be particularly acceptable.

In preparing such articles, it is suggested that contributors state fully:

The object of the device;
Prominent or unusual features of utility of your construction;
A detailed description of the construction;
Results obtained by actual use.

Such contributions will be paid for at a rate depending upon their merit. Prizes will be given for the better class of articles, and those which are used outside of this department will be paid for.

In addition to the articles covering experimental electrical apparatus in general, the editor will welcome articles of timely interest to the amateur field at large, such as criticisms and comments on Government legislation, unusual experiences during previous years of experimental work and suggestions for establishing amateur communications on a more scientific basis.

Experimenters who owned wireless stations in the early days—say, about the year 1904—should be able to write highly interesting articles on early experiences and attempts at communication with the type of apparatus in use at that time.

All contributions designed for the amateur field should be addressed to the Editor of the Amateur Department, The Wireless Age, 42 Broad Street, New York City.

BOOK REVIEW

Timely Book on Wireless Now Ready for Distribution

PRACTICAL WIRELESS TELEGRAPHY—By Elmer E. Bucher. Cloth Bound; 6¼ x 9½ inches; first edition; 322 pages; 323 illustrations. Wireless Press, Inc., 42 Broad Street, New York City. Price $1.50 Net.

The majority of books on wireless telegraphy have heretofore either been devoted to an historical resume of the art or to intensely theoretical explanations of high frequency phenomena. The greater part of the apparatus described is out of date, and hence the student seeking knowledge of modern commercial apparatus can obtain it only by attending wireless schools. A pressing need at present is a series of consecutive lessons in radio which will lead the beginner to a final understanding of commercial wireless telegraph apparatus.

This volume is not only one of the most comprehensive books that has appeared in the field, but it contains a wealth of subject matter which either has not been published previously, or has not been co-ordinated and placed in its proper relation to other parts of a complete wireless telegraph instruction system. The manner in which the text is prepared is particularly advantageous to the elementary student. The author describes and explains in detail the modern types of wireless telegraph apparatus up to the year 1917, beginning with the elementary principles of electricity and magnetism. The fundamentals are presented in a way that will permit the beginner to understand without difficulty the working of all types of wireless apparatus.

Three chapters are devoted entirely to elementary basic electrical principles. The motor-generator, the dynamotor and rotary converter are treated concisely and in detail. The nickel-iron and lead plate storage batteries, now supplied for emergency purposes with all commercial radio equipments are the subject of an entire chapter, a description of the apparatus associated with the charging of batteries and complete instructions for their care being published.

The radio transmitter is treated both in theory and in practice. The book contains complete diagrams, photographs and descriptions of modern commercial marine transmitters and instructions for the adjustment and operation of the apparatus. Receiving apparatus is treated in like manner, descriptions and working instructions being given for all types of up-to-date receiving sets, including the two and three-electrode valves.

A full chapter is devoted to practical radio measurements, showing in detail how to tune a transmitter and receiving set, how to measure inductance and capacity of radio telegraphic circuits, how to determine the strength of incoming signals and the method of plotting resonance curves. A complete explanation of ships' tuning records, Government tuning cards and everything pertaining to the adjustment of a wireless telegraph transmitter and receiver is published.

The emergency transmitters and auxiliary power apparatus of modern ship wireless sets are thoroughly described and illustrated. Descriptions in detail and principle of the Marconi direction finder are given and modern undamped wave transmitters and receivers are comprehensively told of.

The student, for the first time in the history of the art, is given a wide-embracing account of Marconi trans-oceanic stations. This includes their fundamental working principles, the details of the apparatus and the general plan of the great globe-girdling scheme of the Marconi system.

A series of questions appearing in the Appendix will appeal both to instructor and student. These questions relate to the text of the book and were written with the design of not only aiding the reader to obtain a Government license certificate, but to give him information regarding the apparatus for use in everyday practice.

The book is carefully arranged, each particular phase of the art being treated in separate chapters. Numerous formulae, tables and curves are given.

The Monthly Service Bulletin
of the
NATIONAL AMATEUR WIRELESS ASSOCIATION

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

A DIRECTION FINDER OF SIMPLE CONSTRUCTION

SOME amateur experimenters believe that the direction finder is an apparatus complicated and mysterious, requiring such precise construction as to be beyond their skill in assembling. That the Marconi direction finder is an instrument of precision is a fact, but nevertheless it is possible for the experimenter to construct a simple direction-finding apparatus that will give a fair degree of accuracy.

Readers desiring a detailed description and account of the theory and of the series of experiments that led to the invention of the Marconi direction finder should refer to the article on this subject which appeared in the 1913 issue of The Year Book of Wireless Telegraphy. In that article they will find a most interesting discussion by C. E. Prince. The modern Marconi instrument is treated in detail in the textbook, "Practical Wireless Telegraphy."

Briefly, the fundamental principle of the Marconi direction finder is this: Experimental trials have thoroughly proven that a triangular looped aerial will receive with the greatest intensity when its plane points in the direction of an advancing wireless wave. When its plane is perpendicular to the incoming wave, the loop will receive no induction, that is to say, both sides of the loop are acted upon equally and there will be no response in the receiving apparatus connected thereto. At any intermediate position between the two points above mentioned, the loop will be acted upon inductively and the strength of the current (induced in the loop) will be proportional to the cosine of the angle between the advancing wave and the antenna.

In the Marconi direction finder, two stationary looped aerials are employed which, through the medium of the two primary windings, act inductively upon a receiving detector circuit, the secondary winding of which is made of a ball that can be rotated on its axis. By turning this ball the general direction of a given transmitter can be found by apparatus located within the station.

A simple direction finder for amateur use, however, can be constructed in which but one aerial is employed, provided the antenna is so arranged that it can be turned in a complete circle of 360 degrees. It will not always be convenient to erect an antenna of this particular style and shape required for this device, but many experimental stations

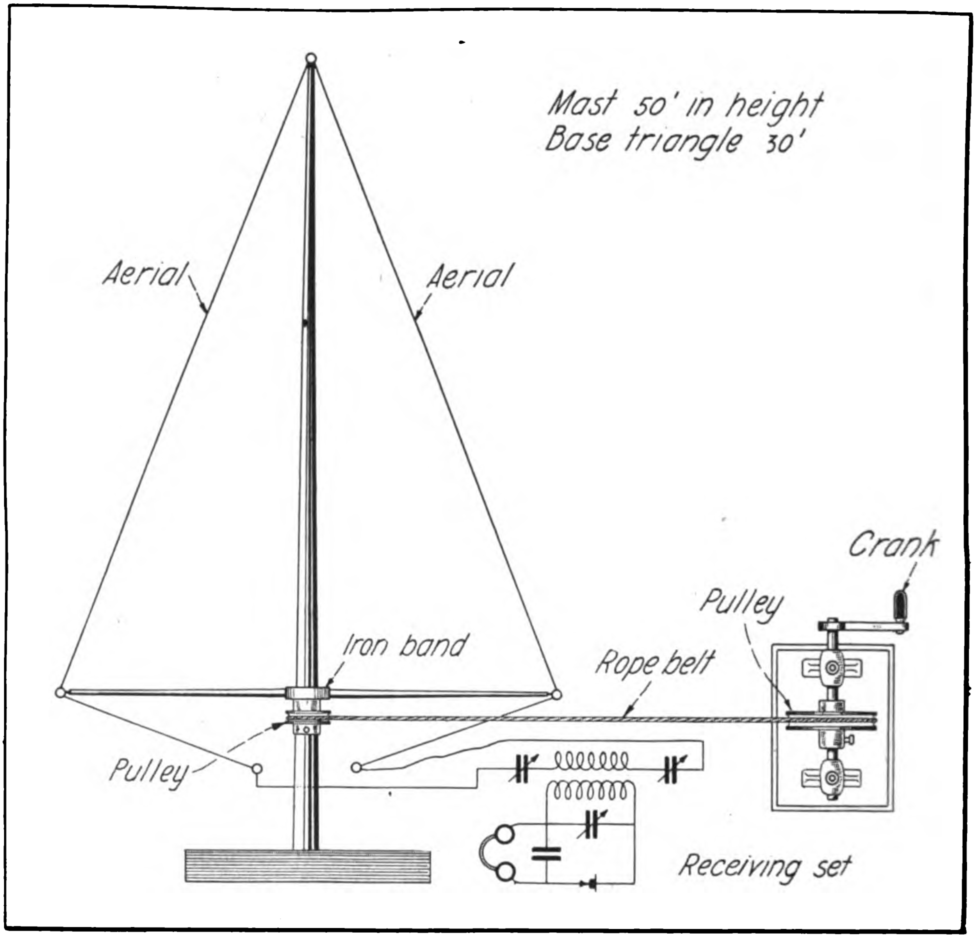


Figure 1.—Drawing showing design of direction finder

are so located that there will be no difficulty in erecting the proper structure.

The general design of the antenna is shown in Figure 1. It will be observed that the antenna has the form of an isosceles triangle, the apex of which is attached to the top of a 50-foot mast. About 10 feet from the earth, spreaders extend out from 15 to 16 feet on either side of the base, the two sides of the loop being bowed out and the lead-ins connected to the primary of a receiving tuner.

In order to find the direction of a station, it will be necessary to turn this aerial through a complete circle, and a variety of ways of doing it will suggest themselves to the experimenter. One method is shown in Figure 1, where a pulley is attached to the iron band at the base of the mast and extended within the station house to a smaller pulley to which is attached a crank. A rope belt, which is given a complete turn around the loop of the base of the mast, and also is attached to the pulley within the station house, is employed. It is necessary that the outriggers at the bottom of the mast should be attached to an iron band which fits loosely, permitting the entire antenna to be turned freely. It is also suggested that a cast iron socket be attached at the top of the mast, with a hole bored in it, to receive an iron peg with an eye through which the antenna can be threaded.

By interposing an inductance coil at the base and two variable condensers at either side, the capacity of which can be varied simultaneously by one control handle, the loop can be accurately tuned to a distant transmitting station. It will receive the maximum induction when it points in the general direction of a passing wave train.

By turning the entire antenna from one position to another, the maximum strength of signals will be obtained when the plane of the antenna points in the direction of the passing wave. The correct position is assured when the loudest possible signals are obtained in the receiving telephone.

Assume, for example, that the loudest signals are obtained from a given station when the loop points directly east and west; this will not indicate whether the passing wave is radiated from the east or from the west, but if the station, for example, is located near the ocean and signals are received at the wavelength of 200 meters, it is obvious that the station being received is located inland, unless by chance the ship should employ a wave-length of 200 meters, which is not at all probable.

Experimenters should see that the local detector circuit is coupled to the antenna inductance, and, in practice, should select the degree of coupling which will give the loudest possible signals. Beyond this to determine the direction of a given transmitting station, it is only necessary to turn the aerial on its axis. The accuracy of this direction finder will be rather surprising; in many cases a station may be located within two degrees of accuracy.

This apparatus will not only act as a direction finder, but it will permit the receiving operator to "screen out" a considerable amount of interference because, as previously remarked, any wave which advances in a direction perpendicular to the plane of the antenna will act equally on both sides and produce no current flow; in other words, the signal will not be heard.

If a sensitive receiving apparatus, such as the three electrode valve, is employed with a looped aerial of this kind, it will give nearly as strong signals as the ordinary aerial; in fact, by the use of looped aerials of enlarged dimensions signals have been received across the Atlantic ocean.

In a later issue we may describe the construction of a direction finder employing two-looped aerials which remain stationary, the direction of a given transmitting station being found by simply turning a handle attached to a receiving set within the station.

The United States Army and Navy Departments still require the services of several thousand radio operators to carry on war operations. Members of the National Amateur Wireless Association who are at least eighteen years of age and who have had several months of amateur experience, particularly those who possess first or second grade commercial licenses, should apply to the nearest recruiting office for further particulars. The N. A. W. A. should be well represented in all departments because its membership contains the most highly trained group of amateur wireless telegraphers in the United States.

Those who are not proficient enough in the telegraph code to average ten words a minute should either join a telegraph school or arrange a buzzer test outfit by which the necessary instruction can be obtained. There can be no doubt that the signalling divisions of the Army and Navy represent the most interesting and instructive fields for the patriotic young man desirous of serving his country.

Applicants who can qualify as high-speed telegraphers will naturally receive preference in appointments; hence, it behooves every member of the Association who desires to enter this field of the work to "brush up" in the telegraph code at once.

A reader writes: "The suggestions you put forth in a recent issue of The Wireless Age advising amateur operators to pay attention to their sending and to endeavor to acquire a more uniform method of forming the code characters have been noted. The points are so well taken that I wish to add my views on the matter.

"I have a criticism to offer. You have neglected to mention and segregate the various kinds of 'Morse mutilators' which we often hear. These do not exist in

Guglielmo Marconi receiving members of the Women's Division of the National Amateur Wireless Association at the Ritz-Carlton Hotel, New York City

the ranks of the amateurs alone, but may be found elsewhere. Take for example, the musical sender with the 'fife and snare drum habit,' the man who is troubled with a sort of fistic inertia; his sending sounds as if he were attempting to imitate some ragtime skit. He seems to forget that straightforward sending is not to be done to jig tunes. Then there is another type who forms his dots too briefly, but prolongs his dashes to such an extent that one receiving at the other end believes his key to be sticking. I cannot understand why all this extra effort is put in the dash. Why not save the power bill for the next dash? In other words, make the dashes of reasonable length and the dots of sufficient length so that they can be heard.

"There is still another type of sender coming within the scope of these remarks. This fellow, while transmitting to a far distant station, prolongs the code characters and slows down his speed. Evidently he believes that a slowly made radio signal will carry to a greater distance than one sent at the more normal speed of fifteen words a minute. Often we obtain the impression that such a sender is waiting for each tion before sending out the next following.

"Finally, I might mention as undesirable the fellow who hammers the atmosphere unnecessarily about 200 times while he is merely adjusting the back stop of a telegraph key, never stopping to ascertain whether he is interfering with a neighboring station or not. This type of sender will keep on 'fuddling' with the key until he accidentally gets his fingers in the wrong place, whereupon the superfluous sending stops.

"The remedy in each and every case is obvious: Promiscuous sending should be abolished. Experimenters should make the characters as Professor Morse intended, clear and uniform and above all, they should keep quiet when they have nothing to say. They should not only aim to acquire speed, but should take care to form each dot and dash correctly and uniformly without unnecessary pauses."

One of the best methods of suppressing fatal amateur legislation is to inform your congressman of instances where amateur stations have supplanted existhaps have been the means of saving human life. Tell him of the educational benefits derived in experimenting with the wireless apparatus and the fact that the services of the amateur have been of inestimable value to the War Department. Prove to him that the statements sent broadcast concerning interference on the part of amateurs are, in the majority of cases, without foundation, and that the 200-meter wave will in no way interfere with the working of a well-designed modern commercial station. Show him the possibilities of important inventions being made by experimenters whose activities are not curtailed by commercial demands and point out particularly that there are a few, if any instances, where an amateur station has done direct harm to the United States Government or to the operation of its stations.

TAKING LICENSE EXAMINATIONS

(*Continued from page* 838)

should use the symbols generally employed in wireless telegraph diagrams and should try to draw them in the simplest way possible, making sure in so far as possible, to keep all parts of the transmitting or receiving apparatus in the place where they actually belong in relation to other equipment.

It will be difficult to show the functions of an antenna change-over switch unless the operator has some knowledge of perspective drawing. If he is unable to make such a drawing, he should make a plan and elevation sketch, explaining briefly just how the various contacts function, and what office they perform in the different circuits. Particular care should be taken not to have an open circuit in any part of the wiring diagram, and above all, to avoid a haphazard method of drawing.

When giving a circuit diagram of the receiving apparatus, the student should remember that there are two methods in use of connecting the potentiometer in the local circuit of the carborundum crystal. In one circuit the potentiometer and head telephones are connected about the crystal and in another circuit about the fixed or stopping condenser. In the latter method, the current from the local battery circuit flows through the secondary winding of the tuning coil.

To turn to another phase of the examination—every student operator should strive to acquire skill in penmanship. It is a surprising fact that although many students have the ability to receive at a speed of from twenty to thirty words a minute, they cannot write legibly as fast as this. The result, oftentimes, is that when called upon to write at a speed equal to that of the reception of signals, their handwriting is so poor as to be undecipherable.

It should be kept in mind that a knowledge of the International Telegraph Regulations and the United States Navy Regulations is important. All students of wireless are expected to have an understanding of the more important rules, and particularly of the use of the "Q" signals by the use of which official conversation concerning traffic is carried on.

Careful attention to these matters will not only save the examining officials much trouble and labor, but will also tend to increase the efficiency of the radio operator; in short, it will offer more assurance of success in the examination.

The Marconi high-power stations at Glace Bay, Nova Scotia and Clifden, Ireland, have maintained for several years a twenty-four hour operating schedule for the transmission of trans-Atlantic traffic. A unique feature of these stations is the use of 15,000 volts direct current to charge the high voltage condenser, the source of current being 7,000 storage cells connected in series.

In place of the usual oil plate condenser, air condensers are employed which consist of a number of metallic sheets suspended on high voltage insulators, the di-electric being air at atmospheric pressure.

Both of these stations are arranged for duplex working, a transmitter and receiver on either side of the Atlantic being separated fifteen and thirty miles.

INCREASING THE RANGE OF SETS

I have read with interest the reports in The Wireless Age of the remarkable distances "covered" by amateurs of the West and the Middle West. It is generally believed by experimenters that small spark coils will not work well with an oscillation transformer, but I believe that if the average experimenter would take the trouble to construct one of the correct proportions and dimensions, the range of his apparatus would be noticeably increased.

For the maximum degree of efficiency it is quite necessary to tune the set by means of a hot wire ammeter and a wavemeter. If the experimenter does not possess the funds to purchase an aerial ammeter, he may make use of an ordinary 110-volt, 4, 8 or 16 candle-power lamp, connected in series with the aerial, with a fair degree of accuracy. Satisfactory constructional diagrams of both the hot wire ammeter and wavemeter, have appeared in previous issues of The Wireles Age and in the book "How to Conduct a Radio Club."

I tuned my transmitting set by means of a lamp such as mentioned, and, of course, did not thereby obtain the maximum efficiency but afterwards the set was tuned by means of a wavemeter constructed after the plan described in a previous article in The Wireless Age.

As a source of high potential I use one of the Duck Company's 2-inch spark coils operated by a 6-volt battery. With this transmitter, in time of peace, I can pick up IABO, South Meriden, Conn., about 18 miles distant from here, any hour of the day provided the owner of that station happens to be listening in. One day I was particularly surprised to hear that my signals had been picked up by the owners of IZZ, an amateur station located in Farmington, about thirty miles from here, but the signals were so weak that he could barely read me. This work was accomplished by using a coupling between the primary and secondary windings, separated by about 2½ inches.

The achievement of A. Petrie (station IEMP), located a couple of miles from my station is still more remarkable. He employs an oscillation transformer, a Manhattan 1-inch spark coil, condenser, stationary gap and a 4-volt battery, the entire set being tuned in the same manner as mine and the emitted wave being approximately 200 meters. With this small set his signals have been repeatedly copied by IABO, at a distance of about twenty miles. This, I believe, to be remarkable for a 1-inch spark coil operated from a 4-volt battery.

Florian J. Fox, *Connecticut.*

The United States Radio Regulations specify that the logarithmic decrement of the antenna oscillations in a spark transmitter must not exceed .2. This means that there must be at least twenty-four complete oscillations in the antenna circuit for each spark discharge at the gap. Modern spark dischargers, when properly adjusted, often give an antenna decrement of .03 per complete cycle which means that 150 complete oscillations take place for each spark discharge at the gap.

A properly adjusted spark gap is one which gives a clear spark discharge and does not permit the retransference of energy from the antenna circuits to the local spark gap circuit, once the antenna circuit is set into oscillation.

The decrement of a transmitter is measured by an instrument known as the decremeter which is simply a wave-meter with some sort of indicating instrument connected in series.

Ship's aerials in commercial radio service have either 4, 6 or 8 wires connected in parallel. It is found in the average case that four wires fulfil the requirements, but when the space for erection of the antenna is limited, eight wires are frequently employed in order to obtain the maximum possible capacity.

In the year 1873 James Maxwell presented a masterly treatise on electricity and magnetism and predicted the existence of electrical waves.

Marconi's first British patent for wireless telegraphy was filed June 2, 1906.

From and For those who help themselves

Experimenters' Experiences.

FIRST PRIZE, TEN DOLLARS

Reading Radio Signals With the Capillary Electrometer

I have found that the capillary electrometer originally described by Professor Lippman to be useful for reading radio signals by sight.

A description of the instrument follows: Referring to Figure 1, C is an ordinary soft glass tube, say one-fourth inch bore, and bent as shown. It is filled nearly to the top of the shorter limb with pure mercury. On top of this a

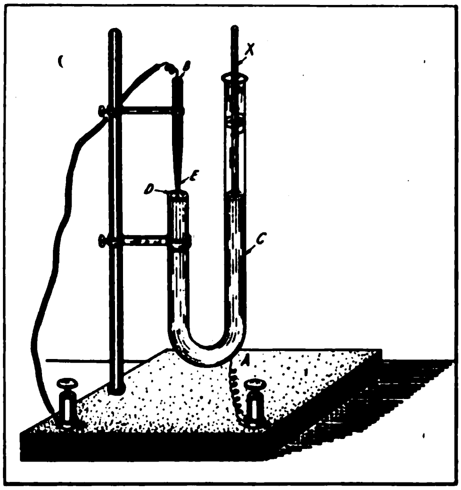


Figure 1, First Prize Article

small amount of twenty per cent. pure sulphuric acid is poured into D. Dipping into the acid is a small piece of capillary tubing drawn out to a very fine point at the lower end, E, and which is filled with clean mercury. It is necessary to construct several of these points of different lengths and degrees of fineness to find by trial the one which gives the best results with the particular instrument in use. In any case the point must be fine enough to prevent the mer-

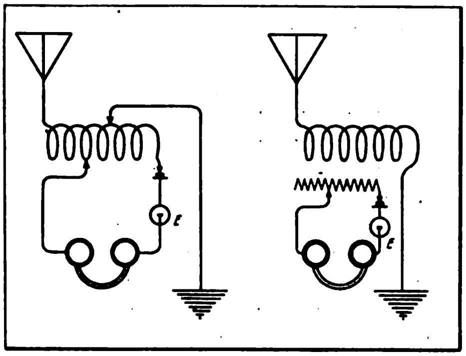


Figure 2, First Prize Article

cury running through by its own weight. The finer the tube is drawn out, the higher must be the column of mercury in the capillary tube. The inner bore should be about as fine as a human hair, but not too fine, otherwise the instrument will operate at a disadvantage.

X is a rod of ebonite or hard rubber which may be attached to the longer limb by a clip. It should be raised and lowered in the mercury until its level is properly adjusted.

To adjust the instrument for use, dip the point, E, into the sulphuric acid at D, and force the mercury out by blowing with the lips through the capillary. (*Don't Swallow.*) When the mercury is bubbling through the point in minute drops, stop blowing. It will then be drawn back for a short distance by capillary attraction and the sulphuric acid will follow up as it retracts.

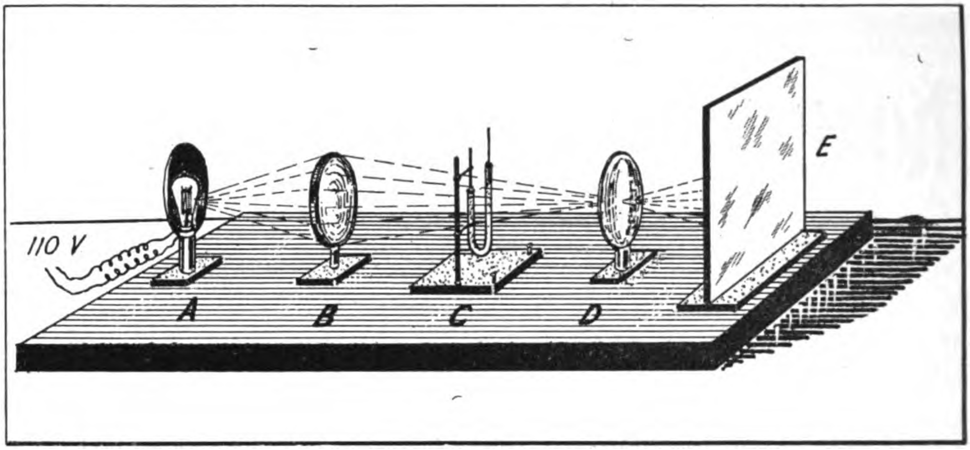


Figure 3, First Prize Article.

Connections brought to suitable terminals are made to the mercury at A and B with short pieces of platinum wire.

The vital point in connection with the operation of this device is that the most minute difference in potential set up between the two masses of mercury will, by affecting the surface tension, cause the fine point at the junction of the liquids at E to move perceptively up or down. The direction of motion will depend upon the direction of the flow of the current through the junction. So sensitive is the instrument that a motion is observed with the aid of a low power microscope even when the fingers are laid across the terminals.

If the electrometer be connected directly between the aerial and the earth, it will not be affected by wireless signals, but it is interesting to observe how it indicates varying electrostatic charges on the aerial wire. It is especally active during a thunderstorm and it is often possible by its use to predict within a few seconds when a flash of lightning will occur. As the potential rises on a charged cloud, perhaps many miles away, an opposite charge of increasing magnitude is indicated on the aerial and the little mercury column moves in sympathy a relatively long distance up and down. Then the flash occurs and the column falls back again with a jerk.

In order that the instrument may respond to wireless signals, the oscillating current must first be rectified; therefore a crystal detector is connected in series. The complete circuit is shown in Figure 2, where E is the electrometer. It is worth while to note that the telephones can be left in circuit with the electrometer and it is possible to read signals from the station in the ordinary way and at the same time to observe through a microscope or on a projected screen (which is preferable) the little column of mercury rising and falling in step with the audible spark signals.

It will be obvious that, after the column is once in proper adjustment the recording of signals is merely a matter of substituting an ordinary photo recording drum with suitable screening arrangements. Such an instrument, if made carefully, can be used in a variety of ways. For instance, by fitting a small electromagnet and a pencil, an excellent record of one's sending practice can be obtained. It can be also used to record earthquake shocks since the working parts of a seismograph are fairly simple to make. There are many other uses for the electrometer.

The general arrangement of the recording apparatus is shown in Figure 3. A is a powerful source of light (40-watt lamp), preferably with some sort of reflector; B a ground glass screen to distribute and diffuse the light; C the electrometer; D a double convex lens; E a plain white screen.

These parts are to be adjusted until the image of the electrometer tube is increased to four times its actual size. The image will be inverted. The connections at the electrometer must be reverse if necessary so that the image moves downward during the reception of a radio signal.

If the image be magnified about four times and the top of the column be marked by a dot of ink on the screen, when all is quiet, a downward movement of about one-fourth or one-third of an inch can be noticed from a distant station, while nearby commercial and powerful amateur stations cause the column to move one-half inch or more. The movement during the reception of very rapid signals was between one and three millimeters. This is ample for controlling a light spot. When the image is sharply focused, the screen is removed and the recording drum substituted.

Inasmuch as there are a great variety of simple recording drums open to the experimenter, that matter will not be discussed; in fact, the idea of substituting a recording drum is optional.

HERMAN EDWARD WERNER, *Ohio.*

SECOND PRIZE, FIVE DOLLARS

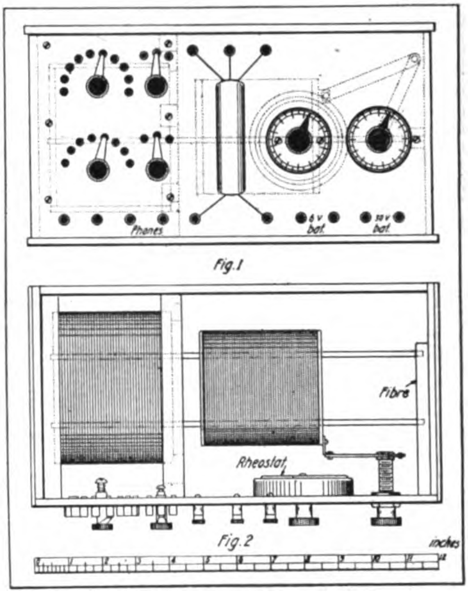
A Regenerative Receiving Set of Compact Design

One type of receiving apparatus which, above all else, held the attention of the amateur before the Government closed the amateur stations, is the regenerative tuner. While the amateur is for the time being, prevented from using wireless apparatus, there is nothing to hinder him from building new apparatus and have it ready for use when the Government restrictions are removed. With this thought in view, I shall describe a regenerative tuner which I have constructed and which gave excellent results on the 200-meter wave.

The cabinet shown in Figure 1, made of either maple or mahogany, is 12 inches in length and 6½ inches in width.

The primary winding of the inductively coupled tuning transformer is wound with eight turns of No. 22 D. C. C. wire. Taps are taken off every turn for the first ten turns and are brought out to a ten-point switch on the panel. A tap is then taken off every ten turns until eight taps are made. These, of course, are connected to an eight point switch.

The secondary has the same number of turns as the primary, but the winding is divided into three groups and three



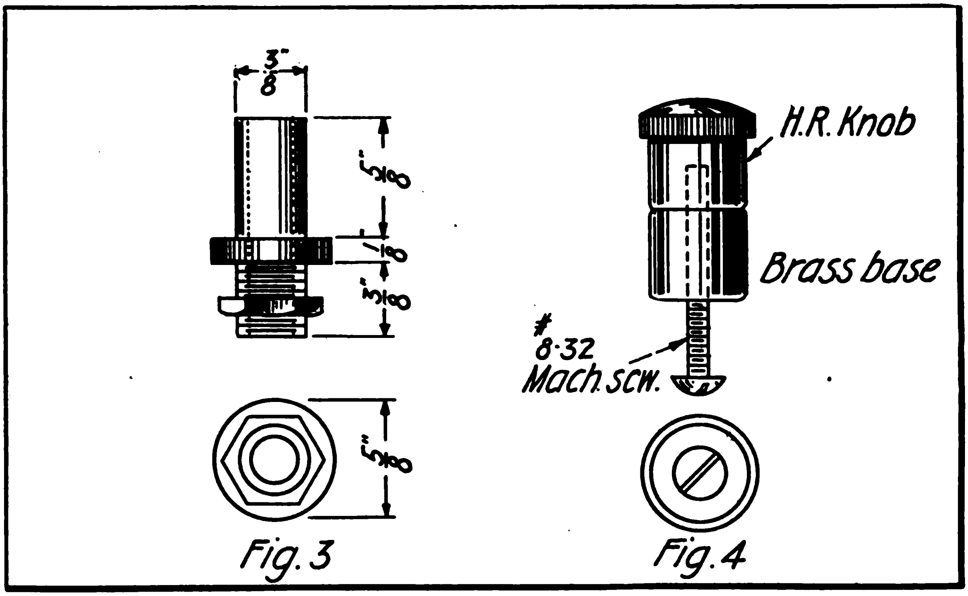
Drawings, Second Prize Article

taps are brought out through flexible cords to a three-point switch.

As will be noted from Figure 1, the secondary is moved in and out of the primary by a knob mounted on the front of the case by means of two brass strips constructed as shown to the right hand of the drawing. The longer of the two strips is 3 inches in length and the other 2½ inches in length. The 2½-inch strip is fastened solidly to a 3-16-inch brass rod which extends through the bushing shown in Figure 3 to the front of the panel upon which a knob and pointer are fastened.

The panel itself is of hard rubber or of bakelite. The scales for the various elements can be stamped on and filled in white, which gives them a very neat appearance.

The resistance for controlling the filament current of the vacuum valve is of the porcelain base type familiar to all amateurs. It is mounted directly on the



Drawings, Second Prize Article

panel. The high voltage batteries and control switches are mounted in a separate box and are connected to the binding posts shown in Figure 1. The variable condenser is screwed to the top of the cabinet and leads are brought down through to the panel.

Referring to the diagram of connections (Figure 5): A loading coil can be placed in series with the primary although it is not absolutely necessary. This coil can be made by winding 100 turns of No. 22 D. C. C. wire around a tube 6 inches in diameter, with the taps taken off every ten turns.

B, B, in the diagram are small stopping condensers made by covering both sides of a piece of mica, 2 inches by 1 inch, with tinfoil.

John B. Coleman, *Pennsylvania.*

THIRD PRIZE, THREE DOLLARS

A Multi-Contact Switch for Receiving Tuner Circuits

I have designed a multi-contact jack switch which may be put to a variety of uses in amateur receiving sets, particularly in changing the connections of a tuner for either the vacuum valve or a crystaline detector. I find that a switch of this type is inexpensive and can be constructed by anyone who possesses a small amount of skill and a large amount of patience.

I would advise the reader to follow my instructions thoroughly, as I have built several of these switches and have found, after trying several different designs, the construction shown to work the best.

The first part in the order of construction is the L arm or standard which supports the spring contact. As this arm is no part of the electrical circuit, it can be made of iron. It is also superior to brass because it is more rigid and in addition it can be heated to red heat and

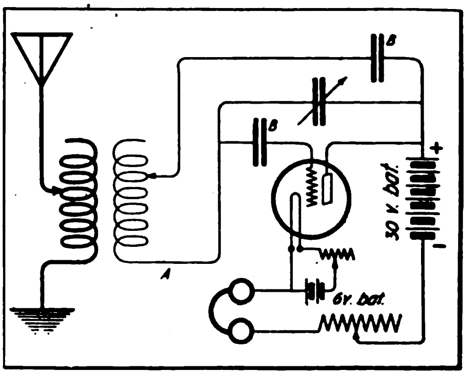


Figure 5, (diagram of connections) Second Prize Article

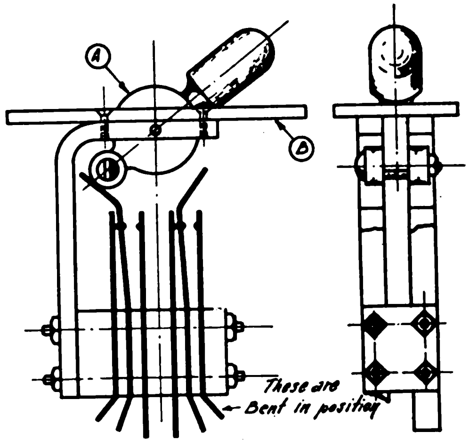


Figure 1, Third Prize Article

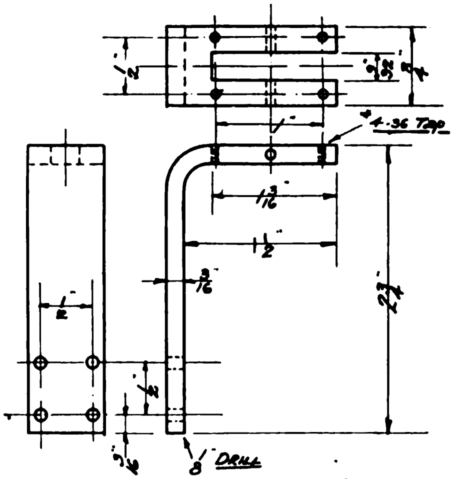


Figure 2, Third Prize Article

bent into position. If a piece of brass, for instance, were used, it would have to be bent cold and would be a much more difficult job. In addition, it will be found somewhat easier to tap the iron for the necessary machine screws.

After this part is constructed, the piece, A, can be made. It is constructed of brass and fitted with a hard rubber knob. It is mounted in position by means of a small pin or shaft so that it will rotate easily.

After this is completed, the hard rubber top can be made and a slot cut to take piece A so that the handle at the top can move freely from side to side.

In order to facilitate the easy moving of this switch, small roller bearings, made of fibre three-sixths of an inch in diameter and one-fourth inch in length are fitted on the lower end. These are mounted on a small stud or shaft which is then riveted over to prevent the rollers from becoming loose. Some may prefer to attach these rollers solid, but it should not be done, if possible, as the switch will work more easily if constructed in the way that I have described.

The springs should now be made and shaped according to the drawing. There are twelve in all. These are separated by pieces of fibre which can be made up of small thicknesses until the right position is obtained for each

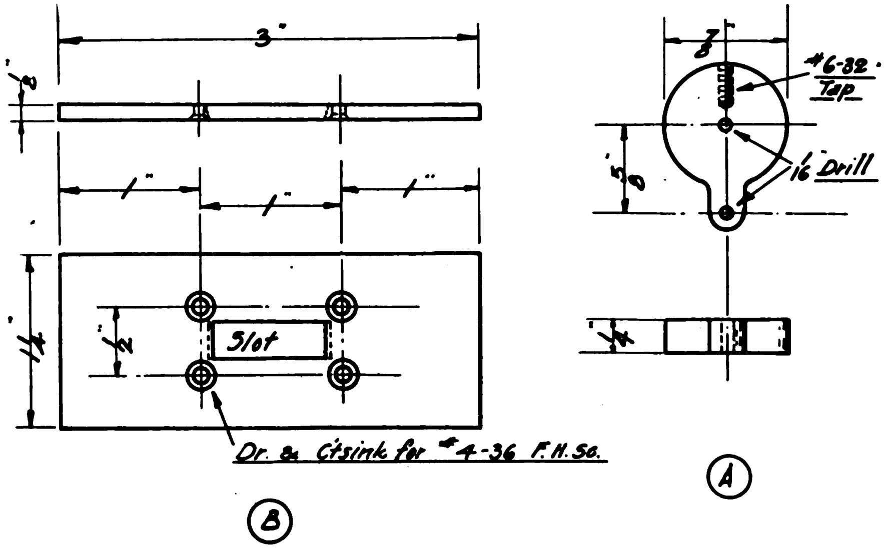


Figure 3, Third Prize Article

contact. In the building of these strips, it is best to drill one at a time and to use the holes in the standard for a template. The entire switch is then assembled and the spring bent in proper position as shown. To insulate these springs from the rods, the latter should be wound with a couple of layers of Empire cloth.

The knob shown for throwing the brass relay from right to left can either be made or purchased. It should be at least ½ inch in diameter, as this size brings the lever to a stop at the proper distance. I made my knobs of red fibre, which seem to present a good appearance in contrast with the hard rubber black top.

This switch can be mounted flush on the panel of a receiving set and will make a very neat appearance. By merely shifting the lever, any amount of connections or disconnections can be made according to the inside wiring. The details of construction of the switch are shown in Figures 2 and 3. The connections for this switch will be readily understood by the experimenter.

Omer E. Cote, *Rhode Island.*

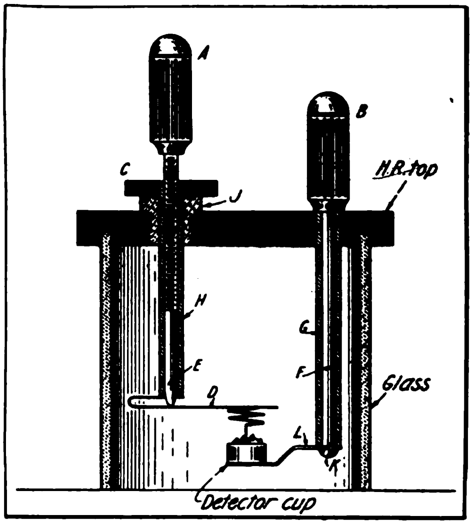
FOURTH PRIZE, SUBSCRIPTION TO THE WIRELESS AGE

A Dust-Proof Detector Which Overcomes Difficulties

To a considerable degree the accompanying drawing of a dust-proof detector I have used is self-explanatory. No dimensions are given as it can be constructed according to the materials at hand in the amateur workshop.

The crystal is mounted in a glass containing case which is an ordinary oil cup glass, such as used on gasoline engines. The top is made of hard rubber grooved to fit the glass. The brass bushing, J, should fit tightly or screw into the top; similarly the brass tube, G. The brass tube, H, should fit tightly enough to prevent it from turning in the bushing when the knob, A, is turned. A hard rubber knob, C, is fastened to the top of the tube.

A flat brass spring is soldered to the side of A and bent directly over the end of the tube. A spiral of No. 28 or No. 30 copper wire is soldered to the end of the spring to make contact with mineral in the detector cup. The cup is supported by spring L which is fastened to the end of rod F. This rod should not turn too

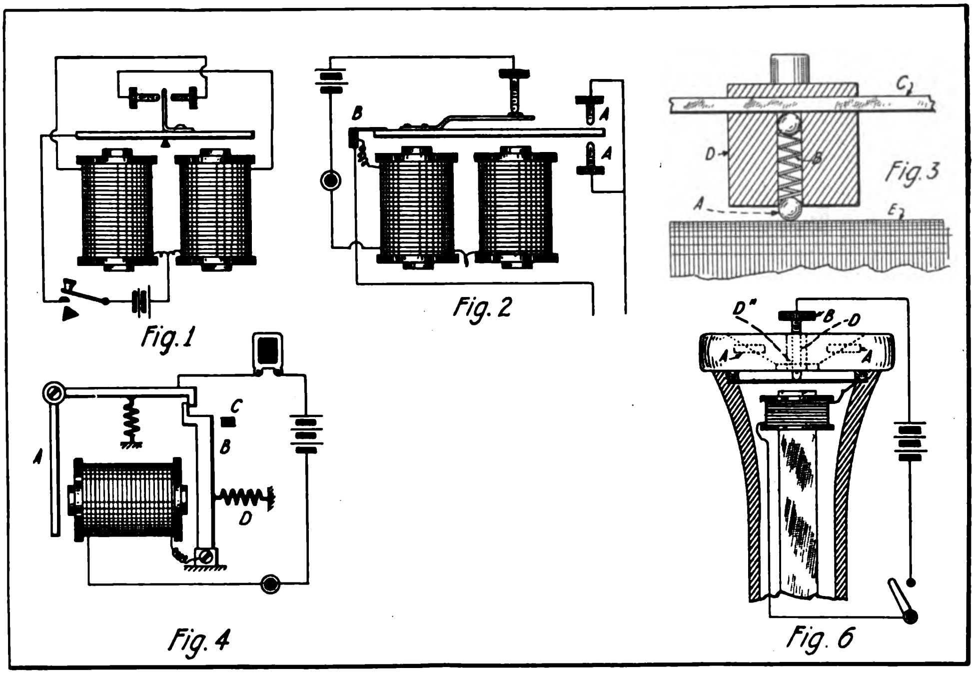


Drawing, Fourth Prize Article

freely in the tube, C, and it is adjusted by the knob, B. The hole in tube H should be small enough to be threaded with an 8-32 tap at the top for about a quarter of an inch. The remainder of the tube is drilled out with a No. 18 drill to clear an 8-32 screw. The spring, D, should be of such length as to permit the point at the end to reach the farthest point on the crystal when the cup is in the center. By alternately turning knobs A and B all points of the crystal can be reached and an extremely fine adjustment, which is hard to knock out, secured.

The detector is held firmly to the base by two one-eighth inch rods, threaded at each end and placed just inside of the glass tube. Up to the present my chief difficulty with the crystal detector has been not only a matter of the accumulation of dust on the crystal; the poor method of adjustment which the average holder afforded was disheartening. With the detector herein described, these difficulties have been wholly overcome, and besides it does away with the inverted crystal heretofore employed to prevent the accumulation of foreign matter.

Roy Hoffman, *Nebraska.*



Drawings, practical applicdtions of the electromagnet

HOW THE ELECTROMAGNET CAN BE PUT TO PRACTICAL USE

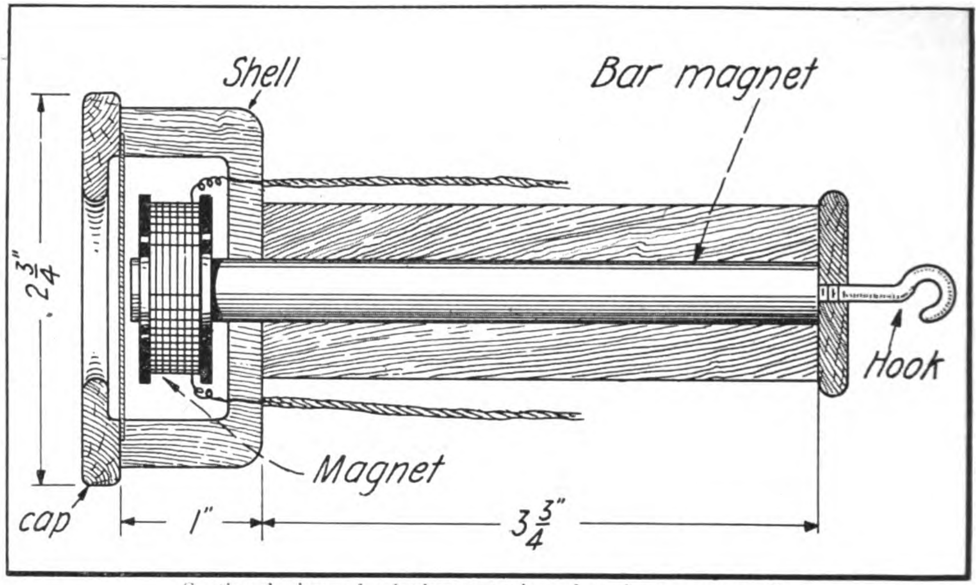
Before describing the various ways by which the electromagnet can be put to practical use in the experimental workshop, I should like to state that I have received my first copy of THE WIRELESS AGE and I am delighted with it. I like particularly the department "From and For Those Who Help Themselves" and best of all the "Queries Answered" department.

I have found that the simple electromagnet is one of the most important features of equipment about the average amateur station. The accompanying drawings show how it can be put to practical use.

Drawing No. 1 is a double action buzzer which is so simple that it needs no explanation. Drawing No. 2 shows how an electromagnet can be adapted for use as a tikker and thereby make audible undamped oscillations at any receiving station. If the spring on the vibrator is attached firmly to the soft iron armature, a very high rate of interruption will be secured, although if the spring is rigid a fairly high rate will be obtained with the ordinary construction. The circuit to be interrupted is of course, connected through the armature, B, and the opposite terminal of the circuit to either side of the stationary contact, K.

Drawing No. 3 shows a slider particularly suitable for fine wire tuners and giving the great advantage that it does not wear off the wire. In the drawing two ball bearings are shown at A; B is a spiral spring and D a copper tube built as shown. C is the slidder rod and E is the top of the tuner.

Drawing No. 4 shows a magnetic break arrangement which has to be set each time it is used. It is useful where only one surge of electricity is required to manipulate certain apparatus. When A is drawn towards the magnet, the lever, B, is released which spring D pulls back against C, thus breaking the circuit. This particular arrangement would have



Sectional view of telephone receiver for short amateur lines

better application on time clocks and similar apparatus.

When the D. P. D. T. switch is thrown over only one-half of the coil is in use, and the sliding contact can be progressively run over its turn, but if the switch is thrown to the opposite position the other half can be put into circuit and the tuning can be varied from this point on to the maximum value of inductance. This arrangement is especially adaptable to loading coils for the reception of long wave-lengths.

In drawing No. 6 is shown an arrangement whereby telephone receivers can be converted into a high frequency buzzer. At A are shown braces driven half way into the top of the receiver, and at B a contact screw which is held in place while the cavity is filled with plaster Paris and allowed to dry. The connections are made as shown. The buzzer is adjusted by screwing down the contact screw until contact is made with the platinum point mounted on the telephone diaphragm. I have found this to be a very efficient high frequency buzzer for testing the sensitiveness of wireless crystals.

ERWIN F. GRAY, *New York.*

AN INEXPENSIVE TELEPHONE RECEIVER

The telephone receiver of the type shown in the accompanying drawing is satisfactory for short amateur telephone lines, and although it may appear difficult in construction the exercise of a little time and patience will bring the desired results. A receiver of this type can be made from a piece of curtain pole 3¼th inches long and about 1⅛ inches in diameter. A hole ⅜ths of an inch in diameter is bored along the axis throughout the entire length. This is to hold the permanent magnet. The shell of the receiver is a cup-shaped piece of hard wood, 2½ inches in diameter and 1 inch in depth. It will have to be turned on a lathe. Its exact shape and dimension will be better understood by examining the drawing. The shell is attached to one end of the curtain pole with a good grade of glue.

The permanent magnet shown is a piece of hard steel, ⅜ths of an inch in diameter and 4⅝ths inches in length. The steel will have to be tempered or hardened before it will make a suitable magnet and this can best be done by a blacksmith who will heat the rod and plunge it into the water when at the right temperature.

One end of the steel bar is fitted with two thick fiber washers about ⅛th of an inch in diameter and spaced ¼th of an inch apart. The bobbin so formed is wound full of No. 36 B. & S. gauge single silk-covered magnet wire. The ends are passed through two small holes in fiber washers and then connected to a pair of heavier wires.

The wires are run through two holes in the end of the curtain pole, passing lengthwise from end to end, parallel to the hole bored to the receiver bar magnet.

The bar magnet is then pushed through the hole until the end of the rod on which the spool is fixed extends slightly below the level of the edges of the shell.

The two wires leading the magnet are run along the inside of the bar magnet and terminate. A suspension hook is attached to the receiver as shown. The diaphragm can be bought for ten cents. The magnet should fit into the hole very tightly so that it will not change its position, in fact, it should be fastened in place by set screws.

CLYDE R. BATTIN, *Ohio*.

A CARD INDEX OF AMATEUR STATIONS

Having an extra card index in my station which has been of inestimable value, it occurred to me that a similar one would facilitate the work of all experimenters, particularly those owning the more important amateur stations. The general plan I have put into use may be of interest to the readers of THE WIRELESS AGE.

Important or well known amateur stations were indexed, of course, according to station call, and then the location and distance from my station were jotted down. The balance of the card was used for other station information, such as could be gleaned from the magazines, and from acquaintance with the owners. Thus a sample card would be made up as follows:

> 9 ZF, Smith & Doig.
> 848 So. Emerson St., Denver, Colo.
> Wave: 425800.
> Power: 1 k. w. Hytone.
> Description of set in May W. A.

In this way the amateur can become more familiar with the apparatus used by other experimenters, and he will have less trouble in choosing suitable instruments for his own set.

This same idea can also be applied to the information found in technical magazines on wireless subjects. I find it very helpful to jot down a note of every bit of valuable data I find in responsible publications, and then card index it. Then, at a later date, I can at once refer back to all the subject matter on a particular subject that I have in my magazines, which saves a lot of time and worry.

ARNO A. KLUGE, *Nebraska*.

The vacuum valve detector can be used to amplify the incoming signals of a radio station in a number of ways.

In the regenerative system, the amplification is effected by coupling the local telephone circuit to the grid circuit through the medium of a direct or inductive coupled oscillation transformer. Either the currents of audio or radio frequency can be amplified individually or by the use of an audio and radio frequency transformer, simultaneously.

In the cascade system of amplification, the strength of the incoming signals may be progressively increased by transferring them from bulb to bulb, and as in the regenerative system, either the currents of audio or radio frequency can thus be strengthened.

In the radio-frequency cascade amplifier, the local telephone circuit of the first valve is coupled to the grid circuit of the second valve, and so on throughout the series, the valves being coupled together through a conductively or inductively-coupled transformer. As many as six bulbs have thus been connected in cascade, but three bulbs only are ordinarily required. The radio-frequency amplifier permits a remarkable degree of selectivity in tuning out interfering stations.

Suggestions and Ideas for the Wireless Inventor

Timely Discussion on Unsolved Problems of the Art

DESPITE the scientific research that has been brought to bear upon the developing and perfecting of radio telegraph apparatus, there still remain certain unsolved problems which offer to the experimenter, with the time and facilities for carrying on such investigation, an unusual opportunity for original work. In fact, it may be said that the further development of radio telegraphy presents a practically unlimited field.

The all-important problem in commercial radio telegraphy is that of the total elimination of atmospheric electricity at the receiving station. The present methods of combating this interference consist in the use of a high-pitch spark note at the transmitter, the employment of abnormal power at the transmitter to give a strength of signals that can be heard above the roar of the atmospheric discharges and the use of special means at the receiving station.

The Marconi balanced valve receiver has helped largely to eliminate the crashing charges of static electricity in the telephone receivers, but the radio field still awaits the development of a device that will wholly eliminate this disturbing element. Another method of eliminating this interference is found in special adjustments of the three-element vacuum valve. If advantage is taken of the volt-ampere characteristic of this valve, then by manipulation on a certain critical point on the characteristic curve, the effect is to limit the production of sound in the local head telephone. This reduces the interference of crashing static discharges to a considerable degree, particularly when the "beat" method of reception is employed.

A direct advantage of a static eliminator would be that it would permit communication over extremely long distances with small amounts of power at the transmitter. To hasten the solution of the problem, a new principle must be discovered and, working under its guidance, an earnest student must construct some device which will permit only a uniform alternating current to pass through it, and will not be responsive to an irregularly pulsating aperiodic or alternating current. If this obstructor were placed in series with the antenna system, the heavy intermittent discharges of static would be eliminated. The requirements of the transmitter would be met by using a radio-frequency alternator or a battery of vacuum tube oscillators.

If the reader doubts the possibility of such a device, how will he account for the marvellous development in the application of the pure electron discharge for the production of radio-frequency currents (the conversion of D. C. into A. C.) for magnifying the incoming signals at the receiving station and the use of the electron bulb for the control of the antenna current? The possibility of the employment of these devices for such control was not even imagined or hinted at a few years ago. If the reader will reflect for a moment on the marvellous advances made in the past several years in the development of the vacuum valve, the probable evolution of an apparatus such as we mention will not seem so absurd after all.

The second problem which should draw the attention of all experimenters who have access to a fully equipped laboratory, is producing a vacuum valve oscillator which, in a single bulb, will convert direct current at a power of 2 K. W. into alternating current at a frequency of 500,000 cycles a second, i. e., invent a valve that will be useful for transmission of electric waves at the length of 600 meters. A transmitter of this type would, of course, require a complete change in present day ship station receivers, but if we take into account the selectivity obtainable by the use of undamped waves, the desirability

of this source of radio-frequency current will become apparent.

A device that remains to be perfected not only for use in radio telegraph work, but in other lines of electrical application as well, is the magnetic or hammer interrupter for induction coils. Years of thought and labor accompanied by the expenditure of large sums of money have so far failed to produce an efficient, continuously-operative interrupter that would handle, say, 1 K. W. of direct current.

If some inventor would devise a high-speed interrupter, one that would interrupt the primary circuit of an induction coil, let us say, at rates varying from 500 to 700 times a second and which would convert 2 K. W. of direct current into 15,000 volts alternating current, we would not only have a convenient means of attaining high voltage current, but also would be enabled to do away with the expensive motor-generator and accessory controlling devices which must now be installed on every vessel for use in connection with the wireless apparatus. This is a problem which can be undertaken by a radio amateur, a mechanic, or an electrician, even though he does not possess the most modern working equipment; money and fame await him who solves this vexed question.

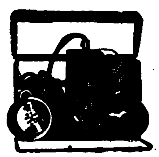
Another way in which the time of the experimenter can be profitably utilized is in trying to discover some new basic principle whereby the waves of wireless telegraphy can be directed and confined to a definite zone. This is already possible by means of the Marconi directional flat top aerial or the Bellini-Tosi triangular aerial, either of which confines the greater part of the radiated energy to a definite direction; but what is wanted is a system that will confine the radiation to a very narrow zone. Such a system would prevent interference with other stations, even though several close to one another operated on the same wave-length.

The improvement of wireless receiving detectors offers an excellent opportunity for closer steps to electrical and mechanical perfection. Take, for instance, the magnetic detector. Although it leaves nothing to be desired from the standpoint of stability, it lacks sensitiveness on the lower range of wave-lengths. Assuming, however, that it had been made to nearly equal the vacuum valve detector in sensibility, the advantages of the device from a commercial standpoint would be so obvious as to require no further comment. Engineers generally assert that the magnetic detector will probably be further developed, but in so far as we are aware, no particular research along this line has been undertaken.

Another invention that will naturally follow the elimination of atmospheric or static electricity at the receiver will be improving the calling apparatus, i. e., the equipment of the local detector circuit at a receiving station, with a positive acting telegraph key relay that will actuate a bell and call the attention of the operator. Such a receiver would have particular value at an isolated wireless station conducting a limited service and on ships not having a constant watch. It would also be of use to lighthouses and lightships, in fact, in all cases where messages are transmitted intermittently.

Following the production of an apparatus of this kind would come the radio controlled torpedo, aeroplane, aero-bomb, etc. The aero-bomb would have particular application to modern warfare, because it could be directed to the enemy's line and so controlled as to discharge its cargo of bombs at the desired point. In fact, there are so many fields open for the use of radio controlled mechanisms, that this limited space will not permit their enumeration even by name alone.

Finally, it should be remembered that it is not always the highly trained scientific engineer who brings out the inventions most important and most beneficial to mankind. Numerous instances could be cited where inventions having great merit and wide commercial application have been evolved by men of limited technical knowledge. Many of the great inventions have been built upon foundations already constructed. The mere reading of the description of a device has frequently suggested an improvement and been made the basis of a greater invention.



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. W. K., Norfolk, Va., inquires:

Ques.—(1) I note that when using a small copper wire as the opposing contact for a galena detector that the sensitive adjustment is frequently lost, and I have wondered whether this loss in sensitiveness could be prevented by the use of several fine copper wires connected in parallel, all of which are placed in contact at different points on the crystal.

Ans.—(1) We are inclined to believe that the single contact will give the best results.

Ques.—(2) I possess a non-synchronous rotary spark gap on which the electrodes are set 3-64ths of an inch apart. Is this separation too great? The voltage of the transformer is 40,000 volts.

Ans.—(2) The rotary spark gap apparently gives the best results with a minimum discharge gap, and if the construction of your rotary gap would permit the electrodes to be set within 1-100th of an inch without injury, this should be done

* * *

H. W., Rockford, Conn.:

The dimensions of the regenerative tuner shown in the June issue of The Wireless Age follow: The over-all length of the tuner, including the length of the rod upon which the coil slides, is 8¾ inches. The end pieces for supporting the rod are ¾ths of an inch in width and 3 inches in height. The wooden discs have an outside diameter of 4 inches, the diameter of the groove being 2½ inches. All three coils are in variable inductive relation. It is quite important in this circuit that there be a variable degree of coupling at the regenerative coupler. It should be obvious that in any inductively-coupled system the best results will be obtained by having the primary and secondary in variable inductive relation. This point requires no further discussion.

Each wooden core for the support of the windings is 1 inch in length and each groove is ⅛th of an inch in width.

* * *

J. A., San Juan, Porto Rico.:

If you will place the loading coil of your receiving set at a right angle to the primary and secondary windings of the receiving tuner. inductive effects between the two circuits will be reduced to a minimum.

It is not essential to wind either the primary or secondary coils of a receiving tuner with a single layer. Multi-layered windings give very good results, principally because they give a maximum amount of inductance with a minimum amount of resistance. If the coils of the receiving tuner are narrow, the multi-layered windings can be separated by a thin sheet of paper, but if the coils are rather long, say 3 inches or 4 inches, it may be of advantage to separate the various windings by an air space of at least one-fourth of an inch.

In the navy type of tuner using multi-point switches for variation of inductance, the wires leading to the studs on the switch are rigidly soldered in place. It is not difficult to take these taps from the winding; a hole is cut in the tube right at the point where the tap is to be taken, and the wire is doubled back upon itself and drawn through this hole until it reaches the stud on the switch. The connection is then soldered to the stud and the winding continued on. If the taps are taken in this manner, it will barely be noticed from the outside of the coil.

You need not fear loss in efficiency by the use of multi-layered coils, as they have proven satisfactory both for the reception of long and short waves.

* * *

G. S. V., Hurst, Ill.:

In order to satisfy yourself on the subject of radio range, you are directed to read the discussions in some of the more important textbooks on wireless telegraphy, for example, "Wireless Telegraphy," by J. Erskine Murray, or "Wireless Telegraphy and Telephony," by W. H. Eccles. The "Textbook on Wireless Telegraphy," by Rupert Stanley, discusses the subject more or less in detail. Various theories have been put forth to account for the increased range of transmission during the night hours, but they are more or less speculative.

You are referred specifically to pages 161, 162, 163, 164 and 165 of "Wireless Telegraphy and Telephony," by W. H. Eccles, a copy of which will probably be found on the book shelves of your local library.

If through a friend you can obtain a copy of the December, 1916, issue of the "Monthly Service Bulletin" of the National Amateur Wireless Association, you will find a complete circuit of the regenerative receiver applicable to the reception of waves at 200

meters. The dimensions of a loose coupler for this range of wave-lengths is given in the last chapter of the second edition of the book, "How to Conduct a Radio Club." The primary winding of a 200-meter coupler may be wound on a tube 3¾ inches in diameter by 2 inches in length, wound with eighty turns of No. 28 S. C. wire. The secondary winding may be 2¾ inches in diameter by 1½ inches in length, wound with sixty turns of No. 30 S. C. wire. The regenerative coupler may have the dimensions of the variometer shown in the book, "How to Conduct a Radio Club," and the inside winding of the variometer may, for example, be connected in series with the secondary winding of the receiving tuner and the outside winding in series with the local telephone circuit. This makes it an oscillation transformer.

* * *

F. G. H., Providence, R. I.:

You, of course, understand that during the period of the war, the use of transmitting or receiving apparatus is prohibited.

We have no distinct data on the life of the various vacuum valve filaments mentioned, but believe them to have about equal degrees of sensibility.

While an oak panel will do for mounting the elements of a receiving set if the panel is dry, bakelite or hard rubber is far superior, particularly if the apparatus is to be used in a damp climate.

You will not require a loading coil 40 inches in length to increase the wave length of your set to 10,000 meters. A coil 24 inches in length, wound with No. 26 S. S. C. wire, would fulfill your requirements. The secondary loading coil could be 30 inches in length, wound with No. 30 S. S. C. wire.

The book, "How to Conduct a Radio Club," describes fully the construction of a long distance receiving set.

* * *

W. O., Covington, La.:

You will find a complete answer to your query relative to the derivation of the formula, $\lambda = 59.6 \sqrt{LC}$, in the Appendix of "Practical Wireless Telegraphy," copies of which are now on sale.

* * *

H. W., Seattle, Wash.:

You are quite correct in your statement regarding the direction finder, namely, that it gives the line of direction and does not indicate, for instance, whether the signals emanate from the north or from the south. In the majority of cases, however, there can be no doubt on this point, as it is generally known in the case of the ship, for instance, which side of a vessel a given shore station lies. Take, for instance, the following example: If the direction finder was installed on the Jersey coast and radio signals were heard at the wave-length of 600 meters, and the direction finder indicated that the signals emanated from a point due east or west, and the line of direction over a period of one hour indicated an increasing angle from due east or west, the probabilities, 99 out of 100, are that the signals are radiated by a vessel at sea because the location of land stations in the United States is fully known. Beyond this a hostile station would be recognized by some peculiarity either in the operator's method of sending or in the tone of a spark. Operators in a given vicinity would easily detect a foreign sender.

If your direction finder will perform the functions you mention, it is a very valuable invention and one that would have universal application because it would remove the only ambiguity which the direction finder possesses.

The apparently mysteriously designed receiving set you mention is nothing more than a regenerative vacuum valve set wherein the local detector circuit is coupled back to the grid circuit. The local circuit can either be directly connected through the turns of the secondary winding or inductively-coupled. The latter is probably the arrangement used in the apparatus you mention.

If one knows the capacity of the condenser and the effective inductance of the coil, and, furthermore, a scale of calibrations is furnished for the condenser over its entire range, the wave-meter can be calibrated by the following formula:

$$\lambda = 59.6 \times \sqrt{LC}$$

Where L = the inductance of the coil in centimeters.

C = the capacity of the variable condenser in microfarads.

The ordinary variable condenser will not give a progressive increase of wave-length in accordance with the condenser scale; consequently, you will have to make from eighteen to twenty-four calculations for a complete calibration.

* * *

G. H. K., Baltimore, Md., inquires:

Ques.—(1) Will you please explain what is meant by "corona" loss? I have often noticed this expression in electrical publications, particularly in reference to high voltages.

Ans.—(1) The term "corona" is applied to the glow which appears between two parallel conductors when subjected to a high voltage. When the voltage produces a visible discharge it is termed the visual voltage, but if the E. M. F. be gradually increased and the conductors are well separated, a glow takes place around it which is termed "corona." If the voltage still is increased, a brush discharge takes place and finally a spark discharge.

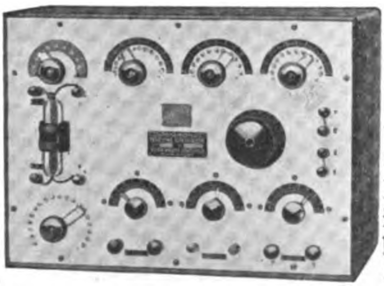
The energy dissipated by corona loss is often quite considerable. Such losses have been investigated experimentally by a number of noted scientists.

* * *

C. L. K., Chicago, Ill.:

We do not know the exact constituents of electrose except that it is a pulped vegetable fiber.

Hardfiber is cotton paper pulped in zinc chloride.



The diameter of 0000 B. & S. wire is .46 of an inch; No. 20 B & S. wire, .031 of an inch, and No. 36 B. & S. wire, .005 of an inch.

* * *

A. P. D., Portland, Ore., inquires:

Ques.—(1) What is the maximum value of capacity permissible for use across the secondary winding of a receiving tuner coupled in connection with a carborundum crystal rectifier?

Ans.—(1) We would arbitrarily place the upper limit .0005 microfarad for the maximum strength of signals, although larger values are frequently employed.

Ques.—(2) Where can I obtain a complete wiring diagram of the Marconi 107-A tuner?

Ans.—(2) A complete and detailed description of this tuner appears in the textbook, "Practical Wireless Telegraphy." It is a modified valve tuner, one which was formerly employed in connection with the Fleming oscillation valve, but has now been rearranged for use with the crystal rectifier.

* * *

A. R. K., Pensacola, Fla., inquires:

Ques.—(1) What is meant by note tuning? I frequently see the term employed in wireless literature.

Ans.—(1) Note tuning at the receiver is the adjustment of the telephone circuit for maximum response to a given spark frequency. It consists of tuning the local telephone circuit to the spark frequency of the transmitter. Various types of spark-frequency tuning circuits have been devised. The majority of them have an iron core inductance and a condenser in the telephone circuit which give this circuit a low natural frequency suitable to the spark of the transmitter.

Ques.—(2) What is the resistance of 1,000 feet of No. 36 wire in the Standard wire gauge?

Ans.—(2) 176.5 ohms.

Ques.—(3) What is the resistance of 1,000 feet of No. 36 wire in the B. & S. gauge?

Ans.—(3) About 420 ohms.

* * *

A. B. R., Atlantic City, N. J., inquires:

Ques.—(1) Please advise how the neutral position for the motor brushes is found on the motor generator sets of the Marconi Company.

Ans.—(1) The neutral position is found by experiment, or there may be marks on the rocker arm and on the frame showing the exact neutral position. In some types of motors the position of the brushes is fixed, but in other types their position can be altered by swinging a rocker arm upon which the brush holders are mounted.

In the event that the machine is not marked for the neutral position of the brushes, it may be experimentally found as follows: Place the handle of the starting box on the first contact and watch the brushes for sparking. If excessive sparking takes place immediately, shift the brushes until a minimum sparking is obtained. Then gradually pull the handle across the contact studs of the starter, slightly varying the position of the brushes until no sparking is obtained.

Ques.—(2) In several wiring diagrams of wireless apparatus which I have observed, I note the use of a telephone transformer in the local circuit of a receiving set which apparently has a step down ratio of turns. Why is such an instrument employed?

Ans.—(2) The telephone transformer is not employed where a pair of high resistance telephones are available. When the resistance of the receiving detector is much greater than that of the head telephone, high resistance windings are desirable, but if only a 150 to 500 ohm receiver is available, better signals will be received by a step down transformer.

The Baldwin telephone is completely described in the book, "Practical Wireless Telegraphy."

* * *

T. R. B., Toledo, Ohio:

The land stations of the United States are now under the supervision and control of the United States Navy, and to secure an appointment at one of these stations, you would be required to enlist for four years. Further particulars can be obtained from any naval recruiting office in the United States.

The Marconi Company requires the services of many ship operators to take care of the rapid extensions of its service, and you would have no difficulty in securing employment in the Eastern Division if you possess a first grade Government license certificate.

The article entitled, "Designing your own Transformer" appeared on page 193 of the December, 1915, issue of The Wireless Age. This is an excellent article and one which you would do well to study in detail.

We have not been advised that the Pupin static device has been perfected. In fact, we have no detailed information except that obtainable through the columns of the newspapers.

* * *

E. M. R., Detroit, Mich.:

The emergency apparatus on a trans-Atlantic vessel comprises either a 10-inch induction coil operated by a thirty-volt storage battery or a sixty-cell battery of sufficient capacity to run the motor generator direct.

* * *

A. B. L., St. Louis, Mo.:

In a paper presented by Dr. Alfred N. Goldsmith before the Institute of Radio Engineers, the subject of frequency changers is completely discussed, and you are referred to it for further information. In fact, the subject is so comprehensive that we cannot give space to a complete discussion of the principles upon which these devices operate.

The paper on the "Magnetic Amplifier for Radio Telephony" was presented before the Institute of Radio Engineers, February 2, 1916. It was reprinted in The Wireless Age in May 1916.

D. V. A., Philadelphia, Pa.:

The bulletin you desire is entitled "Some Contact Rectifiers for Electric Current," issued by the Bureau of Standards. Ask for No. 94, Volume 5, issued in 1908.

Zincite and chalcopyrite in combination have been found to give good rectification; also zincite and bornite will work very well in combination as a radio receiver.

* * *

D. L. A., New Orleans, La.:

The Exide storage cells in the Marconi Service are rated from sixty to 224 ampere hours, and those of larger capacity are employed for lighting auxiliary lamps just as well as operating the motor generator.

It is customary to give the Exide cell an overcharge once per month. The pointer of the ampere hour meter is placed at point 50 followed by placing the cells on charge until the pointer of the ampere hour meter returns to zero. These switchboards are fitted with an underload circuit breaker which is automatically tripped when the pointer of the ampere hour meter returns to zero. Operating instructions for the care of these cells generally appear in the radio cabin. These cells are the property of the steamship company and not the Marconi Company. The radio operator is supposed to have sufficient knowledge of the charging panel so that he can take proper care of it. He should understand its manipulation either during charge or discharge.

* * *

A. B. G., Boston, Mass.:

Just how close the coupling of the oscillation transmitter can be, in order that the transmitter may radiate a pure wave, depends upon the action of the spark gap. If the gap is free from arcing, a rather close coupling can be employed, but if there is evidence of arcing, there will be a retransference of energy from the antenna circuit, and two waves will result. Whether or not two waves exist in the antenna system can be determined by means of a wave-meter placed in inductive relation to the earth lead.

* * *

D. R. B., Franklin, Pa.:

Faraday's discovery of electromagnetic induction was made in 1831. Quoting his own description, he said, "203 feet of copper wire in one length were coiled around a large block of wood: another 203 feet of similar wire were introposed as a spiral between the turns of the first coil, and metallic contact everywhere prevented by twine. One of these helices was connected with a galvanometer, and the other with a battery of 100 pairs of plates four inches square with double copper and well charged. When contact was made, there was a sudden and very slight effect at the galvanometer, and there was also a similar slight effect when the contact with the battery was broken."

Pierce's conclusions from the experiments he made with crystal rectifiers are fully set forth on pages 199 and 200 of the "Principles of Wireless Telegraphy," written by himself. Inasmuch as this is rather lengthy, we shall have to refer you to his textbook.

* * *

J. R. F., Howe, Ind.:

Contrary to your statement, the book, "How to Conduct a Radio Club," contains a complete circuit diagram for connecting one, two or three vacuum valves in cascade. The connections for the double vacuum valve amplifier given in that publication can be duplicated for a third vacuum valve.

In the book entitled "Practical Wireless Telegraphy," now on the press, complete circuits of all types of vacuum valve receivers are published, including those which amplify radio-frequencies as well as audio-frequencies.

* * *

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

Ques.—(1) What is the International keep out signal?

Ans.—(1) QRT, "stop sending," is generally used.

The signal, QRS, means "stand by, I will call you when required or needed."

* * *

O. A. P., Wallowa, Ore., inquires:

Ques.—(1) Can you advise me of a good method for polishing hard rubber for cabinet wireless receivers?

Ans.—(1) Tripoline wax rubbed on a buffing wheel will give a very neat polish.

Hard rubber can be brought to fine polish by first rubbing it with fine emery paper followed by another rubbing with fresh charcoal and oil.

* * *

C. E. M., Madison, Wis.:

It is doubtful whether the 1/6 K. W. transmitting set which you mention will permit transmission over distances of thirty to fifty miles unless the receiving station is equipped with a supersensitive receiving set such as a double vacuum valve amplifier. Ordinarily we would not expect a set of this power to transmit more than five or six miles, although under favorable conditions, increased range might be obtained.

* * *

R. B., Seattle, Wash.:

We have no information regarding the efficiency of the K. & C. wireless transmitting set.

The fading of signals which you mention is in some instances due to leakage at the transmitting apparatus, but in the majority of cases it is caused by conditions external to a transmitting or receiving station. It is generally believed that long distance transmission at night time on short wave-lengths is largely due to reflection and refraction of the advancing wave between the earth and the upper conducting shell above the earth's atmosphere, and since this conducting shell (from which the waves are reflected) varies in position from hour to hour, the signals vary in accordance at the receiving station. The actual cause of this phenomena has not yet been accounted for.