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JANUARY 1920

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Edited by *H. Gernsback*

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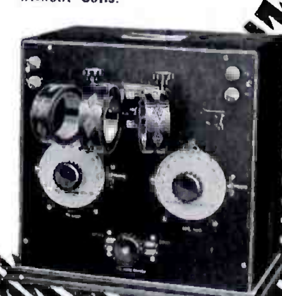

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RADIO AMATEUR NEWS

CONTENTS

FOR JANUARY

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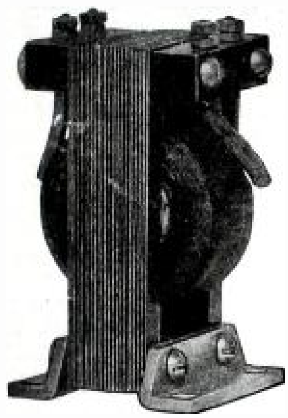

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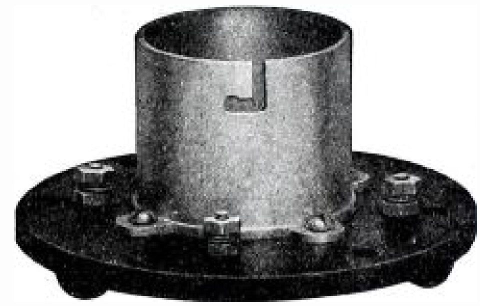

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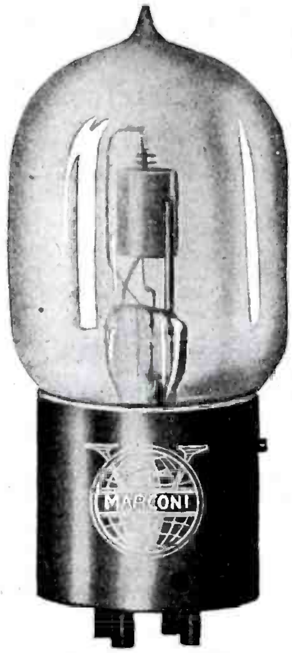

Fleming Pat. No. 803,684
De Forest Pat. Nos. 841,387-879,532

A WARNING

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Purchasers
Users of

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The Marconi V. T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

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RADIO AMATEUR NEWS
H. GERNSBACK — EDITOR

Vol. 1. JANUARY, 1920 No. 7

ETERNAL WAVES

WHEN Marconi first started his historic experiments with his spark coil as a transmitter and his coherer as a receiver, it took a surprising amount of energy to cover even small distances. A specially constructed coil throwing a spark over eight inches long and which required half a kilowatt transmitted only over a fraction of a mile

After a while we substituted a carbon detector using steel needles as an imperfect contact, in series with a pair of telphones as a receiver. We immediately found out that we only required a fraction of the former energy of the transmitter, to send a given distance. Then came the electrolytic detector which again increased our receiving range enormously, due to its greater sensitivity. In turn we had the still more sensitive crystal detectors, which again increased our receiving radius. Later came the audion which surpassed anything in sensitivity we knew heretofore, and once more our range was vastly increased.

After that came the two-step amplifier which quadrupled the best receiving performance of the single audion we had known. Finally we see the seventeen-step amplifier, with which—so we are told—you can hear the spark from a 1 kilowatt station, at any point of the globe—12,000 miles to be exact—which is practically half the circumference of the earth!

Indeed during the war the British used a *seventeen step amplifier* to listen to *buzzer signals* used for inter-communication between German warships in the North Sea. And the distance was often 300 to 400 miles! Just think of picking up such an infinitesimal amount of energy over such a great distance. It is so small that the little fraction that impinges upon the receiving aerial is well nigh incalculable. It would take a long string of zeros to express the value in amperes. Of course, it goes without saying that a seventeen step amplifier is a most temperamental affair and a great deal more "nervous" than the proverbial cat!

A trolley car starting up a mile away will give out shrieks in the horn connected to the seventh bulb. A bell rung in a distant building will produce a Niagara of noise in the horn. If you wave your hands ten feet away from the seventeen-stepper the change of capacity of your body will produce a loud noise in the receiver! Our English friends who first perfected the seventeen-stepper were wont to say that you couldn't even think hard near the instruments for fear of disturbing their balance! But perhaps this was an exaggeration. Few of us ever think—hard!

Recently great improvements have been made in multiple step amplifiers and it becomes more and more feasible now to weed or filter out extraneous disturbances, so that the final bulb will only emit such signals as we actually want.

Once arrived on these premises there will then be no trouble to make a 50, or a 100 or even a 1,000 step amplifier! Perhaps you laugh at such a suggestion. Ten years ago you would have laughed at a seventeen step amplifier which can pick up buzzer signals 300 miles away! So the prediction does not matter much—it will soon be a fact anyway.

But I didn't start out to tell you about a 1,000 step amplifier, rather I wanted to make a strictly philosophical observation on a rather surprising FACT.

The question before us is: *How far can you detect an electrical wave.* Theoretically there is no limit. In other words, as time passes and our detectors become more sensitive we find that we can reach further and further. We will all live to see the day when the waves emitted from a buzzer will be picked up after having traveled around the globe a distance of 12,000 miles. Undoubtedly they reach much further but unfortunately our earth will then have become too small, for the emitted waves certainly travel infinitely further.

Electromagnetic waves, like space are infinite. A radio wave shot out into free space—just exactly like a light ray—will keep on traveling at a speed of 186,000 miles per second, for thousands of years to come.

Just as we can pick up light rays from distant worlds of the Universe, which left there thousands of years ago, and are only now seen by us, so do radio waves travel on towards distant worlds, to be intercepted there centuries hence.

This ought to make us careful when and how *we* tap the key!!

H. GERNSBACK.

TO OUR READERS

DUE to the great printer's strike which paralyzed New York's entire printing trade, RADIO AMATEUR NEWS was printed out of town for several months. This greatly delayed us and prevented your magazine from reaching you on time. RADIO AMATEUR NEWS is now printed in New York once more, and soon will appear again on schedule time.

This, the January issue, should be in your hands on January 22nd. The February issue will come out on February 11th. March issue on March 6th. April issue March 29th.

We desire here to thank our readers for the patience they displayed with us, during a very trying period.

THE PUBLISHERS.

Radio Telephone on Mount Hood

Forest Protective Wireless Telephone at an Elevation of 11,225 Feet

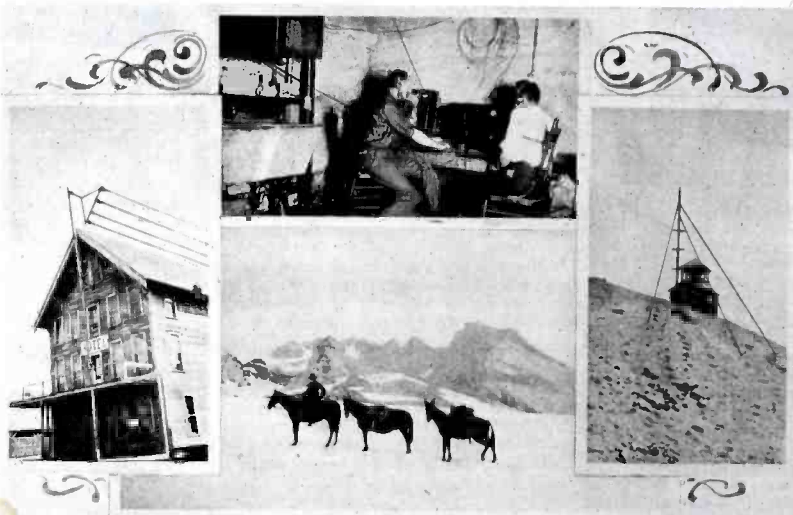
By C. M. ALLEN

THE success of a forest fire protective organization, in the work of fire prevention, is determined to a large extent by the efficiency of its system of wire telephone lines. While these lines give excellent service, they fail occasionally on account of physical conditions which cannot be controlled. The possibility of using the wireless telegraph to supplement the wire telephone line under these conditions has been considered, but the complicated nature of the apparatus, in the past, together with the knowledge of the code required for its operation, combine to make its use impractical. However, radio apparatus, particularly the wireless telephone, has been very much improved and simplified during the past year; and the United States Forest Service, recognizing the need of an auxiliary to the wire line system of communication, is now carrying on a series of tests with the wireless telephone for the purpose of determining to what extent it may be used. While these tests are not yet completed, the results have been so satisfactory that it is believed a very optimistic view of the future possibilities is justified. There are, of course, limiting conditions regulating wireless telephone transmission, but the work so far this year has demonstrated that the apparatus in its present stage of development can be set up and operated successfully by Forest officers under extreme conditions.

Two wireless telephone sets were loaned to the Forest Service by the War Department, and permission for their operation in making certain tests was granted by the Navy Department about July 1, last year. They are vacuum tube sets known as the "S. C. R. 67", for use on the ground by the Signal Corps for airplane communication and are purposely designed for a limited working range of about 12 miles.

For the preliminary tests it was decided to locate one of the sets at the lookout station on Mt. Hood which has an elevation of 11,225 feet, with the view to making it a permanent station, and the other set at Government Camp, which has an elevation of 4,000 feet and is some eight miles from the top of the mountain.

Very little data were available for use in designing the station on top of the mountain. There was a wide variance between the suggestions from radio engineers, many of which were impracticable on account of physical conditions. For instance, the umbrella type of antenna was very strongly recommended. This would have required a number of captive balloons anchored around the top of the mountain for holding the outside ends of the wires, and as the supply of balloons was limited, it was not attempted. There was also a wide range between suggestions made in regard to the construction of the counterpoise which would have to be used, as an earth ground was out of the question on the summit.



Left—Wireless Telephone Aerial at the Government Camp Hotel Mt. Hood. Upper Center—One of the Wireless Telephone Outfits Set Up for Experimenting in the Basement of Mr. Allen's Residence. Lower Center—Pack Horses Were Used in Transporting the Radiophone Sets Across Four Miles of Snow Covered Fields. Right—Great Difficulty Was Experienced in Erecting a Mast on the Mountain Top. The Lookout House Stands at an Elevavtion of 11,225 Feet.

However, it must be understood that these differences of opinion were not due to an insufficient knowledge of the underlying principles of radio work, but to a lack of knowledge of physical conditions, and it was decided that in this case, as it will undoubtedly be in other cases, the only thing to do was to get results—if impossible with one type of antenna or counterpoise, to be prepared to try another. Consequently more material was packed to the top of the mountain than would be needed for a permanent station, but much valuable information was obtained. The transportation was by auto truck from Portland, Oregon, to Government Camp (which was used as a base), a distance of about 57 miles; from there by pack horse to the foot of Crater Rock, a distance of about eight miles, four of which are across the snow fields; and from there packed by Forest officers about 1,000 feet up to the summit of the mountain.

After making a careful examination of the conditions on top of the mountain, it was decided to erect an inverted L shaped antenna 250 feet long, supported at one end by a 50-ft. mast erected by the side of the lookout cabin, and the other end attached thru strain insulators to wires extending some 50 feet farther southwest to a short mast set in a point of rock sticking up beyond the small glacier. Two and a half inch bamboo, in 6½-ft. lengths, was used in the construction of the long mast. Each piece was reinforced by wrapping bands of No. 19 spring brass wire about 1½-in. wide between joints. The lengths of bamboo—eight in number—were joined by fitting oak pieces inside of the ends; and the mast was held rigid by four ⅛-in. special steel airplane cordage truss guys, from top to bottom, these being spread about 36 in. at the center by ½-in. oak spreader arms. The use of the oak pins for spreader arms was a mistake, as the first sleet storm coated them to a thickness of about 3 in. which snapped two of them off and allowed the mast to crumple up. One-half inch iron pipe was substituted for the oak pins and proved very satisfactory. A 4-wire antenna was used at first, each wire being a No. 10 stranded copper wire 250 feet long, with a spread of 3½ feet between wires. As it was impossible, due to glacier ice, to make an ordinary earth ground, a counterpoise was used with fair results.

Operation of the sets was started about August 1st. The best results in the tests which were made during the remainder of the month were obtained with the use of a two-wire inverted L type antenna, 30 feet high, with a spread of about 10 feet between the wires. There was practically no difference in the results obtained with the use of either an insulated counterpoise composed of two insulated copper wires laid on the ground under the two antenna wires, or a counterpoise made of two strips of 12 in. chicken wire netting. In both cases about six-tenths ampere radiation was obtained.

In telephone conversations between the two sets the voice carried very clearly and was about as loud as over the wire lines; telegraph signals from many stations over the continent were picked up. They came in particularly strong on top of the mountain, in some cases loud enough to be heard all over the cabin. *Static, or electric interference, in regard to which there had been so much speculation, and which at times was very annoying on the wire line to the summit, was almost entirely absent in the wireless receiver.*

The energy for operating each set was furnished by two 5-cell Edison storage batteries. About 8 amperes, at 13 to 15 volts, or about 110 watts, which is a fraction over one-tenth of a horse-power, is the amount

(Continued on page 383)

Static Elimination By Directional Reception

By GREENLEAF W. PICKARD

IN the early days of radio communication, those disturbances which have been variously called "static," "atmospherics," "X's" and "strays" were either attributed to distant lightning, or more vaguely and correctly to "atmospheric electricity." While it is still true that our knowledge of static causes is far from satisfactory, we have at least progressed to the point where the distant thundershower has ceased to be considered an important source of static, and are now able to concentrate our attention on the higher levels of the atmosphere. Such disturbances as may exist at these levels are unquestionably electrical, so far as they concern our receiving circuits, and are due to a supply of electricity which in some way is generated in or supplied to the atmosphere. The normal electrification of our atmosphere, observed as a rather marked potential gradient in the lower and more accessible layers, accompanied by downward electrical currents and attended from time to time by high level auroral displays and magnetic storms, is undoubtedly due to ultra-terrestrial sources. According to Arrhenius, the sun is the ultimate cause of electrical phenomena in our atmosphere, and altho his original theory has suffered certain modifications and additions in the past fifteen years, it will well serve as an introduction to this paper.

The sun being an intensely heated body, must in consequence have emitted electrons in such abundance as to have acquired a very large positive charge. This charge, estimated by Arrhenius as three billion volts, forms a powerful center of attraction for stray electrons and negative ions, which are gathered in even from space far beyond the confines of the solar system. An electron or a negative ion, moving in toward the sun under this force, will eventually reach the outer and cooler solar atmosphere, where it will form a nucleus for condensation. A droplet, perhaps consisting of iron or calcium, will grow around this nucleus until it attains a diameter of the order of a wave-length of visible light. At this point in its growth, the pressure of light upon its surface considerably exceeds the solar gravitational pull upon its mass, and the droplet moves away from the sun. Such of these minute particles as may reach the vicinity of the earth fall into our upper atmosphere, and as they carry with them their original electrical charges they constitute an important source of electricity. There are, however, two other sources, also solar, but differing materially in their mechanism. One of these is the ionization produced by the shorter wave-lengths of the sun's light, as it impinges upon the gas atoms in the upper strata. The other consists of a direct emission of either electrons (Beta rays) or, according to Chapman, charged helium atoms (Alpha rays). This direct emission apparently does not take place all over the sun's surface, but jets out in streams, presumably most vigorously from sunspot areas, in consequence of the great thermal gradients and magnetic forces existing at such spots. When such a stream, which may be ten or more degrees wide, sweeps across the earth, it makes itself evident as magnetic storms and intense aurora.

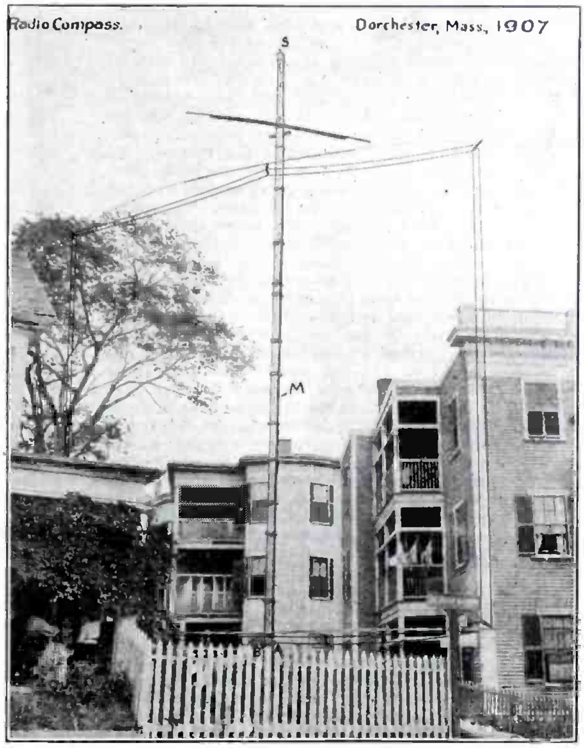


Fig. 5—This Type of Coil Aerial Was Demonstrated By the Writer at Dorchester, Mass., In 1907. Note How It Conforms to the Loop Aerial So Much In Vogue at the Present Time.

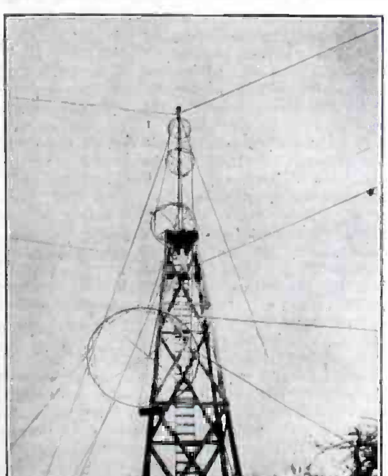


Fig. 3.—The Pre-Dieckman Shielded Antenna is a Complete Solution of the Hissing Variety of Static.

The aurora, or Northern Lights, give us a certain illumination as to the manner in which these charged particles arrive and move in the upper levels of our atmosphere. Perhaps the most striking part of this phenomena is the streaky or discontinuous structure of most aurora. It would appear as if, instead of a steady shower of charged particles, they arrived in clouds, these clouds being eventually drawn out into streaks or lines roughly parallel with the lines of force in the earth's magnetic field. This is exactly what we would expect of a charged particle in rapid motion, when it encountered a magnetic field. It would tend to spiral its way down a magnetic line of force, at least until it reached and penetrated the upper level of the atmosphere, whereupon it would begin to spend its energy in ionization, with light as one of the less objectionable by-products.

The writer is well aware that a theory is at the most tentative, and under suspicion of unsoundness, until it yields confident forecasts. Until such time as it may have been proven by this acid test, it is unwise to over-burden a theory by speculative exterpolation. However, even at this risk, as well as the graver one of diversion from the subject matter of this paper, the writer cannot refrain from a speculation as to the possible connection of the auroral structure, above outlined, with certain facts as to the difference between east-and-west, and north-and-south radio communication. If, as would certainly appear from the visible aurora, east-and-west bound waves encountered a celestial hurdle, while north-and-south waves ran peacefully between the ionized filaments, the ease of north-and-south, and the comparative difficulty of east-and-west radio communication would be readily explained. One might go a step further, and attribute, at least at times, a sufficiently periodic spacing to these ionized clouds for the formation of a gigantic reflection grating, and thereby account for de Forest's observation of the easy transmission of certain wave-lengths, and the high absorption of others. Certainly the visible aurora frequently has a very regular spacing, and it might be intesting to ascertain if it be of the right order to account for these effects.

But for the purposes of this paper it

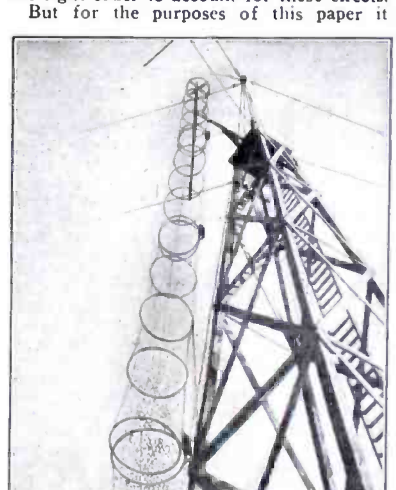


Fig. 4—Another Type of Pre-Dieckman Cage Antenna, Patented by the Writer In 1907.

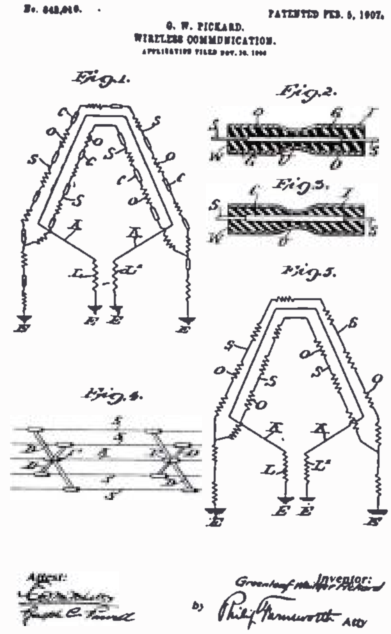


Fig. 2—Copy of the Cage Antenna Patent Showing the Method of Connecting the Antenna and the Shields.

will be sufficient to assume only that the charged particles enter out atmosphere in a discontinuous manner. Charged clouds will be formed at some high level, probably drawn out so that their greatest length lies approximately north-and-south, and in a manner similar to that observed in a thunderstorm, there will be equalizing discharges between these clouds. At first, because of the low dielectric strength of the atmosphere at the higher levels, such discharges will occur at small potential differences, and hence will tend to be of small individual intensity but of frequent occurrence. As the charges sink toward the earth, they will reach denser air, and there the discharges will become of greater individual intensity but less frequent.

We recognize today two important, that is to say bothersome, varieties of static. One of these is the "click," consisting of rather widely separated but very strong disturbances, reminiscent of the discharges of that aptly named apparatus, the static machine. The other is the "grinder," which runs the gamut of noise from a grating or grinding sound thru something resembling handfuls of gravel thrown against a window, with perhaps slushy or even hissing sounds at the other end of the scale. The clicks are most probably relatively low level discharges. This is supported by the fact that local thunderstorms give rise to clicks which can sometimes be identified with visible discharges between cloud and cloud, or cloud and ground. Grinders, however, would seem to have two possible origins. In the first place, they might arise from very high level discharges of considerable tho irregular frequency. The writer has succeeded in imitating, with a disconcerting fidelity, grinding static by the simple process of discharging a small condenser thru a series circuit of a wet string and a vacuum tube, replenishing the condenser from an influence machine. Grinding static might also arise from the summation of many distant clicks. There is some experimental evidence of the existence of these two varieties, either singly or mixed, and to this a later reference will be made. For the present, our principal interest is in the manner in which the static waves arrive at the receiving station. If we assume a more or less uniform distribution of discharges in the upper atmosphere, the condition of affairs with respect to the receiving station might be pictured somewhat as in Fig. 1. Here a discharge stratum, H-H, forms a portion of a sphere concentric with the earth's surface E-E. This stratum is not only above the receiving point R, but envelops this point in all directions, even to the horizon. It is at once apparent that individual discharges, as at *a*, *b* and *c*, will set up waves or pulses which will arrive at the receiving station with intensities inversely proportional to their distances a-R, b-R and c-R. This may be approximately expressed by saying that the intensities will vary as the sine of the vertical angle, save near the horizon. To exactly state the law would obviously require a knowledge of the height of the stratum H-H which we do not yet possess. However, it is apparent that the intensity on the horizon, as at *d*, is far from being zero, and is most probably between five and ten per cent. of the zenith intensity. The maximum static intensity, tho by no means confined to the zenith, is evidently distinctly *above* the receiving point R. At first thought it would seem that the total amount of disturbance produced by static would be represented by the product of the individual intensity by the frequency. Inasmuch as the number of individual discharges included in a given small solid angle near the zenith, as at *e*, is much smaller than the number included in the same solid angle taken nearer the horizon, as at *f*, varying in fact approximately as the square of the cosine of the vertical angle, it would seem that the total effect should *increase* as we pass from the zenith to the horizon. In general, the writer finds this to be the fact, altho it not infrequently happens, particularly in the forenoon, that light static comes down from above, with very little from the horizon. This may be explained by considering such horizontal static as consisting of weak discharges at great distances from the receiver, and of so great frequency (because of the summation of so many individual discharges) as to blend into a distinctly "soft" disturbance. Bearing in mind that static acts upon a receiving circuit by pure impact, a not inapt analogy is that of a bell, set into vibration by irregularly spaced impacts. For the same amount of energy in a given time, a bell will give the greatest response when the taps are individually strong and fairly well separated in time, rather than when the taps are weak but frequent. Furthermore, at least until such time as all reception is photographic, the psychology of the receiving operator must be borne in mind. There is doubtless an illy defined, but none the less existent frequency of maximum disturbance. For example, the writer finds irregularly spaced disturbances most troublesome when their mean frequency is about twice that of the signal element.

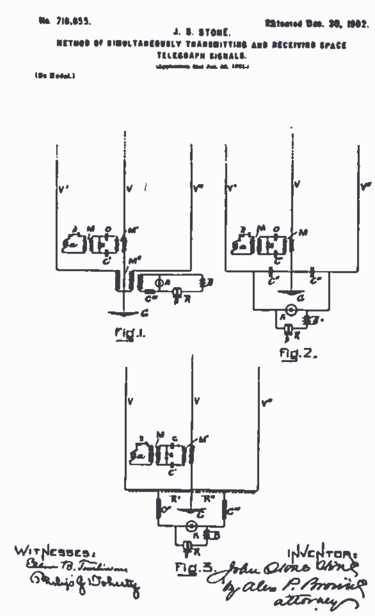


Fig. 7.—A Method of Obtaining Sharp Directional Reception Invented by J. S. Stone in 1902.

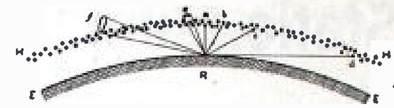


Fig. 1.—A Discharge Stratum As It Appears Forming a Portion of a Sphere Concentric with the Earth's Surface.

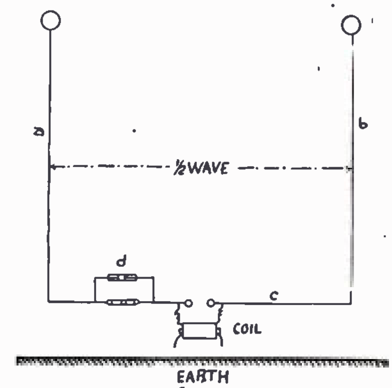


Fig. 6.—Two Separate Collectors Are Employed Spaced a Material Fraction of a Wave Length.

If the discharging clouds are drawn out in a north-and-south direction, we should expect that the waves arising from such discharges would show a certain uniformity in their planes of polarization. Altho it would be absurd to think of the discharging clouds as accurately oriented linear oscillators, nevertheless there should be a certain preponderance in that direction.

The writer's theory of static might be summed up as follows: According to the assumed character and location of the discharging masses, static waves may be expected to come in on the receiving stations from all angles in altitude and azimuth, with a maximum individual intensity from above, and a maximum frequency in the neighborhood of the horizon. The total disturbing effect will in general come in from points nearer the horizon than the zenith, altho the altitude of the ring of maximum disturbance is indefinite. The individual planes of polarization may take all possible angles, but with a preponderance in a direction determined by the earth's magnetic field. Finally it would seem that the most probable static wave form was a single highly damped pulse, because of the low conductivity of the discharging masses.

According to the above theory, the problem of the elimination of static and the preservation of the signal consists simply of the reception of a wave-train originating at a definite point, and the exclusion of static pulses originating at all points in altitude and azimuth. In a broad sense, there are two solutions for this problem, one involving a separation of signal and static based upon their difference in wave form, and the other a separation based simply on sharply directional reception. It is quite clear that if we could restrict reception to a small solid angle including the distant station, there would be relatively little static included. To use an optical analogy, the problem is essentially like that of receiving monochromatic light signals in full daylight. A spectroscope or a filter screen would be one solution, and directive reception as by a telescope another, but best of all would be a combination of the two. In present day radio communication we have already highly developed the spectroscopic or filter separation of signal from static, as by sharply resonant circuits and beat reception. But altho we have had two practicable types of sharply directional receiving circuits for the past twelve years or more, very little use of these appears to have been made until quite recently.

In a paper, entitled "Absorption and Reflection of Electrical Waves," read before the New England Wireless Society on December 7, 1912, the writer, after discussing the probable relation between ionization conditions in the upper atmosphere and electrical wave transmission, went into some detail of his early experiments to determine the nature of static. At his first experimental station, at Blue Hill Observatory, Milton, Mass., he conducted a long series of tests which apparently showed a relation between the wind velocity and the number of disturbances in a given time, which led to the conclusion that effect was a local one, possibly consisting of an actual discharge to the receiving aerial from electrified masses of air moving past the antenna wire. This theory was rudely upset by his further work in 1901, when comparison of tapes at Galilee and Brielle, N. J., about twenty miles apart, showed the same dots and dashes from static day after day. It was clear from this that some static, at least, came from discharges at

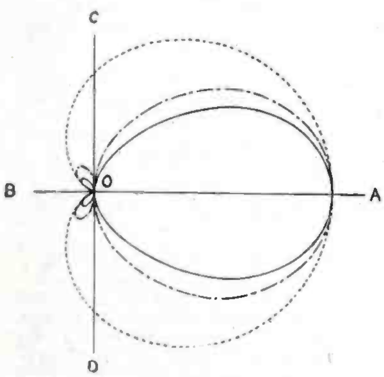


Fig. 8A.—Showing the Receptive Curve of the Combination of Two Loop Aerials.

considerable distances from the receiving aerial. He then said:

"A little later, I surrounded a receiving aerial by a Faraday cage constructed with loading inductances to avoid shielding the aerial inside from the desired signal. This seemed to eliminate a small portion of the static—probably that portion due to direct discharge to the wire from the atmosphere—but had no observable effect upon the distant variety."

At this point, the writer wishes to call attention to the careless manner in which members of this Institute refer to the Faraday cage antenna shield as a "Dieckmann Cage." Dieckmann, in 1912, first published his description of an aperiodic shield or cage around an aerial, so designed as to permit the passage of signal waves, but to be opake to static pulses. The writer has published, in a patent filed six years before Dieckmann's date, this exact thing. Reference to Fig. 2 will show the antenna wires A, A, surrounded by a cage, sectioned off into short elements which are connected together by impedances and grounded thru other impedances so that an aperiodic shield results. While he is inclined to agree with Weagant that the device is of small utility

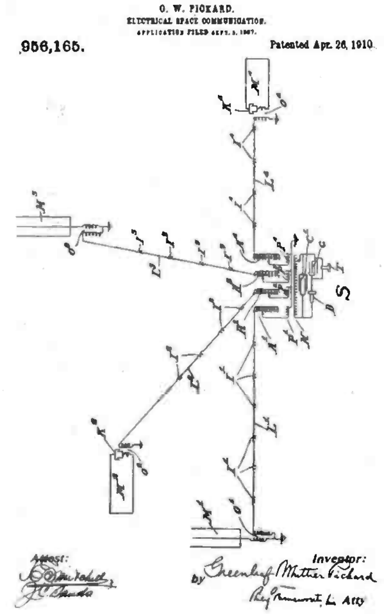


Fig. 8.—System Devised by the Writer in 1905, in Which Two Aerials Are Tuned to the Distant Transmitter.

as against the most bothersome varieties of static, it seems only fair that he, and not Dieckmann, should receive whatever credit is due for this invention. While the shielded antenna is open to attack from clicks and grinders, it is a complete solution of the hissing variety of static, due to a direct dischange to the aerial. Where a series condenser is employed in the antenna circuit, this is very apt to charge up to the limit of its dielectric strength, and then spill over, giving an excellent imitation of pistol shot static. This occurs most markedly during snow storms, and on shipboard, where the aerial is slung immediately over the funnels, the vessel manufactures this type of static in abundance, and delivers it effectively to the waiting antenna. Shielding is of distinct value in such cases.

Continuing his paper before the New England Wireless Society, the writer then describes his early work with directive aerials, particularly with the ungrounded coil or loop aerial. Again, as with the Dieckmann cage, the writer must pause to correct a heresy. Altho it has been fashionable of late to attirbute this invention to MM. Bellini and Tosi, it should be noted that these gentlemen first published an account of their work on November 14, 1907[10]. The writer began his development of the coil or loop aerial in 1902, and published an account of his work on June 15, 1907[15], almost exactly five months prior to MM. Bellini and Tosi. It is of interest in this connection to note that the writer, on September 13, 1907, demonstrated one of his coil aerials at Dorchester, Mass., to Lieut.-Commander S. S. Robison, detailed by the U. S. Navy for this purpose. This particular coil aerial is shown in Fig. 5, and consisted of two turns of wire forming a square about nine meters on a side. Altho but two turns are shown, from one to ten turns were actually employed, depending of course, upon the wave-length. Exceedingly accurate bearings of a number of distant stations were taken, some over sixty kilometers away from the loop, with a maximum error not greater than 2 degrees of arc.

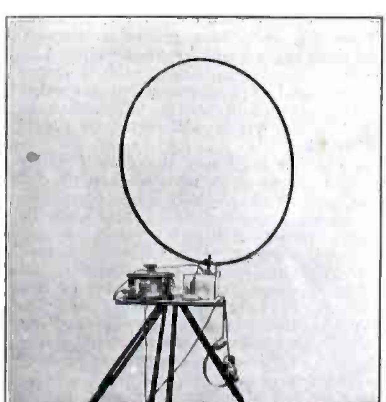


Fig. 9.—The First Portable Radio Compass.

Further on in the 1912 paper, the writer said:

"But the worst summer static appears to be at a very considerable distance from the receiver, and I believe it originates at some of the higher levels already discussed in this paper; probably many miles over our heads. I also believe that static is simply a discharge from one high level cloud of ions to another similar cloud, very like what we see from cloud to cloud in a thunder shower; that is, an equalizing discharge. Like lightning, static appears to be non-oscillatory, as may be readily found by experiment."

The writer does not claim novelty for the "static from above" theory. In fact, Airy, said in 1911:

"It was concluded that most of the disturbances were not due to local weather

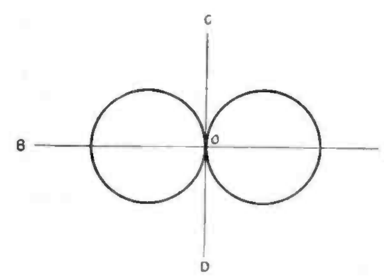


Fig. 10.—A Cosine Curve of a Vertical Loop Drawn in Polar Co-Ordinates.

conditions, but to discharges taking place in the upper atmosphere, and at very great distances from both stations. He thought it would be eventually proved that these atmospherics were connected with magnetic disturbances, and that they had the same common origin—*i. e.*, the arrival of negatively charged electrons from the outer space into the earth's atmosphere."

The writer concluded his 1912 paper with the following up-to-date treatment of the static problem:

"I believe, as a result of considerable experimental work, that the real solution of the static problem lies in the use of sharply directional receiving antenna. Provided only that the static does not originate at the same point as the signal, good directional reception should eliminate most of it."

As already stated, there are two practical methods of obtaining sharply directional reception. In the first method, originally suggested by Elihu Thompson, in 1899, patented in England by S. G. Brown in the same year, more fully disclosed and patented in this country by Stone in 1902[10], elaborately worked out for two, three and four collecting circuits by Braun in 1906.

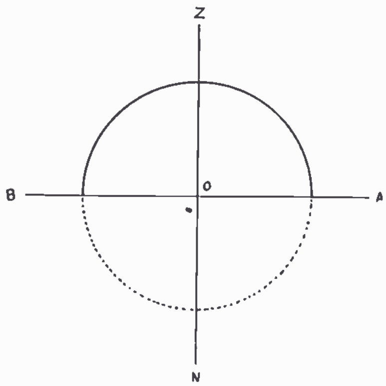


Fig. 11.—When the Vertical Loop Is in the Vertical Plane the Reception Curve Is in the Form of a Circle.

and more recently used by Weagant[12], two or more separate collectors are employed, spaced apart a material fraction of a wave-length in the line of propagation, as shown in Fig. 6. These collectors act upon a common secondary circuit in such wise that when the collectors are simultaneously affected by any disturbance, the currents set up therein will arrive in phase at the center of the system, and there, by opposed windings, be placed 180° apart in phase in their effect upon the secondary. Because of this opposition, such currents will not affect the detector, and no signal will be produced. On the other hand, the signal wave, passing the collectors successively, will set up currents therein which will arrive at the center of the system in an out-of-phase relation. and such signal currents will add in their effect upon the secondary and affect the detector. This is very well shown in Fig. 7, and clearly explained in the specification of the Stone patent of which Fig. 7 is the drawing. The writer, in 1905, devised a system in which two aerials, tuned to the distant station and separated on centers by some thousands of meters, were connected to a common secondary by way of phase adjusting means, so that the currents were added in the secondary in such phase as to produce the maximum signal. This method was first published in a patent filed in 1907[13] and is shown in Fig. 8. The particular case discussed in this publication involved two large loop or coil aerials, arranged in an east-and-west plane for the purpose of transatlantic reception. These loop aerials consisted of long, low rectangles, and were tuned to the desired wave-length by inserted series capacity and inductance. With this system, it is possible to so adjust the phase relations of the currents arriving at the secondary that interference or static arriving from any particular direction is cancelled out in the secondary, and does not affect the detector. A further advantage of this system, which has recently been pointed out by Weagant[14], is the fact that it has materially greater or sharper directional reception than any single type of collector. This is obvious when we consider the fact that the loop aerials M_2 and M_4 have simple cosine reception curves in the horizontal plane, and that a pair of open or non-directive aerials, separated as are M_2 and M_4 in Fig. 8, by a considerable fraction of a wave-length, with currents combined in a common secondary, have also a cosine curve characteristic. The combination of two loop aerials in the manner shown in Fig. 8 has therefore a cosine square reception curve.

The second method of directional reception, devised by the writer[15], does not involve, even for long wave reception, such geographical dimensions as the systems shown in Fig. 8. This second method consists simply of a closed tuned circuit or coil aerial, of dimensions small as compared with a wave-length. In its most effective form, consisting of a coil aerial combined with a so-called "open" aerial, this method gives true unilateral reception. The coil may be of quite small dimensions, particularly when it is employed simply as a radio compass. In Fig. 9 is shown the first portable radio compass, which was employed by the writer in 1907-1908 for mapping out the wave-front around a transmitting station. This radio compass consisted of a three-turn loop, one meter in diameter, shunted by a variable air condenser and a crystal detector.

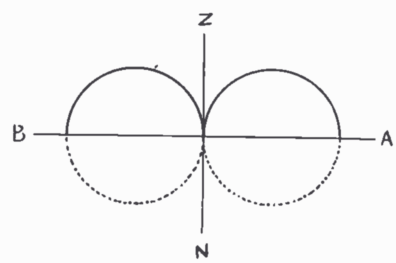


Fig. 14.—Showing the Complete Reception in Any Vertical Plane Passing Thru the Antenna.

Heretofore, the reception characteristics of aerials have been studied principally, if not exclusively, in the horizontal plane. The writer is not aware of any publication dealing with the three-dimensional characteristics of aerials, although for quite some time past points of wave origin other than the horizon have been common, *e. g.*, static, and more recently transmitters on aircraft. Just why radio engineers have elected to live in a two-dimensional world is rather puzzling, and if this paper has no other effect than to add another dimension to their life, the writer will feel fully repaid for his labor.

In Fig. 10 is shown the now familiar reception curve of a vertical loop or coil antenna in the horizontal plane, consisting of a cosine curve drawn in polar co-ordinates. This is an ideal curve; actually a coil aerial gives a more or less distorted figure-of-eight, sometimes tending to an hour-glass shape, and usually more or less unsystematical. The reasons for this distortion have only recently been worked out in detail, and some of the more important causes of distortion will be explained later in this paper.

In a vertical plane including the plane of the loop itself, reception is obviously symmetrical, and the reception curve in this plane is a circle, as shown in Fig. 11. If the loop is near the ground, the lower half of the reception curve is normally without interest, because signals do not often originate from under foot, and hence is shown in dotted line.

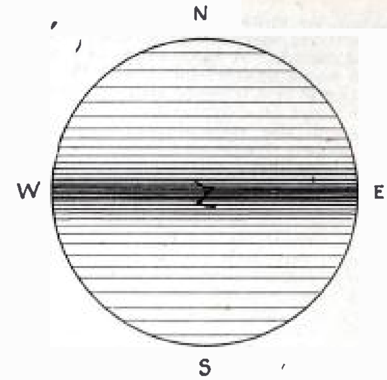


Fig. 13.—This Figure Represents a Plan of the Hemisphere Over the Loop.

If, however, a loop is placed aloft, as in aircraft work, the useful reception curve in this vertical plane is a full circle. Finally, the complete three-dimensional reception surface of the loop is a torus. This torus is shown in Fig. 12, and differs from the conventional anchor ring or doughnut in that it has no hole in the center, this peculiarity making its representation somewhat difficult. The significance of this last figure is obvious—the loop receives more or less from all points in space, excepting only along a line passing normally thru its center. The further meaning of this figure is that maximum reception occurs only in all directions in the plane including the loop, and the significance of this fact is perhaps best brought out by Fig. 13. This figure represents a plan of the hemisphere over the loop, just as if one were looking up at the zenith, and the shading indicates the amount of reception from different points in this hemisphere by a loop placed in an east-and-west vertical plane. The zone of maximum reception is a belt passing across the sky from east to west, reception decreasing to zero on the horizon at points north and south of the loop.

A so-called open antenna consisting of a vertical wire, short as compared with a wave-length, has in the horizontal plane a simple circle diagram, that is, it receives equally well from all points on its horizon. In any vertical plane passing through the antenna a quite different reception curve results, as reception is a maximum on the horizon, and decreases to zero at the zenith. The complete reception in any vertical plane passing through the antenna is shown in Fig. 14, and is, of course, the familiar cosine curve. That portion below the horizon is shown dotted in the figure; if the open antenna consisted of an ungrounded

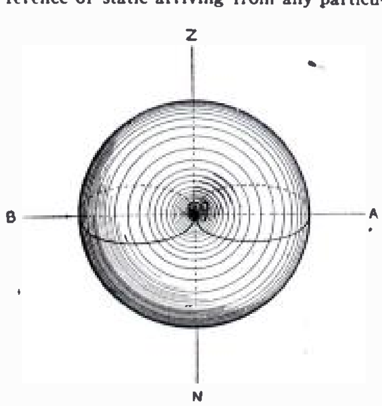


Fig. 12.—This Signifies That the Loop Receives More or Less from All Points in Space Excepting Along a Line Thru Its Center.

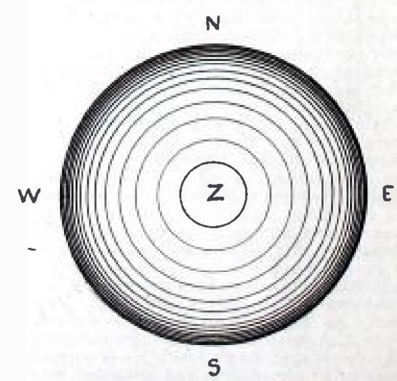


Fig. 15.—Here the Reception Belt Rings the Horizon and Reception Is Zero from the Zenith.

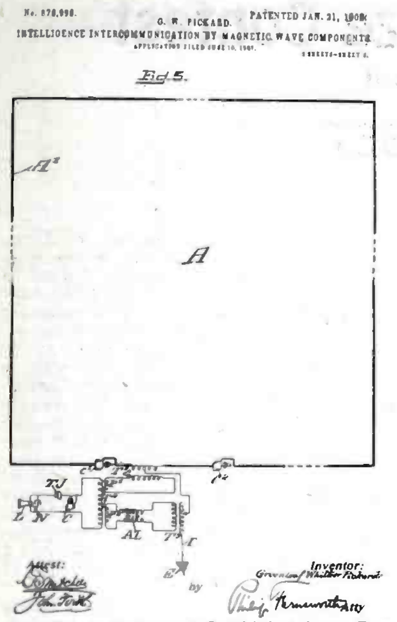
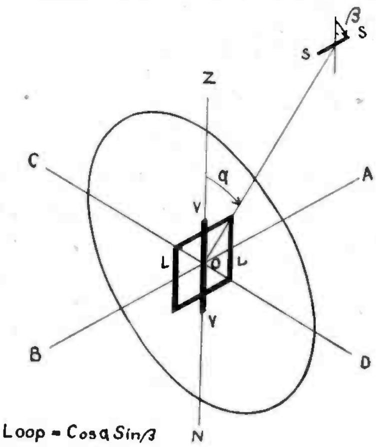


Fig. 16.—A Method of Combining Loop Reception with Open Antenna Reception.

linear oscillator considerably removed from the earth, the lower portion of the curve would interest us. Actually, just as with the loop or coil aerial, and for similar reasons, this ideal curve usually suffers considerable distortion, partly because actual vertical aerials have an appreciable horizontal length in most cases, and partly because of unsymmetrical or electrically warped surroundings. The complete three-dimensional reception surface of the open antenna is therefore just like Fig. 12 laid down flat, or, more exactly, laid down flat and half embedded in the ground, if the open antenna is on the earth's surface. It will be seen from this that the loop and the open antenna have identical reception surfaces, but in planes 90° apart. Similarly to the loop, Fig. 15 shows a plan of the hemisphere over an open antenna. In this figure, the reception belt rings the horizon, and reception is zero from the zenith. If static came solely from above, an open antenna would make an ideal eliminator. Equally, if static came in on the receiving point with the same intensity from all points in altitude and azimuth it would be difficult to account for the well-known freedom of the loop from statics. But if we assume that in general static is at its worst near the horizon rather than the zenith, a comparison of Figs. 13 and 15 will show a reason for the relative immunity of the loop.

In Fig. 16 is shown the method referred to above, which combines open antenna reception with loop or coil reception. A glance at the date of this drawing—June 10, 1907—will make it obvious that the combination of loop and open reception cannot be attributed to MM. Bellini and Tosi, often as this has been attempted of late. In this figure is shown the coupling of a loop and an open antenna to a common secondary, by way of phase adjusting means, so that the currents in the loop and the open antenna, normally 90° out of phase, are added in phase in the secondary circuit. If now, as by suitable dimensions of the loop or by coupling adjustment, or by both, the currents from the open antenna are made equal, in their effect upon the secondary, to those from the loop, the result of this addition, in a reception curve on the horizontal plane, is shown in Fig. 17. Reception is at a maximum from the direction O-A, is zero from the direction O-B, and has intermediate values from other directions, the complete curve being a cardoid. Such a circuit, employed as a direction finder, gives the true bearing of the distant station, and does not, as with the simple loop, leave the direction indeterminate by 180°. In a vertical plane including the loop the reception curve is also a cardoid, as shown in Fig. 18, with a maximum on the horizon at A, and zero on the horizon at B. Reception from the zenith, that is, along the line O-Z, being limited to the loop, has half the value of reception along the line O-A. In a vertical plane at right angles with the loop, that is to say, at right angles to the plane of Fig. 18, the reception curve is that shown in Fig. 19.



Loop = Cos α Sin β
Open = Sin α Cos β
Loop + Open = Cos α Sin β + Sin α Cos β

Fig. 19.—This Is the Familiar Cosine Curve Again Tilted Thru 45° with the Vertical O-Z.

This is the familiar cosine curve again, tilted thru 45° with the vertical O-Z. The complete three-dimensional reception surface is difficult to show in a two-dimensional figure, or even to describe accurately in words. It is a distorted apple-shaped figure, with the origin at the stem pit, and the vector of maximum reception at the other end. Some idea of this surface may be obtained from Fig. 20, which gives its sections in three perpendicular planes, passing thru the origin O at the front of the figure. Altho it is not an exact figure of revolution, inasmuch as the principal distortion is at the front of the figure, it will suffice for our immediate purposes to consider that it is essentially a cardoid of revolution.

From a consideration of the three-dimensional unilateral reception of the circuit shown in Fig. 16, it will appear that static originating at points other than on the horizon in the direction of the distant transmitter will either be weakly received, or, if it happens to originate on the horizon at a point 180° from the transmitter, it will not be received at all. The circuit shown in this figure is not at present, however, the best arrangement for this method

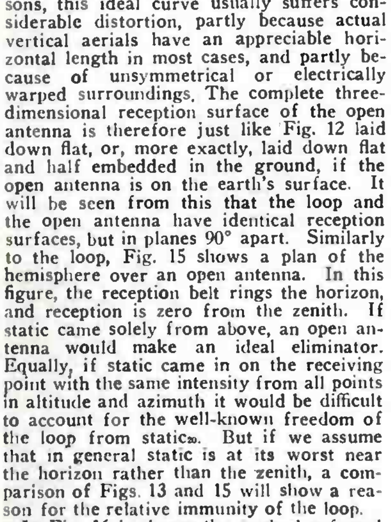


Fig. 20.—This Figure Has the Origin at the Stem Pit, and the Vector of Maximum Reception at the Other End.

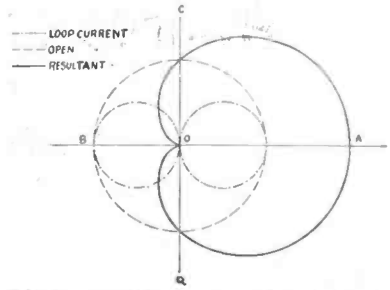


Fig. 17.—Here the Reception Is at a Maximum from the Direction O-A, and Is Zero from O-B.

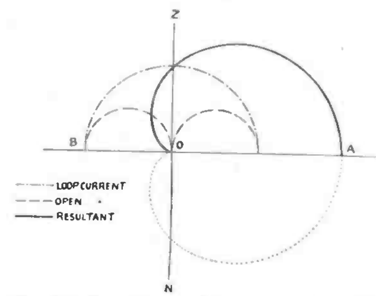


Fig. 18.—In a Vertical Plane Including the Loop the Reception Curve Is Also a Cardoid.

of static reduction. As the effect of static on a receiving circuit is practically pure impact excitation, complex waves will be set up in the two coupled circuits—the loop and the open antenna—with the result that the just shown ideal diagrams of reception curves and surfaces are but roughly approximated. These diagrams are, of course, only true for undamped wave reception, or for static reception on substantially aperiodic circuits.

Shortly after America entered the war, the Wireless Specialty Apparatus Company equipped a radio station for Mr. Alessandro Fabri, at Otter Cliffs, near Bar Harbor, Me. When the station was completed, Mr. Fabri donated it to the Navy, and it was first used as a low power spark station. However, it was very shortly found that the location was an excellent one for transatlantic reception, and this eventually became its principal service, the station finally becoming the premier reception point in this country. The summer of 1917 having shown that altho the Otter Cliffs station had excellent signals, it also had overwhelming static on occasion, Mr. Fabri invited the writer to install directional receiving circuits for static elimination adapted to the requirements of transatlantic service. Within a few days after this request, the circuit shown in Fig. 11 was installed, combining open antenna reception with loop or coil reception. This was immediately found successful in improving the signal-static ratio, and was at once placed in service. The loop A consisted of a solenoidal coil of four turns of No. 16 B. & S. (1.3 mm.

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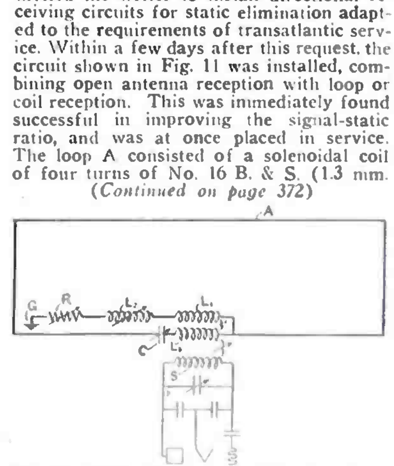


Fig. 21.—Solid, Uninterrupted Copying During Periods of Severe Static Was Made Possible with This Circuit.

Awards of $100 Radio Prize Contest

3rd Prize Winner $25.00 in Gold

AN IDEAL RECEIVING SET

By URBAN D. WORNER

THE set to be discussed, is of the cabinet type as shown in the photograph. The cabinet itself is made of mahogany wood and is 20 in. long, 11 in. wide, and 11 in. high. The base is 12 in. longer than the cabinet in order to accommodate the secondary, which rides upon the two brass rods fastened to the upright piece of wood near the end of the base.

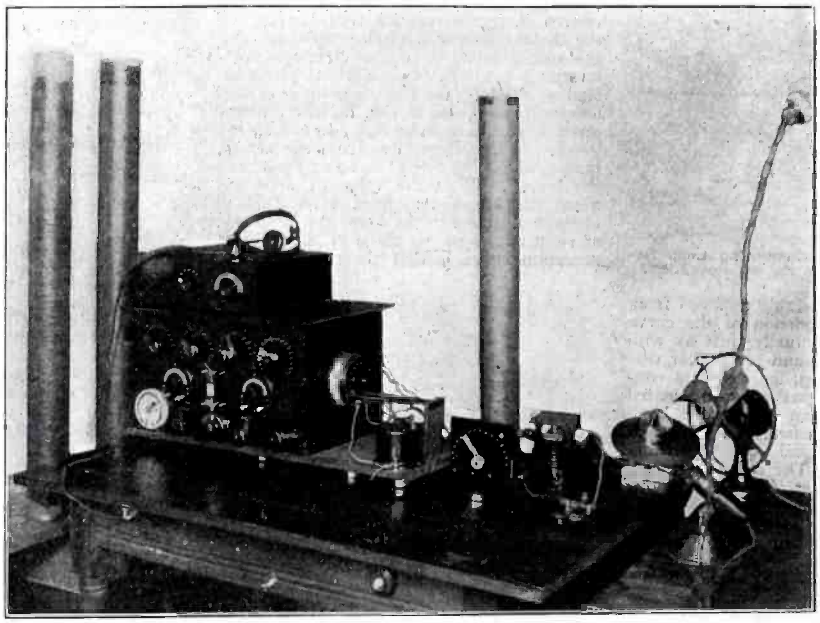
The terminals of the individual instruments are brought out to binding posts on the back panel. In this way it is an easy matter to change to any desired hook-up, without undue trouble or any unnecessary wiring.

All the instruments, except the loading inductances, the coil L, and the variable condenser C^5 are mounted in the cabinet. The primary P of the receiving transformer is 10 in. long, 6½ in. in diameter, and is wound with No. 24 S. C. C. magnet wire, being varied by the usual units and tens system.

The secondary S, which can be seen in the photograph, is 10 in. long and 5½ in. in diameter, being wound with No. 28 S. C. C. magnet wire, and is varied by means of a sixteen point switch, the connections being brought direct from the secondary to the binding posts on the base. The secondary S, is shunted by a Murdock variable condenser C^3 which has 23 plates and a maximum capacity of .0005 mfd.

The hook-up used in the secondary circuit is the well-known Armstrong circuit employing a second air coil adjustable transformer M, which has the following dimensions: P^1 is 4 in. long and 4 in. in diameter and divided into eleven sections: S^1 is 4 in. long and 3¼ in. in diameter, divided into fifteen sections. Both P^1 and S^1 are wound with No. 30 S. C. C. magnet wire, the sections being brought out to taps on the upper left-hand side of the front panel. Connections between P^1 and S^1 are clearly shown in the diagram. The coupling between P^1 and S^1 is adjusted by means of a coupling device which projects through the side of the cabinet, just back of the filament rheostat. It is absolutely necessary to have the coupling between P^1 and S^1 adjustable, as through the mutual inductance of M, energy is forced back from the wing circuit to the grid circuit, which results in the amplification of signals when the coupling is properly adjusted. It is not necessary to have P^1 and S^1 divided into sections, but for very close running it is desirable.

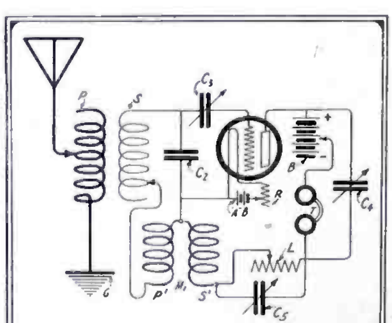
The detector is of the DeForest old tubular type audion, and gives very gratifying results, both on arc and spark stations. Its oscillating qualities being marvelous. The detector can plainly be seen in the centre of the front panel of the cabinet.



Here Is a Neat, Compact and Efficient Receiving Station. Note the Cabinet Design—the Tuner and Audion Control Are All Contained In the Same Unit.

The filament F is lighted by a 6 volt 80 A. H. storage battery, the current being regulated by the 10 ohm rheostat shown on the extreme lower left hand corner of the panel. The filament current is cut on or off by the small switch next to the rheostat.

The grid condenser C^2 should have a capacity not exceeding .0001 mfd., and is usually of the variable type; but I have found that equal results can be obtained by using a very small fixed condenser, consisting of two brass plates separated by mica.



Wiring Diagram of Urban Worner's Prize Set.

The coil L in the diagram is 32 in. long and 3¼ in. in diameter, a tap being taken off every 2 inches, and is shunted by the variable condenser C^5 (Murdock) having a capacity of .001 mfd. It is necessary to have a condenser of rather large capacity here, so by filling C^5 with a good grade of paraffin oil its capacity is raised to .005 mfd. which is suitable for all purposes. By means of L and C^5 signals are greatly amplified; this is more pronounced on long than on short waves.

The plate circuit is brought into adjustment by means of the high voltage "B" battery, which consists of eight No 710 "Eveready" flashlight cells which are sealed in wax. The voltage is regulated by both taps and a high resistance carbon rheostat. The reason for this double adjustment of the "B" battery is because in this circuit it is necessary to have the voltage at a critical point in order to get the best results. The variable C^4 is of the Murdock construction and has a capacity of .001 mfd. and is widely used to vary the tone of the incoming signals. Brandes 2800 ohm phones are used, which give excellent results. The wave-length of the primary and secondary circuits is increased by means of the two large loading coils. These coils are used only for arc stations having very long waves. The coils are identical in size, being 42 in. long, 4 in. in diameter and wound with No. 22 S. C. C. magnet wire. A tap is brought out every 4½ in.

My aerial is of the inverted "L" type, has four No. 14 copper wires, spaced 3 ft. apart, 65 ft. long, 55 ft. high at one end, and 50 ft. at the other. The lead-in is taken from the lower end and is composed of four No. 14 copper wires, bunched just before coming into the station, all connections being well soldered.

The ground is connected to the city water pipes and to a series of 10 ft. pipes driven down in moist earth. The lead-in from the ground to the station is composed of two ½ in. copper ribbon wires which are brought in directly to the aerial switch.

My aerial is rather small to do very much long distance work, nevertheless surprising results are obtained, from both arc and spark stations. NBA, Darien, Panama, using an arc set can be copied at all hours of the day or night, the signals being strong. NAA also can be heard both during the day and night; by adjusting M, the coil L, and the condenser C^5, NAA's spark signals can be amplified to such an extent (Continued on page 384)

Construction of a Simple Radio Telephone

By E. S. ROGERS

THE accompanying photograph shows the radiophone set which the writer built, and which has proved very satisfactory in every respect. In the following article only the constructional details and a few points on the operation of the set will be described.

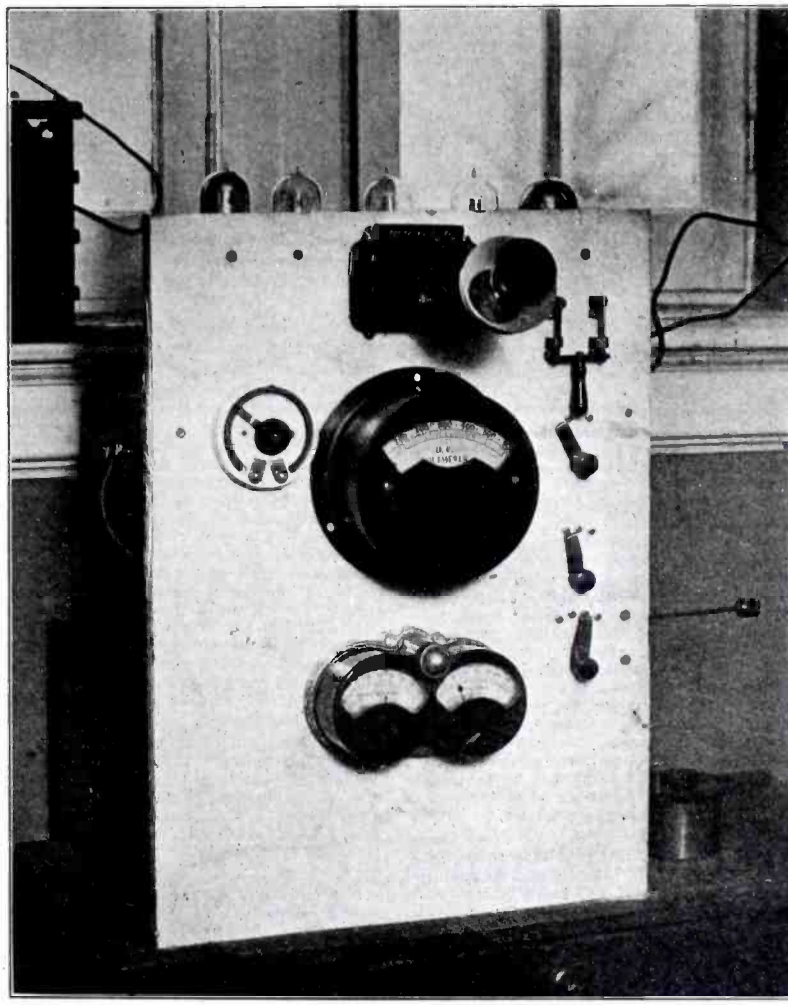
As seen in the photo, the set is mounted on a piece of marble 18" x 24". The Marconi bulbs are observed mounted at the top of the panel. The microphone shown is one of the Stromberg Carlson long distance transmitters. In the center can be seen the voltmeter which reads up to 600 volts. At the bottom of the panel is shown the milli-ammeter which is connected in series with the plate circuit, while on the right side are the switches and controls for the inductance mounted on the back. The rheostat for regulating the filament current is mounted on the left.

The inductance used in the set consists of two coils L1 and L2 and L2 is made to telescope inside of L1. The coil L1 is 4½" in dia. and is wound for distance of 4". L2 is 4" in dia. and is also wound for 4". Both coils are wound with No. 16 D. C. C. magnet wire. The filter system used, consists of two choke coils. connected in each line from the generator and shunted by two condensers of 2 mfd. capacity as shown in the diagram. A choke L4 is also connected in series with the grid of the modulator valve. The inductance L3, is of one to two micro-henrys. A small glow lamp is connected in series with the aerial lead. All connections should be made with heavy insulated wire and all the joints well soldered. The wires from the different circuits should be kept as far away from each other as possible.

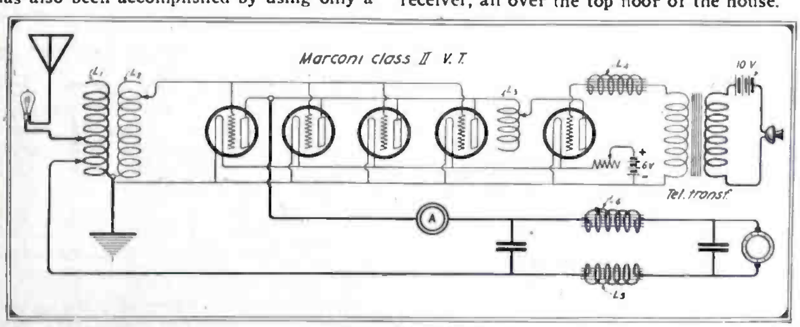
The bulbs used by the author were the Marconi V. T., Class II, as already stated. It was found that some of the "harder" tubes would oscillate on voltage as high as 500 V, but that the average would work on not more than 350 V. The motor generator used, is after all not such an expensive article as most amateurs think. A good second-hand outfit which was purchased for this set did not cost over $50.00.

In tuning the set, make the milli-ammeter and aerial glow lamps show the greatest readings for max. radiation. It is a very simple matter to see if the set is oscillating. By cutting off the switch connecting the grid to 12, the milli-ammeter will drop off in value, if the set has been oscillating properly. When the V. Ts. are working at full output the plates get very warm, often getting cherry red in color.

The voice and phonograph music have been transmitted all over town, and even received with galena receiving sets. This has also been accomplished by using only a two-bulb oscillator and one-bulb modulator. By using the whole five bulbs as oscillators, powerful signals can be produced for telegraphy. As a matter of fact, one station situated in west end of the city, has heard the signals on his one-bulb oscillator receiver, all over the top floor of the house.



Here Is a Simple Design of Radio Telephone. With This Set Mr. Rogers, a Canadian Amateur, Is Having Remarkable Success, Not Only In Voice Transmission But Also In Phonograph Concerts.



The Circuit Used Is Simple and Any Amateur Should Have Little Difficulty In Constructing This Set.

NEW WIRELESS TELEPHONE STATION.

As the North Jersey coast was selected as the field for the establishment of the first of the great transatlantic wireless telegraph systems, so has it been chosen as the proper location for experimental purposes in connection with the inauguration of wireless telephone service between Europe and America. Operations have for some time been under way on the Foxhurst farm west of Elberon on the construction of one of four wireless telephone stations along the Atlantic seaboard thru which it is hoped to make possible the carrying of the voice from one continent to the other with the same facility as now marks the sending of messages thru the ether from points hundreds and thousands of miles distant.

All the vast resources of the Western Electric Company are behind this particular wireless telephone project.

Three big towers, rising more than 160 feet into the air, already have been placed, and the complex system of ground wires laid.

The Design of Multiple Stage Amplifiers

By PROF. C. L. FORTESCUE, M.I.E.E.

THE simplest amplifying circuit is that shown in Fig. 1. Here A, G, and F are the valve electrodes, the anode, grid and filament respectively. The filament temperature is maintained by current from the battery B_1 and controlled by the adjustable resistance R_1. A steady potential is maintained between the anode and filament by the battery B_2 the

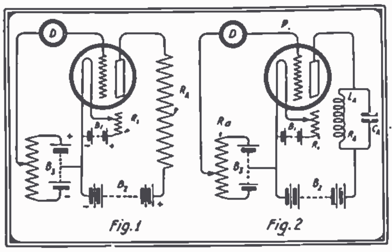
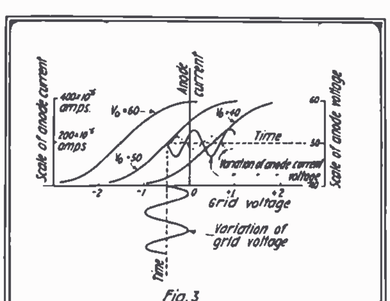


Fig. 1 Shows the Simplest Form of Amplifying Circuit. Fig 2—An Inductance and Capacity Used in the Plate Circuit.

anode current passing thru the anode resistance Ra. The small potential variations to be magnified are superimposed upon upon the steady voltage maintained by the battery B^3 between the negative terminal of the filament and the grid. These variations may be looked upon as being produced by a tiny alternator D, representing the input circuit. Under these conditions the potential variations consist of a rise above and fall below the mean potential of the grid relative to the negative end of the filament. The changes of the grid potential are immediately followed by changes of the anode current which in turn are accompanied by changes of the anode voltage due to the change of potential difference across the resistance Ra.

The curves of Fig. 3 show these variations and their relative phases, it being assumed that the variations of potential applied to the grid are more or less sinusoidal in form and of constant amplitude. The relative values of the alternating component of the voltage across Ra and the alternating grid voltage give the voltage step-up of the valve and circuit.

With this arrangement of pure resistances thruout the variation of the voltage across Ra can be made an exact reproduction of the variations of the grid voltage, provided that both are small compared with the range of voltage corresponding to the active portions of the characteristics. For low-frequency changes the conditions of the previous paragraph can be realized without difficulty. But capacity effects are serious at high frequencies (radio frequencies) and the resistance Ra may be replaced by a condenser and inductance in parallel as in Fig. 2, the circuit being accurately tuned to the frequency of the variations of grid potential.



Variations and Relative Phases of the Grid Voltage Plate Current, and Plate Voltage.

To a sustained oscillation this circuit behaves in the same way as the resistance circuit of Fig. 1. But to an oscillation of varying amplitude the behavior is quite different. For example, during the first few cycles after the oscillation is applied to the circuit the current flowing round the circuit La Ca has not been built up to its normal value and the effective amplification is less than is the case at the later stages.

With a circuit such as that of Fig. 2 the tuning of the condenser Ca becomes more and more critical as the resistance Ra decreases. The more critical the tuning the less will be the relative amplification at frequencies other than the frequency to which the circuit is tuned. An efficient circuit consequently leads to a selective amplifier. The effective damping of the circuit can be regarded as being made up of two parts, viz. (*a*) the resistance of the circuit itself; and (*b*) the equivalent resistance due to the resistance of the tube in parallel with the circuit. This latter component decreases with a decrease in the ratio of La/Ca and *vice versa*. With large values of La/Ca it constitutes the principal cause of the damping and may render the circuit almost aperiodic. Thus a circuit having a very high ratio of La/Ca cannot be efficient, and is the reverse of a selective amplifier.

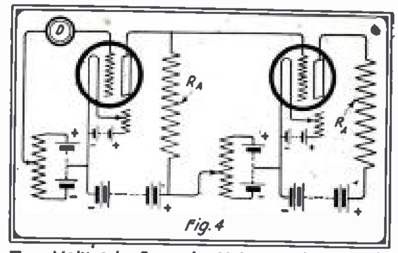
In practice, where high selectivity is essential and tuning is not objected to, the efficient circuits may be used. But where approximately equal amplification is required over a wide range of frequencies, then a high ratio of La/Ca and a valve of low effective anode resistance would be used.

Multiple-stage amplification can be obtained with either of the arrangements of Figs. 1 or 2, the anode-circuit voltage variations of each valve being applied to the grid of the valve next in the series, and so on. Fig. 4 shows a possible arrangement of two valves in cascade, using resistances in the anode circuit. Separate filament and anode batteries are required with this arrangement. In Fig. 5, however, almost the same results are obtained without this disadvantage. A similar arrangement for two valves with tuned anode circuits is shown in Fig. 6.

A cascade arrangement of valves with step-up transformers between the valves is another possible combination and is shown in Fig. 7. When allowance is made for the self-capacity of the windings this circuit is very closely allied to that of Fig. 6.

The action of any amplifying system, electrical, mechanical or otherwise, is strongly affected by any transfer of energy back from the output end of the system to the input end. With the amplifiers now under discussion, the transfer back of energy may be caused by any form of coupling between the output and input circuits. If this coupling is such that the changes at the input end are accentuated, it follows that changes of a given amplitude in the input circuit can be maintained by a smaller external power supply. In the extreme case the coupling may be strong enough to do more than maintain the changes at the input end. The system is then unstable, and if the circuits consist of inductances and capacities, oscillations will be set up and maintained. If there are no inductances or capacities, the voltages and currents will steadily change in one direction or the other until the altered slope of the characteristic curves stops the action.

On the other hand, the coupling between the ends of the system may tend to oppose the changes at the input end. More power is required then from the external source to maintain the changes in the input circuit, and the effective amplification is reduced. Obviously, the greater the opposition coupling, the poorer will be the amplification obtained.



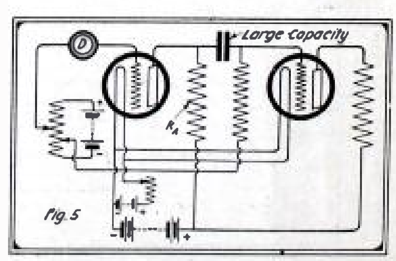
Two Valves in Cascade, Using Resistances in Place of Transformers, in the Plate Circuit.

In an arrangement giving a high amplification ratio (say 1,000 to 1 on the voltage, *i. e.*, 10^6 to 1 on power) the transfer back of a very small proportion of the power from the output end to the input end will be sufficient to render the circuits unstable, or to reduce the amplification very considerably.

It is thus a matter of the very greatest importance to secure an adequate control of the coupling between the low-power and high power ends of the instrument. This coupling may be capacity coupling or a mutual inductive coupling, or a combination of the two. Resistance coupling may also be employed in conjunction with either capacity or inductive coupling. Capacity coupling is always present to some extent. At high frequencies it is always important and is generally the controlling factor. If inductive coupling is also used, the condition actually arrived at is a balance between the two.

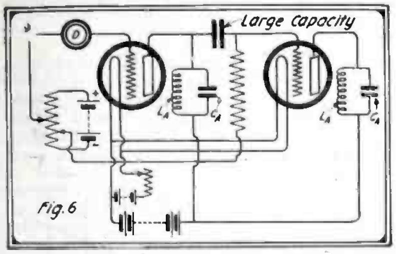
Fig. 8 shows a method of using a capacity coupling, and Fig. 9 a combination of inductve and capacity coupling. Both these systems are applicable to more than two valves, but the connections for the capacity coupling must necessarily be made to the right valves or opposition effects will be obtained.

In practice it is desirable that the action of the amplifier should not depend upon a very critical adjustment of this coupling. Consequently the unavoidable coupling



Here the Same High Potential Batteries and Filament Batteries Are Used for Both Valves. The Results Obtained Are the Same as With the Circuit in Fig. 4.

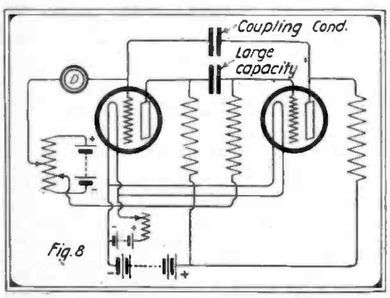
must be reduced as far as possible. For high-frequency working, one of the unavoidable sources of this coupling is the



An Amplifying Circuit Using Tuned Plate Circuits.

capacity between the grids and the anodes of the valves themselves.

A common method of designing an amplifier is to adjust it so that when the mean potential difference between the grid and filament has a particular value there is good amplification with a definite tendency towards the unstable condition. If an adjustment of the grid-filament P.D. is now provided, this tendency can be decreased or increased by making the mean grid-filament P.D. more positive or more negative. When more positive, the grid damping is increased, which increases the effective resistance of the circuits in which the oscillations are produced. Usually, also, the total amplification is somewhat reduced. Both these effects tend towards stability.



Capacity Coupling Is Used Between These Two Stages.

If the grid is made mode negative the conditions are reversed and the tendency to oscillate is accentuated.

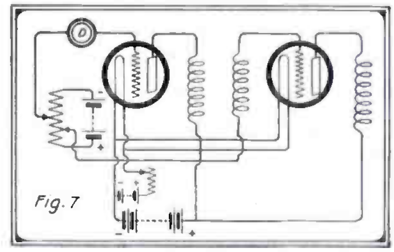
There are two quite distinct ways in which reaction can be employed. In the first place, as has already been pointed out, the tendency to produce self-maintained oscillations enables currents of a given amplitude to be maintained in the input circuit for a smaller power supply from the external source. This is in itself equivalent to amplification. Under perfect conditions, with the reaction under perfect control, it would be possible to secure anything up to an infinite amplification by slowly increasing the power supplied back to the input circuit from the output circuit until the power required from the external source becomes vanishingly small. In practice, however, there are limitations. The control soon becomes very critical and the adjustment so delicate that the least change in the conditions in the valves upsets it. Also, unless all the valves are working on points on their characteristics where the amplification is a maximum, any momentary large disturbance will slightly increase the effective amplification and cause the self-maintained oscillations to set in. Thus amplification by "reaction", which in reality is merely using the amplifier to neutralize the resistance of the input circuit, must be reduced to a very moderate amount. The modern tendency is rather in the direction of avoiding it altogether if possible, the extra amplification required being obtained by using more valves in cascade.

In the second place, where continuous waves are being received by the heterodyne method, the use of a separate set of instruments to generate the beating oscillation is avoided if the amplifier can be so controlled as to generate these oscillations itself and yet maintain its power of amplification. Many amplifiers have been designed which serve the double function fairly well, but generally there is considerable loss of amplification and simplicity of operation. The loss of amplification arises from the fact that, once the beating oscillation is started in the input circuit, it immediately builds up to a value which is large compared with the incoming oscillation to be amplified. By the time that this large oscillation has been amplified by the whole series of valves, the voltage amplitude is such that for the last valves the grid voltage is coursing to and fro far beyond the limits of the slope of the anode-current characteristics. This difficulty is leading under modern conditions to the use of separate low-power generating sets for producing the beating oscillations.

Small irregularities in the action of the valves are due to two causes, viz. (*a*) the electron emission from the filaments is apparently not perfectly uniform; and (*b*) the amount and nature of the residual gas is not constant.

Anything of the nature of imperfect contacts must be scrupulously avoided.

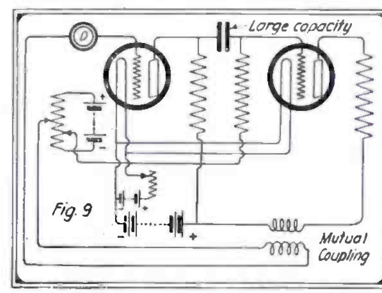
In general, the current and voltage changes which are to be dealt with in amplifiers are small compared with the voltage range of the active portions of the



Here a Step-Up Transformer Is Used Between Stages.

characteristics. So long as this is the case the characteristics may be regarded as straight lines and the changes of current calculated from the observed slopes of the characteristic curves.

This procedure involves a fundamental assumption, viz., that the ordinary static characteristic is followed even at high frequencies and with minute amplitudes. It is difficult to see why the static and dynamic characteristics should not be the same. The fact remains, however, that it never seems possible to secure the amplification per valve that is indicated by numerical calculations from the static characteristics. With high-power transmitting valves a difference between the static and dynamic characteristics is fairly definitely estab-



A Combination of Inductive and Capacity Couplings.

lished and appears to be due to surface changes of the filament. Whether some similar effect takes place in the low-power amplifying valves is a question that requires much further investigation.

Paper read before the Wireless Section of the Institution of Electrical Engineers, London, England. (Abstracted.)

A ROYAL AMATEUR

PERHAPS you did not known it, but King Alphonso is much interested in radio as the accompanying photograph shows.

At the recent opening of the National Engineering Exhibition the King of Spain evinced great interest in the wireless apparatus, which permitted him to listen to communication being carried on between the station of Nauen and one in America. Our photograph shows His majesty listening in on the special apparatus, so designed that reception and interception

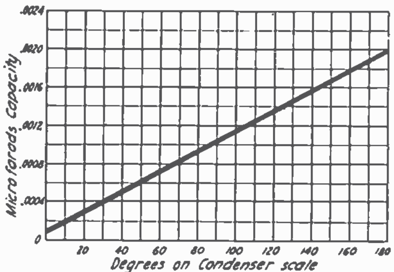
can be effected without the use of a large aerial, although the transmitting stations are very far distant.

In his earlier days King Alphonso was considered a great sportsman and he was keen on all scientific experiments. At present considerable interest in radio prevails amongst royalty and nobility in Europe, not only in the commercial radio but also the amateur side of it as well. It is said that many of the higher minds are well along on the road to the realm of radio bugs.

Rebuilding the Station

By P. F. GEAGAN

NOW that amateur stations are again allowed to operate there is a great deal of activity in the line of placing in commission stations that have been inactive since the outbreak of the war and the closing of all



If You Know the Maximum Capacity of Your Condenser This Curve Will Enable You to Calibrate the Condenser.

stations by the government. Much advance has been made in radio communication during the time that the operation of private stations has been forbidden, and the owners of such stations have read a great deal in the magazines and periodicals devoted to radio in regards to, and in explanation of, the many improvements. Naturally all experimenters have been impatiently waiting for the time when the ban would be lifted, and they would again be able to try for themselves new appliances and circuits about which they have been reading.

In consequence there is at present much digging up of apparatus long lain idle and feverish activity in preparation to get back into the fascinating game, and to listen once more to familiar, faraway sparks. Perhaps without exception all have made mental reservation when planning this resetting up of their station, that it would be an improvement over the old one in many ways, and the purpose of this article is to describe a few simple methods which will enable one to know approximately the values of wave length, inductance, and capacity he is using, without having to make a greater outlay of money than perhaps can be spared.

Of course without knowing the quantities one is handling, getting efficient work out of a mixed lot of apparatus is largely a hit or miss proposition, and it has often happened that the amateur has faithfully followed a method of connection for which much is claimed in a magazine without achieving the looked for results, due to the fact that the values used, unknown to him, were entirely out of proportion. It is of advantage to know the natural wave length, the capacity, and the inductance of the antenna. The wave meter is used to obtain these values, but it is, in most cases, too expensive a piece of apparatus for the experimenter to enjoy. It is possible however to improvise one which will give these values approximately. Variable air condensers are obtainable at moderate cost, and one of these used with several coils of wire of known value of inductance and a small low voltage lamp, such as is used in pocket flashlights, will measure wave length, capacity, and inductance over a considerable range.

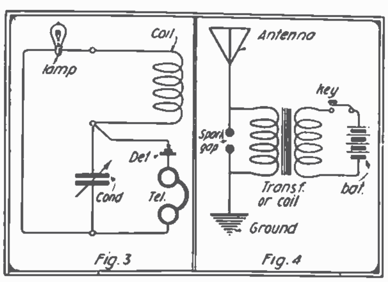


Fig. 3—Method of Connecting an Improvised Wavemeter.

Fig. 4—Exciting the Antenna by Means of a Spark Coil.

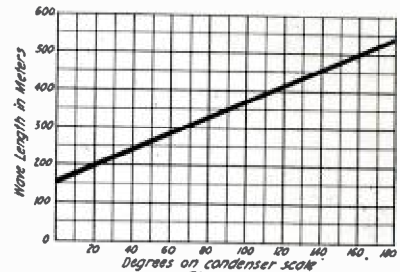
The condenser should be calibrated for capacity, that is, a curve sheet should be furnished with it, showing the variation in capacity from zero to one hundred and eighty degrees of the scale. I believe there are condensers to be bought which furnish such a curve with the condenser, but if one cannot be located, a curve may be drawn that will be fairly accurate, provided the maximum capacity of the condenser is known.

This is marked by the maker in most cases and Fig. 1 shows a curve which would be fairly accurate for a condenser having a capacity at full scale, at one hundred and eighty degrees, of .002 mfd. It is necessary only to lay off at the bottom of a sheet of co-ordinate paper the condenser scale degrees from zero to one hundred and eighty in equal divisions, in like manner mark the left hand side of the sheet in micro-farads, starting with zero at the bottom, and marking divisions equally upward. It is desirable to so divide the number of divisions as to bring the maximum or full scale capacity figure near the top of the sheet, so as to make the curve long and easier to read. It also reduces the error and the liability of mistake in reading to a minimum. *Because of the capacity between the plate edges it is not possible to obtain zero capacity,* and so we must start the curve from some point above zero. This capacity between plate edges is very small however and so we may adopt a point a few divisions above zero to represent it. The capacity at full scale or one hundred and eighty degrees, we mark at the point where the line marked one hundred and eighty and the line marked .002 intersect and draw a straight line from this point to the one marked on the left-hand edge above zero. The capacity of the condenser at any point on the scale then is read at the left-hand side of the sheet where the line from that point, and the line from scale division which we desire to read cross on the diagonal or curve line.

Thus, referring to Fig. 1, the capacity at forty degrees would be .00051 mfd., and at one hundred and twenty-seven degrees would be .001444 mfd. In fixing the zero capacity point consideration must be given to the design of the condenser. If it be built up of a comparatively large number of plates of relatively small area, the edge capacity would obviously be greater than if built of half as many plates of twice the area. Due to the arbitrary method of fixing the zero point there will be a slight error at the lower portion of the curve, this disappears, however, as we go up the curve provided the maker's rating mark is correct.

The inductance coils are not so easy of calibration, and while there are a number of formulae available for calculating the inductance, they are more or less complicated and present a liability of error. It is much better to rely upon comparison or measurement to get these values.

Since the average antenna at amateur stations is of short wave length, it will be necessary to have our number one coil of small value. It should be wound in the pancake form and preferably with Litz wire, it should also be wound upon a form



With This Curve the Wavelength May Be Read Directly from the Condenser Scale.

and held rigid so that the turns may not change position and so vary the inductance value in handling.

Some radio clubs own collectively a wave meter, and in such cases the value of the coil may be obtained by comparison with the wave meter in the following manner. If any oscillating circuit be used to excite the wave meter and a reading obtained, we may then substitute our condenser, coil, and lamp, connected in series, for the wave meter and find the resonance point on the condenser scale. This will be when the lamp glows with greatest brilliancy. It is desirable to make the coupling between the two circuits only strong enough to make the lamp glow a dull red at resonance, as this enables a closer reading to be taken than if lighted brilliantly. Let us assume that such an exciting circuit measures two hundred and fifty meters on the wave meter, and our improvised meter indicates resonance at thirty-six degrees on the condenser. By referring to our condenser capacity curve, Fig. 1, we find that the capacity of the condenser at this point is .00047 mfd., or 423 cm. Using the formula $\lambda = 2\pi\sqrt{CL}$, all in centimeters, (cm.), Then $25000 = 6.2832\sqrt{423L}$

$$\text{or } \frac{25000}{6.2832} = \sqrt{423L}$$

$$\text{or} \left(\frac{25000}{6.2832}\right)^2 = 423L$$

$$\text{or} \frac{\left(\frac{25000}{6.2832}\right)^2}{423} = L$$

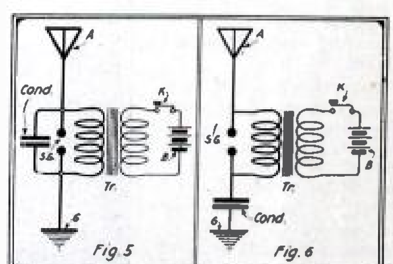


Fig. 5—A Condenser Should Be Used Across the Gap if the Spark Is Not Sharp and White.

Fig. 6—Here a Condenser Is Inserted in the Ground Lead.

This worked out gives a value of 37429 cm. or 37.429 M.H. inductance, the value of the coil. The other larger coils may be worked out in like manner and a wave length curve plotted for each.

To construct this wave length curve, after having obtained the inductance values of our coils, and using the same formula as above, $\lambda = 2\pi\sqrt{CL}$, we figure the wave length at, let us say, two points on the condenser scale, twenty and one hundred and fifty degrees. Referring again to our condenser curve, Fig. I, we find the capacity

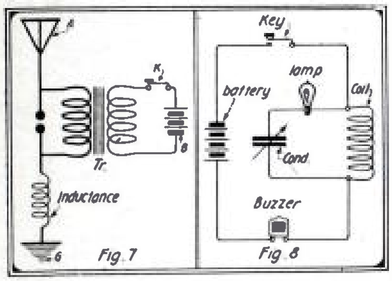


Fig. 7—An Inductance Used in the Ground Lead.

Fig. 8—Here the Wavemeter is Used as a Driving Circuit.

at twenty and one hundred and fifty degrees to be .0003 and .00169 mfd., respectively, or multiplying by 900,000 to convert into cm. 270 and 1521 cm. These values multiplied by the inductance in cm. of coil number one, the square root of the products extracted, and these roots multiplied by 2π or 6.2832, gives us 20000, and 47406 cm., or 200 and 474 meters wave length, respectively. From these values we can now construct a wave length curve similar to our condenser capacity curve, plotting condenser degrees at the bottom of the sheet as before, and meters wave length at the left-hand side. Marking the points where the lines from twenty and one hundred and fifty degrees intersect the lines from 200 and 474 meters, we draw a straight line thru these points from the left-hand margin of the sheet to the one hundred and eighty degree line. This curve, Fig. II, gives us the wave length at any point on the condenser, reading in the same manner as the condenser capacity curve.

Two or more additional coils may be wound and calibrated in like manner, depending on what wave lengths it is desired to measure. The coil values should be such that the resultant wave lengths will overlap, that is, coil number two curve should start below five hundred and forty-five meters, the limit of coil number one.

If a wave meter is not at hand for making comparison, and a coil of known inductance cannot be purchased, it is possible to obtain an approximate measurement in the following manner:

The antenna circuit of the receiver should be tuned closely to some signal of ship or station of which we know the wave length, and couple it to our improvised wave meter with a crystal detector and telephones across the condenser as in Fig. III. Most ships and stations send on a wave length of six hundred meters, or very close to it, so it will not be difficult to obtain a signal of this wave length on which to work. After tuning the antenna circuit as closely as possible, using the regular receiver, reduce the coupling between the primary and secondary coils to a minimum and open the secondary circuit, couple the wave meter coil to the antenna circuit inductively making sure that there is no coupling to the secondary circuit. Then without disturbing the antenna circuit adjust the wave meter condenser to maximum response in the telephones across the condenser. The circuit is then set at approximately six hundred meters, and after we have read our condenser value from the capacity curve we can extract the inductance value of the coil proceeding as with the wave meter comparison. This method will not be as accurate as the other, due to the detector and telephones across the condenser, unless the detector and telephones be used to indicate resonance when measuring wave length instead of the lamp.

We see in the question column of the radio magazines a great many requests for the wave lengths of various antenna, and with such an arrangement as described here this measurement is easily obtained. It is only necessary to excite the antenna as in Fig. 4, couple our meter to it, and measure by reference to the wave length curve for the particular coil used. Any small spark coil may be used to excite the antenna, and as steady a spark as possible should be maintained while taking the measurement, for the reason that if the spark be ragged and broken, a fluctuating reading results which is difficult to read. If exciting from a transformer of considerable power an arc is apt to form at the spark gap and this is to be avoided, the spark should be sharp and white, not soft, red and wavy. If trouble is experienced in getting a proper spark, a condenser capacity placed across the gap, as in Fig. 5, will remedy the trouble provided the value of the capacity is not too great or too small. A condenser capable of withstanding high voltage must be used also, or it will break down.

This reading should be taken with all turns of the sending helix out of circuit, the antenna going as direct as possible to the spark gap, and as direct as possible to ground. In most cases it is necessary to wrap the antenna or ground lead around the wave meter coil a few times in order to obtain sufficient coupling between the two circuits; sufficient insulation to prevent sparking to the wave meter coil must be provided, however, in order that the meter oscillation be due entirely to resonance and not forced by direct coupling.

If it is desired to obtain the antenna capacity or inductance, or both, a second reading must be taken after inserting a known value of capacity or inductance in the antenna circuit as in Fig. 6 and Fig. 7. This capacity must be constructed so as to withstand the high voltage and of not too great value. Denoting the first measurement in meters wave length, or the antenna natural, by λ, and the second reading, with, let us say, a condenser of .001 mfd. capacity in series in the antenna or ground lead, by λ_1, then the antenna capacity $C = \frac{\lambda^2 - \lambda_1^2}{\lambda_1^2} \times .001$. Let us suppose an antenna measuring natural two hundred meters, and with .001 mfd. in series, measuring 165 meters, then by the formula above the antenna capacity $C = \frac{(200)^2 - (165)^2}{(165)^2} \times .001$ or .00046 mfd.

If an inductance be used the same procedure is followed, but the formula becomes $L = \frac{\lambda^2}{\lambda_1^2 - \lambda^2} \times L_1$ where L equals the antenna inductance in cm., L_1 the known inductance inserted in series in cm., λ the antenna natural wave length in meters, and λ_1 the wave length with known inductance in series.

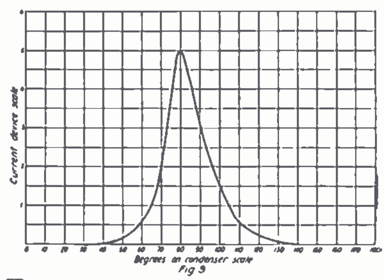
If either the capacity or inductance be found the other may be readily extracted from the formula used in plotting the wave length curve $\lambda = 2\pi\sqrt{CL}$. In the case above the natural wave length being two hundred meters or 20000 cm., and the capacity .00046 mfd., or 414 cm., then

$$20000 = 2\pi\sqrt{414\,L}$$

$$\text{or } \frac{20000}{6.2832} = \sqrt{414L}$$

$$\text{or } \left(\frac{20000}{6.2832}\right)^2 = 414L$$

$$\text{or } \frac{\left(\frac{20000}{6.2832}\right)^2}{414} = L$$



Resonance Curve of the Transmitter.

This worked out gives a value of 24472 cm., or 24.472 mh. inductance for our antenna.

Once the capacity and inductance of the antenna are known it becomes a simple matter to calculate how much inductane will be necessary to add to the antenna circuit to reach a certain wave length, or how much capacity we must insert to reduce to a certain wave length. For instance, using our antenna described above, having a fundamental of two hundred meters and capacity and inductance of respectively .00046 mfd. and 24.472 mh., we wish to know how much inductance we must add to reach a wave length of twenty-five hundred meters. The formula then becomes $\lambda = 2\pi\sqrt{.00046\,(24{,}472 + L)}$, or to put the values into cm. $250000 = 6.2832\sqrt{414\,(24472 + L)}$

$$\text{or } \frac{\left(\frac{250000}{6.2832}\right)^2}{414} = 24472 + L$$

$$\text{or } \frac{\left(\frac{250000}{6.2832}\right)^2}{414} - 24472 = L$$

This worked out gives a value of 3799404 cm., or 3799 M.H. We find then that it will be necessary to add this amount of inductance to the antenna to reach a wave length of twenty-five hundred meters, and if a curve of the inductance coil in use be plotted, taking several measurements in the same manner as in calibrating the wave meter coil, the inductance for any number of turns may be readily ascertained from the curve.

If desired, the receiver, both primary and secondary, may be calibrated and marked in wave lengths by using the wave meter as a driving circuit and sending out waves of known length to which the receiver circuits are tuned. A buzzer is connected to the wave meter as shown in Fig. 8, and the meter set at different wave lengths. With the buzzer in operation the wave meter coil is coupled loosely to the receiver and the receiver tuned to the maximum signal strength, each point being marked as found.

Those fortunate enough to possess a current operated device in the form of a meter to use instead of the small lamp, may determine the logarithmic decrement of their circuits if so desired. This is a profound mystery to many, but is to be found easily if a quantitative reading device sufficiently sensitive is at hand. The method of procedure is as follows: The spark should be as smooth and regular as is possible to obtain in order to prevent fluctuations of the needle. With the wave meter coupled loosely to the circuit to be measured find the point of resonance or wave length, we will denote this by λ. Then without changing the setting of the wave meter, move it into closer coupling until the current reading device reads nearly full scale, next rotate the meter condenser in the direction of longer wave length until the scale reading of the current device drops to one-half its highest reading. Read this wave length and denote by λ_1. Turn condenser back toward low wave length until scale reading of current device rises to maximum and falls again to one-half maximum, read this wave length and denote by λ_2. The total decrement then is equal to $D = 157 \times \frac{\lambda_1 - \lambda_2}{\lambda}$, all three in meters. Since this represents the decrement of the circuits being measured plus the decrement of the meter itself, which we will designate as D_1, the decrement of the exciting circuit is equal to $D = 1.57 \times \frac{\lambda_1 - \lambda_2}{\lambda} - D_1$.

The meter decrement of course will vary with different coils and condensers, but with condensers of approximately .0025 M.F. capacity and well-built coils of Litz wire in pancake form an approximate value may be struck at .05. It should be borne in mind that this value will vary a good deal depending on the construction and values of the coils and condenser, however, even though the error be large it will be of interest to experimenters to make the measurements.

In tuning up the transmitter it is desirable to have the proper ratio of transformation in the oscillation transformer and not too much or too little of the inductance in the loading coils, it being possible to have the two circuits in resonance and still have poor efficiency due to an improper ratio in the oscillation transformer. By means of the wave meter each circuit may be measured separately after setting to best radiation in order to ascertain what difference if any exists in the wave lengths of the two circuits, and also set at different ratio of transformation using the same wave length.

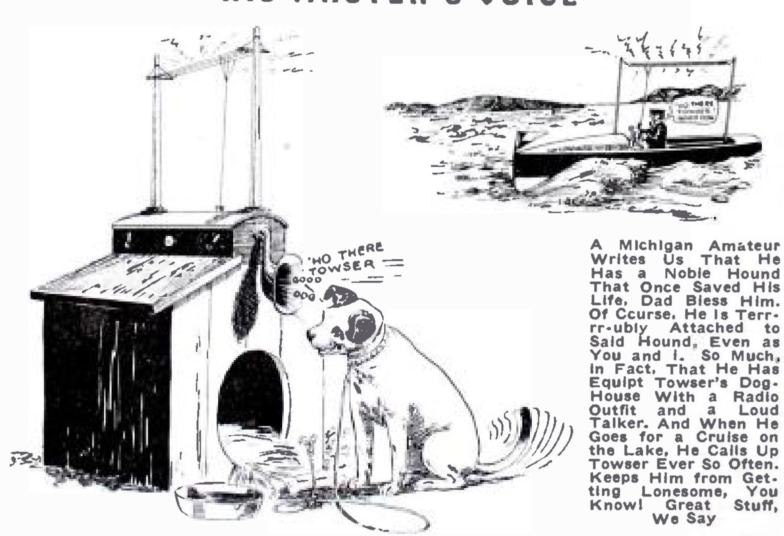
Many interesting measurements may be made with the wave meter. Plotting the resonance curve is one that appeals strongly. To do this the current quantitative reading device is necessary as in measuring the decrement. Setting a clear steady spark into operation and coupling the wave meter to the circuit close enough to obtain nearly a full scale deflection at resonance, we take a series of readings starting at zero on the wave meter condenser scale and reading the current device, lt us say, every ten or fifteen degrees to one hundred and eighty degrees. We may then plot the curve as in Fig. 9, marking degrees of condenser scale at the bottom of the sheet, and current device scale readings at the left-hand side. Marking the points where the lines for each reading intersect and drawing a line thru all the points we have a graphic representation of the manner in which the current rises to maximum and falls to minimum at each alternation or reversal of current flow. By setting the coupling between the open and the closed circuit at different degrees of closeness and plotting a curve for each setting we obtain a number of differently formed resonance curves, provided there is sufficient flexibility in our oscillation transformer. A series of such curves show distinctly the advantage of keeping the logarithmic decrement below a certain value.

It is desirable to mount the condenser and lamp of the wave meter in some substantial way, and make provision on the coils for connection, binding posts, or something similar. The connecting wires should be of low resistance, preferably of copper or brass strip, the idea being that once it is calibrated there should be no change that might produce an error, such as different lengths of leads or positions of parts with respect to one another.

The time and money spent on such a device would be considered well spent by the experimenter, and the editors of our radio publications would obtain some relief from the tedium of answering the mass of inquiries as to the wave length of different antennae.

Squier "Wired Wireless"

"HIS MASTER'S VOICE"



A Michigan Amateur Writes Us That He Has a Noble Hound That Once Saved His Life, Dad Bless Him. Of Ccurse, He Is Terr-rr-ubly Attached to Said Hound, Even as You and I. So Much, In Fact, That He Has Equipt Towser's Dog-House With a Radio Outfit and a Loud Talker. And When He Goes for a Cruise on the Lake, He Calls Up Towser Ever So Often. Keeps Him from Getting Lonesome, You Know! Great Stuff, We Say

"Wired wireless" is a system of guiding radio currents by means of a wire. The currents travel thru the air alongside the wire, which guides them to their destination. The method eliminates one fault of the ordinary radio, which sends the messages broadcast in all directions. Under the Squier method the wave currents stay close to the wire, thus insuring reliability and secrecy.

The principal difficulty in long distance telephoning has been that to carry the direct current to a great distance requires conductors so large as to be almost impracticable. The new method has adapted an alternating current of high frequency to the use of the telephone thru adaptation of the instruments used in wireless telegraphy to the purpose.

The high-frequency current travels along the wire, but not in it, passing thru the ether as do radio waves, with the difference that instead of being diffused it travels in a path of which the wire serves as a core. Enthusiastic persons who know of General Squier's work believe that as many as fifty messages may be sent along one wire simultaneously.

The congestion of telephone and telegraph service during the war gave an impulse to further experimentation with the new method, with the result that those interested in the work believe they have found a way to eliminate wire congestion for good and all. On the ordinary telephone wire an alternating current is used, employing a frequency of from 750 to 2,500 cycles a second. The Squier method increases the frequency and rapidity of the vibrations so that they "step up" to as high as 500,000 cycles a second, a feat which electrical experts had thought impossible.

The perfection of a method of "wired wireless," by means of which at fewest ten and possibly more conversations may be carried on simultaneously by means of a single wire by persons thousands of miles apart, will soon be announced by Major Gen. George O. Squier, Chief Signal Officer of the army.

The method makes long distance telephone communication virtually limitless. Conversations from Nome to Rio, and from Argentina to Alaska will be a matter of course, provided single wires are strung between the points mentioned. The new method will save telephone and telegraph companies large sums of money, as by its use one wire will do the work now done by ten or more.

It is expected to put the new method in practical operation between New York City and Albany in the near future.

Successful tests of the method have been made by Government experts recently along the line of the Harlem Division of the New York Central Railroad. The experiments are still going on, but the results have been so gratifying that General Squier will soon make his formal announcement.

In removing the insulation from Litz wire apply a flame at the place to be bared, rub lightly with emery paper and finally dip it in sulphuric acid. This insures a clean surface for soldering.

A Trigger Relay Utilizing Three-Electrode Thermionic Vacuum Tubes

By W. H. ECCLES, D.Sc. and F. W. JORDAN, B.Sc.

IN a well-known method of using a triode* for the amplification of wireless signals an inductive coil is placed in the filament-to-anode circuit, and another coil magnetically coupled with this is introduced into the filament-to-grid circuit. This "back-coupling," as it is sometimes conveniently called, if it is arranged in the right sense, greatly exalts the magnification produced by the tube in any alternating E.M.F. applied to the grid; for the induced E.M.F. passed back to the grid is in correct phase relation to add directly to the original alternating E.M.F. applied there. If, instead of using inductive retroaction of this kind, we attempt to use resistance back-coupling, then the retroactive E.M.F. applied to the grid is exactly opposite in phase to the original alternating E.M.F., and the amplifying action of the triode is reduced. Since, however, one triode can produce opposition in phase in the manner indicated, it is clear that two or any even number of similar triode-circuits arranged in cascade can produce agreement in phase. Hence we conclude that retroactive amplification can be obtained by effecting a back-coupling to the first grid from the second, fourth, and so on, anode circuit of a set of triodes arranged in an ohmically-coupled cascade.

It is possible to take advantage of the fact above stated for obtaining various types of continuously-acting relay, but the purpose of the present communication is to describe what may be called a one-stroke relay which, when operated by a small triggering electrical impulse, undergoes great changes in regard to its electrical equilibrium, and then remains in the new condition until re-set.

In what follows, the circuit comprising the space in the tube between anode and filament, the external conductors and the source of E.M.F., will be called the anode circuit, and the current flowing in it the anode current. The circuit comprising the space in the tube between the grid and the filament, external conductors and a source of E.M.F., will be called the grid circuit, and the current flowing in it the grid current.

The operation of the relay is most easily explained when two tubes, each with resistances and battery in its plate circuit, and with a resistance and battery in its grid circuit, are used and interconnected in the manner shown in Fig. 1.

The electrical stimulus from outside which it is desired to detect and magnify is applied in the grid circuit in the first tube so as to make the grid transiently more positive in potential relative to the filament. This causes an increase of current in the plate circuit of the first tube, and consequently an increase of the P.D. between the terminals of its plate circuit resistance. This increased P.D. is transferred to the grid circuit of the second tube in such a manner that the grid becomes more negative than before relative to its filament. Consequently the plate current of the second tube decreases, and the P.D. between the terminals of its plat circuit

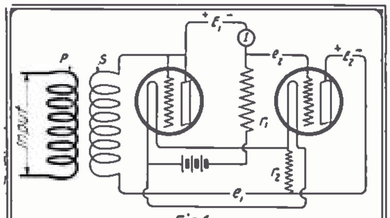


Fig.1

A New Relay Circuit in Which the Electrical Condition Continues After the Original Impulse Has Stopped.

resistance decreases also. This decrease of P.D. is now transferred to the grid circuit of the first tube in such a manner that it tends to make the grid more positive relative to the filament. The result of these processes is that a positive stimulus from outside given to the grid of the first tube initiates a chain of changes which results finally in the plate current of the first tube attaining the highest value possible under the E.M.F. of its battery, and the plate current of the second tube falling to its lowest possible value. This condition, therefore, persists after the disappearance of the initial stimulus. In the initial condition, with the two-tube arrangement just described, the plate current of the first tube is made very small, and that of the second tube large; after the reception of the outside stimulus on the grid of the first tube the final condition is a large plate current in the first tube and a small plate current in the second tube. Either the decreases or the increases of plate current can be used for indicating. In order to restore the initial conditions it is easy to interrupt for an instant the linkage between the tubes, or to stop the operation of one or both of the tubes, as, for instance, by dimming its filament.

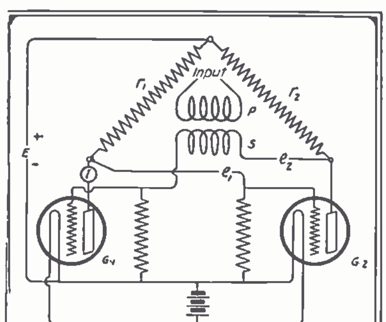


Fig. 2

Another Circuit in Which the Relay Has to Be Reset in Order to Restore the Original Conditions.

The external stimulus is led into the primary *P* of transformer *PS*, of which the secondary is connected to grid G_1. The plate circuit of this first tube contains the indicating instrument *I*, such as an ammeter or a moving tongue relay. The resistance r_1 in the plate circuit of the first tube has its terminals connected to the filament and grid of the second tube. Similarly, the resistance r_2 in the plate circuit of the second tube has its terminals connected to the filament and the grid of the first tube. The plate circuits contain batteries E_1, E_2, and the grid circuits batteries e_1, e_2. The following values are typical, and show the performance of the relay:—

E_1=78 volts. E_2=74 volts.
r_1=22,000 ohms. r_2=12,000 ohms.
e_1=31 volts. e_2=17.5 volts.

The change in the indication of an ammeter at *I* is from 0—2.5 micro-amperes.

The sensitiveness of the arrangement depends on the transformer *PS* to some extent. Using a telephone transformer of the kind made for Army C Mk. III. Amplifier with 20 ohms resistance in the primary, and with the primary connected to a Brown telephone of 60 ohms resistance, the relay is operated with certainty by snapping the thumb and finger at a distance of five feet from the telephone.

Fig. 2 shows another mode of inter-connection of two tubes. The stimulus from outside is introduced to the grid of the first tube through a transformer, as before, and the indicating instrument is again placed in the plate circuit of the first tube. The two plate circuits are in parallel with a common battery *E*, and the connections are such that the changes of P.D. between the anode and the filament of the first tube are imposed between the filament and grid of the second tube, and the changes of P.D. between the anode and filament of the second tube are imposed between the filament and grid of the first. In order to help to maintain the grids' advantageous potentials, grid leak resistances are connected as indicated.

The following numerical values are typical dimensions:—

E=80 volts.
r_1=r_2=100,000 ohms.
e_1=e_2=40 volts.

The sensitiveness of this relay could be made greater than that of Fig. 1, when these large resistances are used.

The circuits described here were the subject of a patent, No. 10290/1918, taken out by the English Admiralty, and the description is now published by permission.

Paper read before the British Association. Section G (Engineering)

* A new English term for a three electrode vacuum tube, i.e., audion.

Women Radio Operators Get Licenses

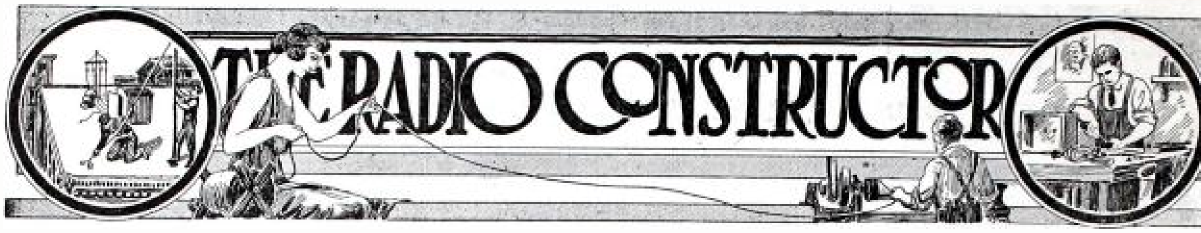
"There are now thirty licensed women wireless operators in New York City. They have formed an organization of their own. Some of them are engaged in other occupations and have taken up wireless telegraphy as a hobby."

As a rule the older men who come to Chief Radio Inspector Krumm of the Second District for a license are a bit shy about confessing their weakness for the hobby. In many instances they pretend that they are simply providing a little fun and a profitable pastime for their little sons.

"The other day the president of a wire concern came to me for an amateur license," said Mr. Krumm. "He wanted to set up an outfit at his Riverside Drive home that would cost at least $5,000. At first he was trying to tell me that he was doing it for his little boy.

"We got to talking about things in general and at last the manufacturer, who is 56 years old, came out with the reason why he spends his leisure moments listening to the wireless ticks.

"In the old days, he told me, he started life as a telegraph operator at $30 a week. Now he is worth a couple of thousand times that amount. One of his closest friends is a Wall Street broker. In the days gone by the two men worked side by side as telegraph operators."



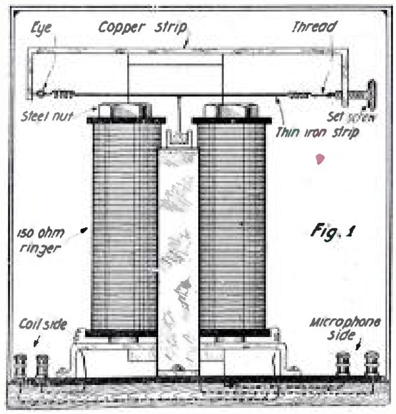
A Sensitive Amplifier

By RAY T. FOSTER

THE instrument which I am about to describe is not very hard to make.

Before you start, look around your work table and gather together the following: One two thousand ohm ringer such as is used in telephones (be sure the circuit thru the coils is not broken). One foot of copper or brass strip; this should be three-eighths or one-half inch wide and heavy enough to require pliers to bend to shape. Two steel nuts or several steel washers (see description below). Two small coil springs about half an inch long made from No. 30 spring brass wire. A brass cup taken from a flash light battery. A piece of the thinnest iron or tin strip about six inches long and about one-quarter of an inch wide. Now get one thumb screw together with a few small wood screws and you are ready to begin.

First take the old ringer and remove the clapper arrangement, and let it clap around against articles on the work bench for possible future use! Hunt up a piece of wood suitable for a base board and mount said ringer on it near or about the center, then connect the two leads from the coils to binding posts near one end. Now take the copper strip and cut off about eight inches; bend each end over at right angles for one inch. In one of these ends drill a hole the size of the aforementioned thumb screw and thread it. In the exact center drill a one-quarter inch hole. Now mount this piece on the extreme top of the ringer movement as shown in Fig. 1.



Showing the Constructional Details of the Amplifier. Note the Connections in the Base.

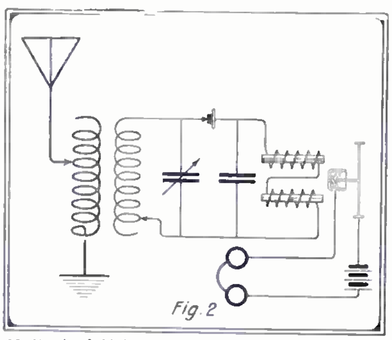
Take the thin iron strip and the two small coil springs and proceed as follows: Solder one of the coil springs to one end of the thin strip and tie a short piece of common sewing thread to the other end of the spring. Now solder a small eye to the point of the thumb screw on the upright; take the iron strip with the coil spring attached and tie loose end of the thread in this eye. Tie it up short, leaving only about one-quarter of an inch between the spring and the thumb screw. The strip should now be stretched across just above the ends of the magnets. Cut off short enough so that the other coil spring can be soldered to it and still have just room enough left to hook it on a small hook which is to be soldered directly in a line with the thumb screw on the other side.

Next take the two steel nuts or the washers, which should fit tightly over the tops of the coil poles, and magnetize them by rubbing them on a permanent magnet. In doing this see that the pole pieces are turned so that there will be a positive and a negative pole at the top. Take the remainder of the copper strip and bend over at right angles to the length of three-quarters of an inch from one end. The small cup taken from the battery should be soldered to this short piece on the top side. Now measure it so that this cup will come up about level with the top ends of the coils on the ringer movement as shown in the figure, and bend over the other end for a distance of one inch. Drill a small hole to take a wood screw and fasten to the board so that the cup will come directly under the center of the iron strip. Next solder a common brass pin to the center of the iron strip. The purpose of this pin is to dip into the cup to about half its depth. This cup is to be filled with carbon grains until the grains touch the needle. If you have no carbon grains take a piece of carbon and a coarse file and file off enough of the carbon to fill the cup. This will work well but the grains are to be preferred.

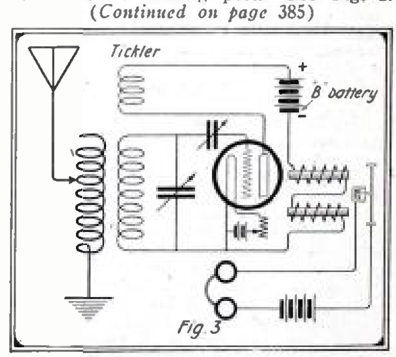
Place two binding posts on the other end of the board. Connect one lead from the upright to which the brass cup is attached and the other lead from the frame of the ringer.

The operation of this apparatus is as follows: Lead a wire from one side of your detector circuit to the binding post to which the ringer coil is wired and another lead from the other side of the detector circuit to the other binding post. See Fig. 2.

(*Continued on page 385*)



Method of Using the Amplifier With a Crystal Detector.



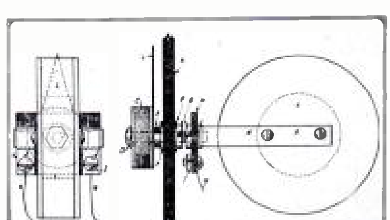
This Shows the Amplifier Connected In an Audion Circuit.

Mounting For Rotary Tuning Coils

To evolve an efficient mounting for the rotary tuning coils, now so much in vogue, is a thing that every experimenter is up against at present. To be efficient it must conform to at least two different things besides being srong.

First—It must be stable; that is, it must be so balanced that it will stay in the position you place it, no matter what its angle to the vertical, without necessitating any undue friction.

Second—It must be so constructed that the coils can be changed quickly without having to change connections, unscrew and fasten nuts, etc.



Here Is a Method of Mounting Rotary Inductances.

The mounting that is presented here conforms to both of these conditions fully. The coil A is composed of a wooden core ¾ in. thick and 2 in. in diameter. The sides are of wood or hard rubber ⅛ in. thick and of an approximate diameter of 4 in. which will vary according to the amount of wire on the coil. Old phonograph records are suitable for this purpose. On each side of this coil is fastened a piece of copper or brass bar 1/16 in. thick, ½ in. wide and from 3½ in. to 4 in. long, the end of which is bent out at right angles ½ in. from the extremity of the bar. The distance from the center of the coil to the ends should be the same in all the coils and provision should be made for the length of the bar accordingly. This is shown as B.

Next procure the following materials:
(C) 1 hard rubber knob, about ½ in. thick—1½ in. in diameter.
(D) 1 brass bolt, ¼ in. in diameter—1¾ in. or 2 in. long.
(E) 1 brass pillar, ¼ in. high with a ¼ in. threaded hole thru it.
(F) 2 brass washers, ½ in. or ¾ in. in diameter—¼ in. hole.
(G) 2 brass ¼ in. nuts.
(H) 1 pc. bakelite, ⅛ in. thick—1½ in. by 2 in. in size. Hard rubber may be used.
(I) 2 small brass bolts with nuts.
(J) 2 pcs. heavy phosphor-bronze strip, ½ in. wide—1½ in. long.

First bend the phosphor-bronze strips J to the shape shown in the drawing, then fasten with the bolts I to the bakelite piece H as shown after having bored a ¼ in. hole in the piece of bakelite. Then after boring a ¼ in. hole in the panel K which is represented as being ¼ in. thick, assemble the various parts as shown fully in the drawing. A pointer L can be added as desired.

Each of the ends of the wire on the coil should be soldered to one of the bars B as at M and flexible terminals N soldered to each spring J. By means of this construction when the coil is inserted in the holder the connections are made automatically.

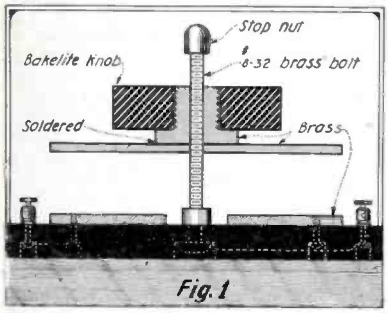
A similar clip should be made to fasten on the bottom of the cabinet to hold the stationary coil when three coils are used to tune with.

This mounting should attract the attention of those "bugs" who are looking for a serviceable and efficient mounting for their tuning coils.

Contributed by EUGENE M. RIEL.

A Variable Condenser

In the experiments which the radio amateur is performing to-day, the variable condenser is an important piece of apparatus, and several are required in nearly



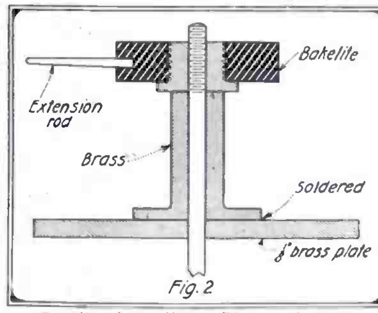
The Capacity of This Condenser Is Varied Thru Increasing or Decreasing the Distance Between the Plates by Turning the Knob.

every hook-up. Reliable variable condensers are rather expensive and therefore many experimenters have attempted to construct their own. The construction is a difficult task, however, on account of the great accuracy necessary in the alignment of the plates, and the skill required in the general construction. Some time ago the author was confronted with the same problem and no doubt his solution will be of interest.

The capacity of a condenser depends upon three factors: The area of the conducting surfaces, the distance between them and the nature of the dielectric. Now, in order to adjust the capacity, it is necessary to make at least one of the above factors variable. In order to change the area of the conducting surfaces, it is necessary to construct a condenser of the "moving plate type" or the "tubular type." This construction is rather difficult, and the average experimenter lacks the proper tool equipment to do a good job. For obvious reasons we will not consider changing the nature of the dielectric. Therefore, we have one possible solution to our problem, and that is to change the capacity of the condenser by varying the distance between the plates.

It is possible with a condenser of this type to obtain a variable capacity large enough for practical purposes, and also one of very delicate adjustment. The dielectric is air, and if calibrated, the condenser will give very accurate results for measuring purposes. If a larger capacity is desired, it may be used in connection with a fixt capacity.

Fig. 1 shows the method of construction and further details are unnecessary.



Details of the Upper Plate and Knob.

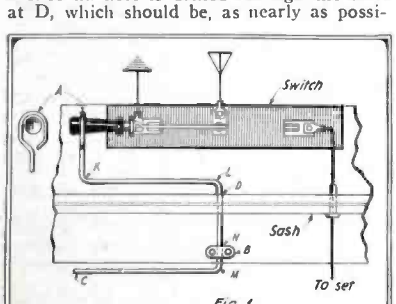
Fig. 2 is another possible construction of the moving plate. This raises the adjustment knob above the plates and eliminates the capacity effect due to the presence of the operator's body. An extension rod may also be fastened on the bakelite knob for this purpose.

Contributed by H. L. BEEDENBENDER.

Lightning Switch Control

The location of the lightning switch on the outside of the building is a source of much inconvenience to the amateur, especially during the winter.

The accompanying drawing illustrates a simple device by which the switch may be thrown from the inside. In Fig. 1 the switch is fastened to the window sill and a 5/16 in. hole is drilled through the sash at D, which should be, as nearly as possi-



Control of the Lighting Switch Mounted on the Window Sill.

ble, opposite to the center bearing of the switch. The bearing B is made from a block of wood, nailed or screwed to the sill so that the hole N is in alignment with the one at D. The iron rod C is about 5/16 in. in diameter.

A large rectangular loop should first be made at A so that there will be sufficient play between the rod and the switch handle. This is necessary and important, for it compensates for inaccuracies in locating the bearings and allows the switch to work smoothly in spite of them. The bends at K and L should be made, preferably with the aid of a vise and hammer. The rod is then placed through the holes at D and N and the bend made at M. This bend will of course have to be made by hand, using heavy pliers.

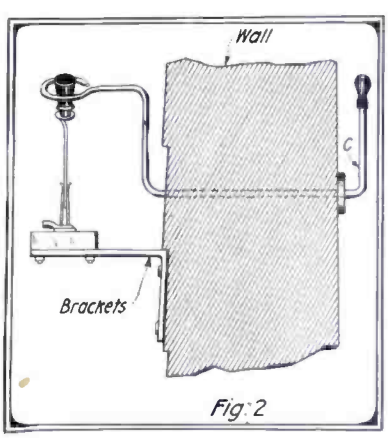
The switch now operates by turning the rod to the right or left.

It is well to wind the end of the switch handle with tape, as the rod otherwise rubs the paint from the handle. This also improves the insulation between the rod and the switch. The insulation value might be further increased by winding the loop A of the rod with rubber and friction tapes; by slipping on a piece of soft rubber tubing, et cetera.

In case it is not desired to place the switch as shown in Fig. 1, it may be fastened on brackets on the side of the building as in Fig. 2. When this arrangement is used, the rod passes directly thru the wall. If the interior is plastered, a block must be put up to serve as a bearing. It might perhaps be better to mount the switch in an inverted position on the brackets to give it more protection from storms.

The above described control, though simple and inexpensive in construction, has proved to be very efficient in operation.

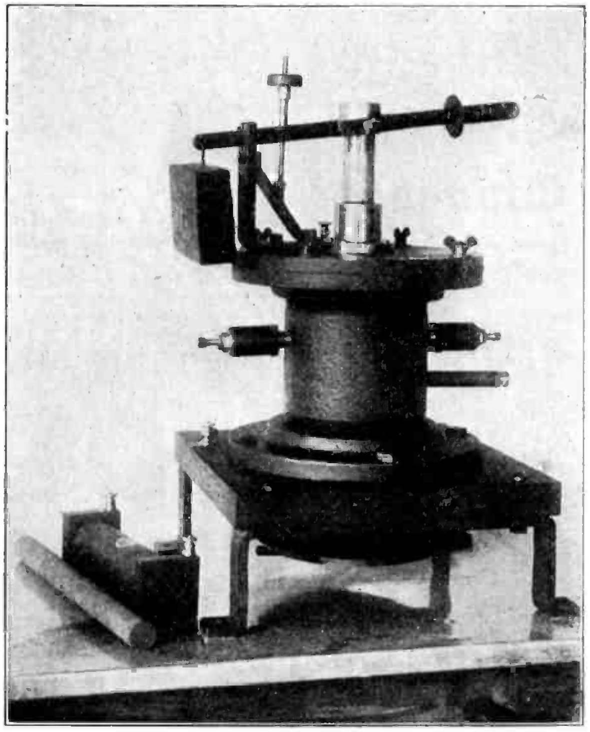
Contributed by FRANCIS S. WILLIAMS.



This Shows the Switch Mounted on a Bracket on the Side of the Building and Controlled by the Handle C on the Inside.

How to Build Arc Generators

By H. WINFIELD SECOR, Associate I. R. E.



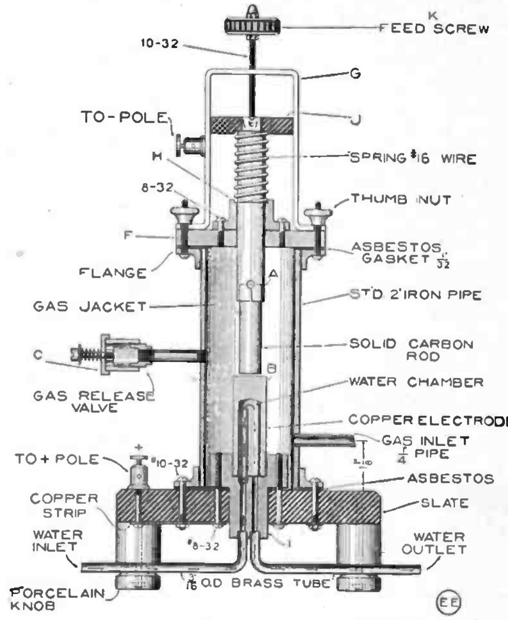


Fig. 2 Above—A Working Drawing of a ½ K.W. Arc.
Fig. 5 Left—Arc of the Magnetic Blast Type.

NOW that amateur wireless has come into its own, once more, everyone is interested in constructing the most efficient transmitting apparatus that they can procure designs on,—particularly in view of the fact that the radio law limits the average amateur station to ½ kilowatt of energy input. Also the general trend of amateur radio development is slowly but firmly wending its way in the direction of undampt wave transmitters, for both telegraphy and telephony.

Of course, the usual thing to do is to procure vacuum bulbs and endeavor to rig up *wireless "telephone" transmitting sets* or *undamped wave "telegraphic" transmitters,* by this means. There are two objections, however, which limit the activities of the enthusiastic radio amateur when it comes to the vacuum bulb proposition.

First, the arrangements for use with the vacuum bulbs to be employed as generators of radio-frequency energy have to be very carefully placed and adjusted and official reports of some of the government departments and other sources tend to show that the undamped wave telegraphic signals, radiated from vacuum tube transmitters, are somewhat distorted and not as satisfactory in all cases, as they might be.

Secondly, another stumbling block is the high cost of these bulbs, even in the smaller sizes. A number of bulbs would have to be connected in parallel or otherwise, to give any appreciable amount of transmitting energy; while if a large bulb is desired a very large amount of money will be needed.

The present article gives data on small arc generators, which can be used for radio telephony or undamped radio telegraphic transmission, and if the constructor buys his materials carefully and does his own work, or even if he has a machinist perform the principal operations for him, the cost will be small indeed, and will not necessarily exceed the cost of a single vacuum receiving tube, such as the standardized type now supplied to radio amateurs.

The first design of radiophone and undampt radio telegraphy and arc transmitter, shown in Figs. 1 and 2, is of a type designed by the writer several years ago, and a number of these arc units have been built, both commercially and privately by experimenters, with success. The outstanding features of the design are that it permits the experimenter to use various gases in the arc chamber; different forms or sizes of electrode materials may be used and the general make-up of the apparatus is simple and rugged, thus minimizing the cost of construction and also the cost of operation of the finished arc.

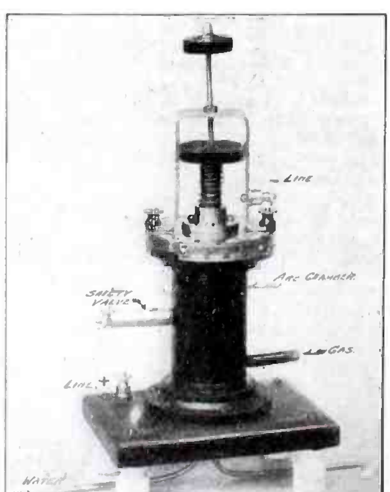


Fig. 1. Showing a Photograph of a ½ K.W. Arc Transmitter—Note the Safety Valve.

The principal dimensions of the arc generator parts are given in Fig. 2. Fig 3 gives the outlines of various parts composing the arc, and these are made of standard materials such as brass, copper, wrought iron, etc., which the average amateur has about his laboratory or can easily procure at any machine shop or machinery supply house.

This arc is suitable for a ½ K.W. input of energy, and may be operated on any potential from 110 volts direct current upward. The higher the voltage used on any of the arc generators, the higher potential, of course, of the radio-frequency oscillations delivered to the antenna circuit.

In this direction, it may be mentioned that very good results have been obtained with applied arc voltages of 500 to 1200 volts. Great care must be exercised, as voltages above 500 are quite dangerous and liable to prove fatal if they come in contact with the body, so as to form a circuit thru it.

There are two distinct ways in which to produce a gaseous envelope about an arc, *i. e.,*—by dropping alcohol into the arc chamber, by means of a graduated oil cup, the alcohol being vaporized by the heat of the arc, and secondly,—a very good envelope for the arc is formed by ordinary illuminating gas such as is used in the average house for lighting.

Doctor Lee de Forest (who was for several years, Radio Engineer for the American Poulsen arc interests or the Federal Telegraph Co., of San Francisco, Cal.) made many important tests with their powerful arc generators, rated at 40 to 50 K.W. and the long distance transmission of undamped wave telegraphic signals, and he found that illuminating gas produced very satisfactory results. In this case, about 1,200 volts D.C. was used on the arcs.

It is of interest to know that at the present time, the Federal type of Poulsen arcs have been developed and perfected to such a degree that they are available in sizes up to 500 K.W. The U. S. Government has found them very satisfactory and has several of the large size Federal arcs in operation at the principal Naval Radio Stations.

In the large Poulsen arcs it has been usual to rotate the carbon or negative electrode and in both of the arcs here shown, the copper or positive electrode is water-cooled. However, this may be submitted by extending the supporting pieces of the copper electrode down below the slate or marble base and fitting a number of metal cooling flanges upon it. Several of the smaller size Poulsen generators, such as ½ up to 3 K.W. capacity, have been successfully operated by air-cooling.

This cooling can also be greatly enhanced by forming cooling ribs or flanges on the wall of the gas jacket, as shown in Fig. 4-B. In the present arc designs the carbon electrode is stationary, and this has proven satisfactory in the smaller size arc generators of standard type, as it is not necessary to rotate the carbon electrode, except in units larger than from 3 to 5 kilowatts.

The arcs here shown are fitted for illuminating or other gas, which is let into the gas chamber surrounding the arc, thru a ¼ inch pipe threaded into the wall of the chamber.

It is important to note that the amateur should never build one of these arc generators without fitting them properly with safety (pop) release valves, which are shown in both of the designs herewith. Either these valves may be made by the experimenter or by the machinist doing the mechanical work on the arc, or they may be purchased from any engineering supply house. They are worth anywhere from 75 cents to $1.25, and are usually adjustable

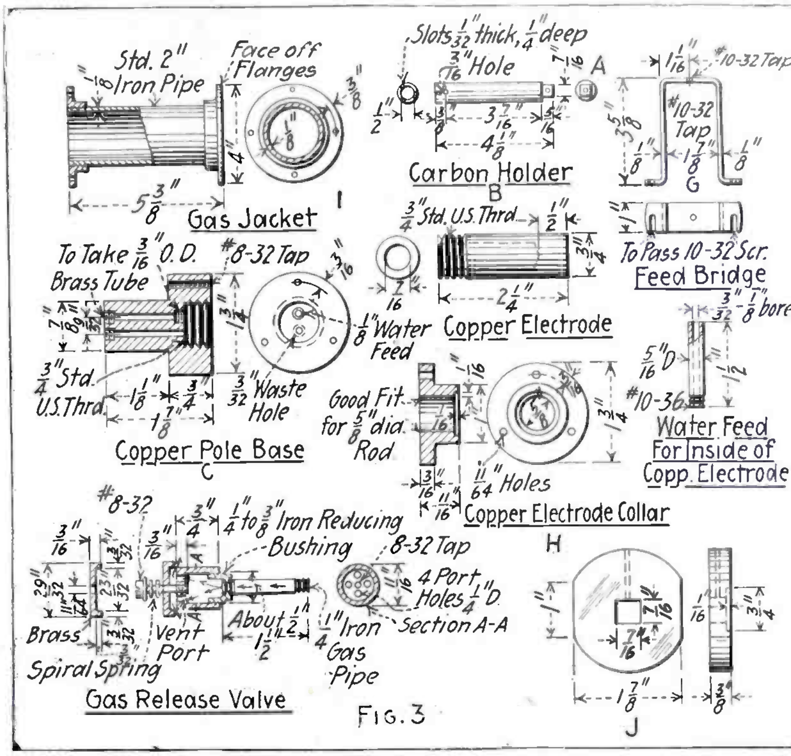


FIG. 3

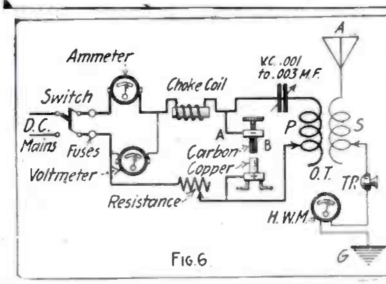


FIG. 6

The Constructional Details of the ½-K.W. Arc Are Shown in the Above Drawing. If the Dimensions Are Carefully Followed the Amateur Will Have Little Difficulty in Building the Arc. The Method of Connecting the Arc Is Shown at the Left. The Choke Coil and Resistance Are Connected in Series With the Arc. The Rest of the Circuit Is Similar to the Ordinary Transmitter Circuit.

so that they can be set for various release pressures of, from five to twenty pounds.

The gas chamber is made air-tight at the top and bottom where flanges fit against the top and base members, by placing circular asbestos gaskets between them, as shown in the drawing, Fig. 2.

As will be seen, the top electrode or carbon cap is pushed downward by pressing on the knob "J", so as to short-circuit the arc and start it. The carbon electrode is simply pushed down, and then released, when the arc forms and the length of the arc can be accurately adjusted by means of the feed screw "K".

The smaller type arc, shown in Fig. 2, is not fitted with a magnetic blast, but the larger arc shown in Fig. 5, has this feature. Those wishing to experiment with a magnetic blast on the arc shown in Fig. 2, may easily do so, arranging a suitable electromagnet co-axially with the copper electrode, as shown in the design in Fig. 5.

Another way, would be to drill holes thru the two sides of the gas jacket of the arc, shown in Fig. 2, and in this case, the jacket should be of some known magnetic metal, thru which holes can be projected the two magnetic coils. The outer ends of the magnet cores would be connected of course, by a wrought iron yoke, somewhat in the manner shown in Fig. 4-C.

The diameter of the carbon electrode in any of these arcs, for ½ K.W. rating, is one-half inch. A ½ K.W. arc carries over a range of 20 to 25 miles and more under favorable operating conditions for speech transmission. A much greater range may be obtained of course, when, transmitting

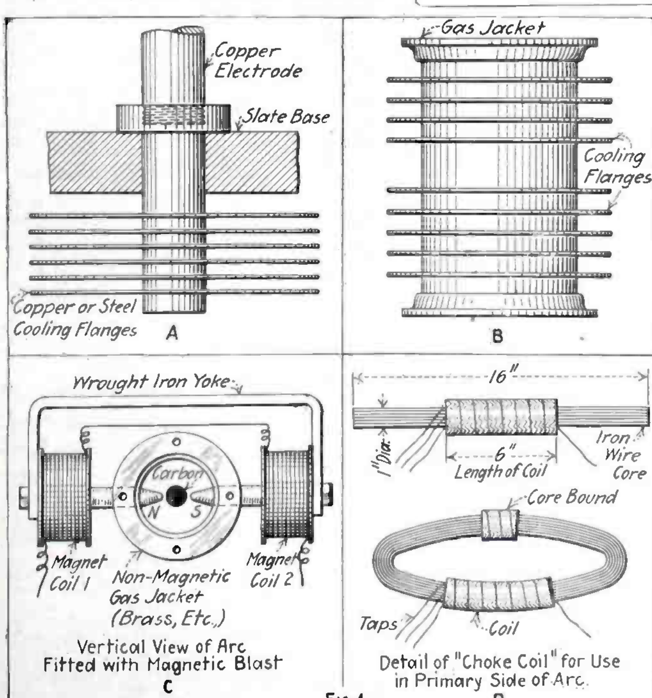


FIG. 4

A. Showing the method of fastening the copper electrode to the base also the method of placing the cooling flanges. Recent improvements have brought about the use of tungsten electrodes in arc transmitters in place of the carbon and copper.

B. The gas jacket with the cooling flanges mounted as shown.

C. Details of the magnetic blast construction.

D. This shows the method of constructing the choke coil used in the primary circuit of the arc.

undampt radio telegraph signals. Of course the arc must never be started without a suitable resistance in the circuit, or it will blow the fuses out; also a properly designed choke coil must be used in series with the arc. The rheostat placed in series with the arc, as shown in Fig. 6, may be an adjustable water resistance, but the best method is to use a resistance wire rheostat of the usual coil type. Any rheostat that will carry about five amperes, without undue heating will serve the purpose.

For radio telephoning, a hot wire ammeter and a microphone are placed in the ground wire as shown in Fig. 6. The oscillating circuit connected across the arc, may comprise a variable condenser placed in oil,—such as castor oil, to improve the insulating qualities. The condenser should have a capacity value of .001 to .003 microfarad. The energy is transferred to the aerial circuit by means of an ordinary oscillation transformer.

Volt and ammeters may be connected in the positions shown in the diagram, and proper fuses rated at about 10 amperes and a switch should be placed in the primary circuit of the arc.

Several improved hookups for modulating the arc *radio-frequency* energy both for telephony and telegraphy are given in several of the newest radio text-books which every experimenter has at hand or can consult at his library.

Two excellent works giving the official U. S. Navy hook-ups of arcs, are Robinson's "Manual of Wireless Telegraphy," and "The Principles Underlying Radio Communication," published by the Signal Corps, U. S. Army; Radio pamphlet No. 40.

A suitable choked coil to be used in series with the primary side of the arc to prevent the radio-frequency oscillation from backing up into the primary circuit, may be constructed as follows:

A core may be made of iron wire about No. 20 gage, and about 16 inches long. Then the bundle of iron core wire is in-

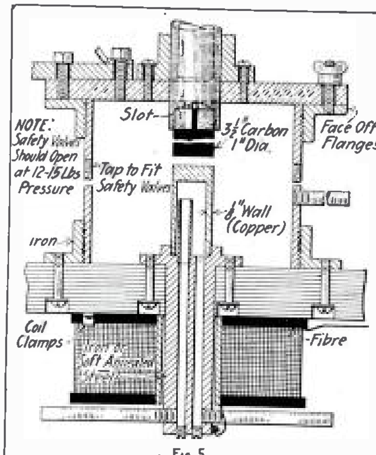


Fig. 5

This Shows the Type of Arc Using the Magnetic Blast.

sulated with six layers of oiled linen for a length of seven inches at the center.

Over this should be wound four layers of No. 14 B. and S. gage D.C.C. or enameled magnet wire, bringing out a tap from the end of the 2nd, 3rd, and 4th layers, to permit of varying the reactance or self inductance of the winding.

After the wire has all been wound on in this manner, the coil should be covered with several layers of oiled linen, being careful to fold it tightly over the ends of the winding, and then the two long projecting ends of the core are bent over and intermeshed. The junction of the core wires should be firmly bound with some pieces of iron or copper wire, so as to make a good firm joint and the completed closed core choke coil can then be mounted on a base.

Mica condensers are often used in the oscillating circuit of the arc, and air insulated variable condensers have been utilized many times, where the plates are separated at least 1/16th of an inch or more, to prevent breaking down due to the surges of radio-frequency energy produced by the arc in the resonant circuit.

The design for the magnetic blast arc generator shown in Fig. 5 is suitable for operation in a cool manner, at loads of 1½ to 2 K.W. Those desiring to build ½ K.W. arc of this same type should simply follow the dimensions given for the gas chamber and the carbon and copper electrodes in the detailed drawings for the previous design, in Figs. 1 and 2. Fig. 7 shows the photograph of the arc.

The magnetic blast coil is connected in series with the arc itself. In striking the arc with this design, it is only necessary to press downward momentarily on the angular projection shown, which slides the carbon holder downward until the carbon and the copper touch.

As the two electrodes are separated, the arc forms in the usual manner and the length of the arc, which is usually about ½ inch, is regulated by the carbon feed screw to the left of the drawing, Fig. 5.

Some arc generators have been fitted with substantial blue or red glass windows about one inch in diameter, placed opposite the arc in the gas chamber wall, so that the length and operating qualities of the arc might be viewed. This is not necessary however for ordinary purposes on small arcs, and the adjustment of the arc is carried out to produce the maximum radio-frequency oscillations in the antenna, or closed oscillatory circuit.

Some arc sets have been fitted with a hot wire ammeter, in both the closed oscillatory circuit as well as in the antenna oscillatory circuit, in order to keep a check on the degree of resonance and the amount of energy passing in either circuit at any instant.

Our Supplement

In presenting to our readers the wireless map which forms a supplement to this issue, we sincerely trust that it will meet with approval. This map is intended to be mounted on heavy cardboard and framed under glass for display in the radio station. The chart has been compiled according to the latest information, giving the names as well as the call letters of the most important radio stations of the world.

An innovation which has not been shown on a wireless map heretofore is the time-finder, or time computer.

It will be seen that on the top and bottom of every meridian a clock dial has been inserted, showing the time on this particular meridian. The time, as is well known, is exactly the same thruout the length for the entire meridian. The time is computed universally from Greenwich, commonly called G.M.T., or *Greenwich Mean Time*. Thus when it is noon on the Greenwich meridian, the difference of time will be as indicated on the different clock dials all over the globe. From this the local time can be readily computed without much trouble by anyone. As will be seen, every meridian, which is really every 15th, represents exactly one hour. There are 360 meridians all told, but for the sake of clearness the map shows only every 15th, each one of these representing a difference of one hour between the one preceding and the one following.

Suppose your station is in Denver, Colorado, which is at 105° longitude off Greenwich. Let us say you are receiving a message from the French station at Bordeaux, France, which as you will note is nearly on the Greenwich meridian. The time difference as you will see from the clock dials, is seven hours exactly.

Now remember that when it is *noon* on the Greenwich meridian, the time *west* of Greenwich is *slow* to the time of Greenwich mean time, while to the *east* of Greenwich the time is *fast*. Thus the time at Denver, which corresponds to about 105°, is seven hours slow to Greenwich time. Therefore, if the Bordeaux station, which is on the Greenwich meridian was sending, while your clock showed 10 A.M. (Denver local time), the actual local time at which Bordeaux was sending would be 10 plus 7, or 5 P.M. The same procedure should be used when converting the time for other meridians for the various localities.

Inasmuch as new great radio stations are continuously erected, the reader may mark such stations on the map himself in red ink, as quickly as such stations are opened and made public.

The chart also shows the various distances, and a rough calculation may therefore be made by anyone in order to compute the distances between different points whenever this becomes necessary.

TIME DIFFERENCE.

Twelve o'clock noon United States standard Eastern time as compared with the clocks in the following cities:

Aden (Arabia)	8.00 P. M.
Alexandria	7.00 P. M.
Amsterdam	5.20 P. M.
Athens	7.00 P. M.
Berlin	6.00 P. M.
Berne	6.00 P. M.
Bogota (Colombia)	12.03 P. M.
Bombay (India)	10.30 P. M.
Bremen	6.00 P. M.
Brussels	5 00 P. M.
Constantinople	7.00 P. M.
Copenhagen	6.00 P. M.
Denver	10.00 A. M.
Dublin	4.35 P. M.
Hamburg	6.00 P. M.
Havana	11.31 A. M.
Havre (France)	5.00 P. M.
Hongkong	1.00 A. M.*
Honolulu	6.30 A. M.
Lima (Peru)	12.00 Noon
Lisbon	4.24 P. M.
Liverpool	5.00 P. M.
London	5.00 P. M.
Madrid	5.00 P. M.
Manila	1.00 A. M.*
Melbourne	3.00 A. M.*
Mexico City	10.24 A. M.
Natal (South Africa)	7.00 P. M.
New York	12.00 Noon
Paris	5.00 P. M.
Petrograd	7.01 P. M.
Rio de Janeiro	2.00 P. M.
Rome	6.00 P. M.
San Francisco	9.00 A. M.
Santiago (Chile)	12.00 Noon
Sitka (Alaska)	8.00 A. M.
Stockholm	6.00 P. M.
Vienna	6.00 P. M.
Yokohama	2.00 A. M.*

* At places marked * the time noted is in the morning of the following day.

For cities situated in countries where "summer" time has not been adopted, one hour must be subtracted from the time given in the above table, during the spring and summer months.

"Eastern" time includes: New York, Boston, Philadelphia,, Baltimore, Washington, Richmond Norfolk, Charleston, Buffalo, Pittsburgh, Montreal, Quebec, Ottawa, Toronto, etc.

"Central," which is one hour slower than Eastern time, includes: Cleveland, Chicago, St. Louis, Minneapolis, St. Paul, Milwaukee, Kansas City, Omaha, Indianapolis, Cincinnati, Detroit, New Orleans, Memphis, Savannah, Pensacola, Winnipeg, etc.

"Mountain," which is two hours slower than Eastern time, includes: Denver, Leadville, Colorado Springs, Helena, Regina (N. W. T.), etc.

"Pacific," which is three hours slower than Eastern time, includes: San Francisco, Portland (Oregon), Victoria, Vancouver, Tacoma, Seattle, etc.

Crystal and Vacuum Tube Detectors

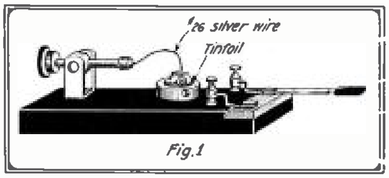
By E. M. SARGENT

THE purpose of this article is to give the experimenter a good understanding of how his detector operates, to tell how to get the best results from it and also to compare the relative merits of crystal and vacuum tube detectors. The crystal detectors will be taken up first.

The most common minerals used for crystal detectors are galena, carborundum, iron pyrites, and silicon, and each one requires a different type of contact to get the best signals. Galena is the most sensitive, carborundum is the most rugged, and is also fairly sensitive, iron pyrites is fairly rugged and somewhat more sensitive than carborundum, while silicon has neither great sensitivity or ruggedness, and is rapidly falling into disuse. In a station having a powerful transmitter near the receiving set it is difficult to keep a point on galena unless special protective devices are used, and a carborundum or pyrites detector may be found to give the best results. However, for a receiving station not troubled in this way galena is better and will give surprising results if used correctly.

The design of a galena detector should be such that the contact may be of the "catwhisker" type, and have a universal control movement, making all parts of the mineral accessible. The "catwhisker" should be a piece of No. 28 B. & S. gage *silver* wire, two inches long, one end firmly fastened to the handle or other device by which it is to be moved, and the other end clipped at an angle so as to form a sharp point for making contact with the mineral. This two inch wire should be looped in a semicircle and arranged so that the point will rest lightly on the galena. It is very important that this contact be light as the sensitiveness is considerably decreased when any great pressure is put upon it.

The galena may be held in a clamp, and must be wrapt in tinfoil before it is fastened into place. This has the double effect of decreasing the resistance of the mineral and of increasing the sensitive area, as it will always be found that the best points on galena are near the place where it is fastened into the holder. This latter effect is of course due to the decreased resistance at these places. Pieces of galena having slightly uneven surfaces are as a rule more sensitive than those with smooth flat surfaces and which break up into perfect cubes. The mineral should be taken from the holder about every week or ten days and thoroly scrubbed with soap and water and then dried with a clean cloth, care being taken not to handle the surface of the mineral after it has been scrubbed.

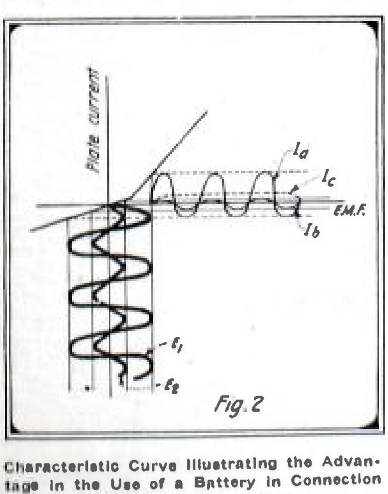


This Shows the Correct Design of a Galena Detector. Note the Short-Circuiting Switch Is Mounted on the Detector Base.

Galena should not be mounted in Woods metal or any similar material, because even the small amount of heat that is used in mounting it in this manner is liable to decrease its sensitivity.

When a galena detector is used in a station having a transmitter the detector must be protected with a short circuiting switch. If this switch is properly connected across the galena the point will not knock out when when the transmitter is used. Use a relatimely heavy single blade single throw switch and mount it right next to the detector. Then run leads of small wire, about No. 28 B. & S., from each side of the detector to each side of the switch, keeping the leads parallel and close together. This will tend to eliminate inductive effects and will not appreciably affect the efficiency of the detector. These leads must be as short as possible to still further reduce the possibility of their picking up any energy from the transmitter. When the switch is heavy single blade single throw switch and mount it right next to the detector. connected in this way, the current picked up by the secondary of the loose coupler will practically all flow thru the switch as the impedance in that path will be many times lower than thru the detector, and owing to the non-inductive leads from the detector to the switch practically no voltage will be induced directly into the detector to burn it out.

Sometimes operators experience difficulty in getting a good point on a catwhisker detector, and blame the trouble on the mineral without further investigation. In nine cases out of ten the trouble will be found to be with the contact wire. In a catwhisker detector the wire does not bear heavily enough on the mineral to be self-cleaning, and consequently when it has been used for some time it gets too dirty to make good contact, with the result that the mineral appears to be dead. If the contact wire is freshly clipped every three or four days no trouble will be experienced from this cause, and the operation of the detector will be more satisfactory as a whole. An efficient design for a galena detector is shown in Fig. 1, together with the protective switch.



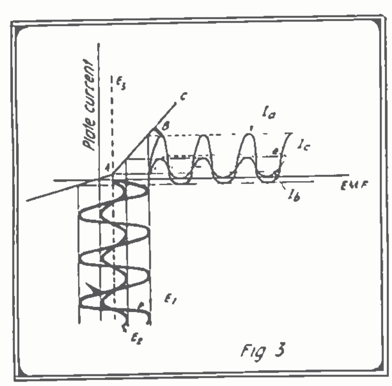
Characteristic Curve Illustrating the Advantage in the Use of a Battery in Connection With Crystal Detectors.

An excellent detector for use with carborundum has been described by Mr. R. F. Gowen in the October issue of the *Electrical Experimenter*. In this detector it will be noticed that considerable pressure can be applied between the contact and the mineral. Unlike galena, the sensitivity of carborundum is not appreciably decreased by a heavy contact and for this reason it may be made very rugged. A blunt piece of No. 18 copper wire makes a good contact for this mineral and enough pressure may be applied so that it will not jar out of place easily.

Iron pyrites is very nearly as sensitive as galena and can be used with medium pressure on the point of contact. It can be used in a detector of the carborundum type, but will work better in a catwhisker detector with a slightly heavier contact wire than that used for galena. This mineral gives very satisfactory results when used in a station where considerable transmitting is done.

If silicon is to be used, the catwhisker detector can be somewhat modified and made adaptable for it. with a piece of silicon the best signals will be obtained if the contact is made by an iron needle resting horizontally across the edge of the mineral. A medium pressure may be used to keep the point from jarring out. To find a point the needle is moved back and forth along the edge of the mineral. Silicon should also be wrapt in tinfoil before being placed in the holder, but even then it does not compare favorably with galena, and should not be used where the best results are desired.

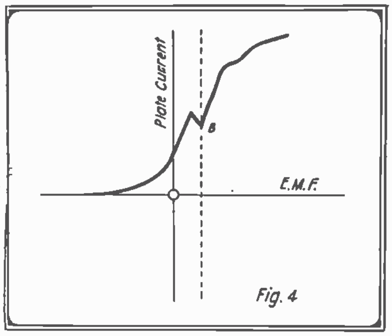
Nearly all crystal detectors will prove more sensitive when used in conjunction with a 3 to 5 volt battery and potentiometer. The reason for this may be seen from the characteristic curve, Fig. 2. It must be remembered that the radio signal picked up by the antenna has a frequency far too high to affect the diafram of a telephone receiver, or to be audible if it did affect the receiver, therefore, it must be converted into some audible frequency before it can be heard. In other words, it must be distorted in some way from its original form. Suppose that two signals, one of amplitude E_1 and the other of amplitude E_2 are being imprest on the detector (Fig. 2). During one-half of the cycle, E_1 produces a current in the detector (and thru the phones as they are in series with the detector) of amplitude I_a and during the other half of the cycle a current in the opposite direction of amplitude I_b is produced. Due to the irregularity in the shape of the characteristic curve I_a has a greater positive amplitude than I_b has negative. Therefore the resultant current I_c whose value depends on the difference of amplitudes of I_a and I_b will flow thru the receivers. One of these resultant currents will flow for each wave train picked up



Here the Curve Shows What Happens When a Positive Potential Is Applied to the Detector.

by the receiving antenna and the signal heard in the telephone receivers will therefore have a frequency corresponding to the wave train frequency of the transmitter. This is an audible frequency. Referring again to Fig. 2, it will be seen that the signal E_2 has an amplitude so small that it does not reach the bend in the curve and therefore it is not distorted and will not be heard in the receivers.

Suppose now that a steady positive potential of value E_3, Fig. 3, is put on the detector. The voltage acting on the detector from signal E_1 will now be the sum of E_1 and E_3 or at any instant $e_1 = E_1\ max\ sin\ wt + E_3$ What has been accomplisht is that the constant E_3 has been added to every value of E_1 and therefore on the diagram the imprest voltage has been shifted to the right by the amount E_3. This is called "shifting the working point". The same happens to E_2 with the result that the positive alternations from E_2 are now greater than the negative, a distorted current is produced, and the signal that was formerly inaudible is now made readable



Characteristic Curve of the Gas Type of Tubular Audion.

in the phones. At the same time the distortion of E_1 has been increased and the resulting signal is louder. If too much steady voltage is applied the working point will be shifted to point B, Fig. 3, and no distortion will result. The correct value for E_3 is somewhat critical and to obtain the best results the potentiometer should be capable of fine adjustment. It will also be noticed that the steeper the portion A-C of the curve the greater will be the distortion and the louder the resulting signal.

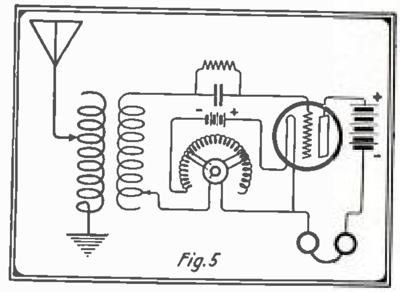
Vacuum tube detectors may be roughly divided into two groups, high vacuum tubes and low vacuum or gaseous tubes. The latter are by far the more sensitive. The high vacuum tubes are very steady in operation, have no critical values for plate potential or filament current and as a rule give uniform results, and their operation under certain conditions and with certain circuits can be predicted. For this reason they are very good for laboratory experiments intended to check results arrived at theoretically or mathematically. They were widely used during the war because the majority of new operators had never seen a vacuum tube and kne .: little or nothing about its operation, and to simplify the adjustments on receiving apparatus, high vacuum or "hard" tubes were used, sometimes with amplifiers to obtain the same results that could be obtained with a single good gas tube by an expert operator. The experimenter should remember that the fact that the navy or army used a certain type of tube widely during the war does not indicate that this tube is a particularly sensitive one. On the contrary the army and navy tubes were as a rule inferior to the tubes used by the amateurs before the war and were used only because of their uniformity and reliability under all different adjustments.

The gas tube, of which the well known old style tubular audion is a good example has a characteristic curve that follows the general form of that of a high vacuum tube, but has irregularities in it, (Fig. 4). When the tube is adjusted so that the working point comes at one of these irregularities extreme sensitivity results. Suppose the plate potential and filament current are so adjusted that the working point falls at point B, Fig. 4. Then either the positive or negative half of the cycle of the imprest voltage will cause an increase in the plate current, and instead of having the difference of the two halves of the cycle for the resultant as in the crystal detector, we have the sum, resulting in a very strong signal in the phones from a relatively small imprest E.M.F.

While it is difficult to maintain the working point at exactly the right place, it is by no means impossible. The easiest way is to have a very fine adjustment on the filament rheostat. Varying the filament current shifts the working point indirectly by changing the height of the characteristic curve. The working point may also be shifted directly by putting a steady potential (usually negative) on the grid. A very good way to get the correct amount of steady grid potential is to connect the filament rheostat in the negative lead of the "A" battery (see Fig. 5). Then make an extra arm for this rheostat and connect it to the filament end of the receiving coil. By varying the position of this arm, the voltage drop between the negative side of the filament and the receiving coil will be changed, and if a leak resistance of 4 or 5 megohms is put across the grid condenser this negative potential will be imprest on the grid. Practically all tubes require some negative potential on the grid for best operation. For those that require positive (as in Fig. 4) put the rheostat in the positive lead of the "A" battery and connect the second arm of the rheostat as before.

The characteristic curves of vacuum tubes are steeper than those of crystal detectors hence louder signals are obtained from the vacuum tube where a moderately strong voltage is imprest on the grid. However, a very important fact, and one that is many times either overlooked or unknown is that a vacuum tube may bring in moderate signals very loud and at the same time be either inoperative or inferior to a piece of mineral on weak or long distance signals. The reason for this is readily seen from the characteristic curve and is analogous to that described for the crystal detector. The working point may be so far up on the curve that detection or distortion will not occur for a very weak signal and at the same time the curve may be steep enough so that when a moderate signal is imprest between grid and filament considerable distortion may take place and the tube will apparently be a good one. Tubes of this type make excellent amplifiers but are poor detectors until the working point is corrected.

A good test for a vacuum tube detector is as follows. By good detector is meant a tube that will pick up weak signals. A source of dampt oscillations should be available. A wave meter may be used, or if there is none at hand, a coil and condenser excited by a buzzer will do. Set up this miniature transmitter and then about three feet from it connect a similar coil and condenser. Run two leads one from each side of the condenser to the middle terminals of a DPDT switch. Connect the vacuum tube detector to one throw of the switch and a good galena detector to the other. Next put on the telephones connected to the galena side and get the best point possible on the mineral and get the coil and condenser in tune with the transmitter. Note the strength of the signal, then put on the vacuum tube telephones,



Showing the Connections of a Rheostat Which Permits Critical Adjustment.

and retune and note the strength of the signals in these receivers. If the signal was of moderate strength on the galena it should be much louder on the tube. Now move the transmitter away until the signal is just audible, then throw the switch again to the mineral and do not be surprised if the signal is both louder and clearer on the mineral. If this is the case throw the switch again to the tube and adjust the working point until the signal is at its best. With most tubes this can be done, and the tube made better than galena, but some are so poor that any adjustment will not improve them. The author has made tests similar to this one on vacuum tubes of the kind now licensed for amateur use and found that a good piece of galena was better in many cases. In performing this test it will be necessary to change the adjustment of the receiving condenser slightly when the shift is made from the vacuum tube to the galena. The reason for this is that the tube, leads, socket parts, etc., have an appreciable capacity, sometimes as high as 30 m.m.f. and this added to the condenser capacity increases the wavelength of the circuit somewhat. The difference probably will not be more than 2 or 3 degrees on the condenser scale.

Dr. de Forest on the Radiophone

Editor Radio Amateur News:

I have just read with great interest your timely and well-stated editorial in the Radio Amateur News for December on "Developing the Radiophone." This article meets with my heartiest approval and I am greatly pleased that you have taken this advanced view of the situation.

As you know, I have for many years advocated the probability that the radio phone must supplant the radio telegraph, and it is only very recently that the art has produced a low power, low priced, and reliable radiophone which the amateurs can acquire and successfully operate.

There is going to be an enormous development and wide-spread application of the radiophone among the amateurs in this country and you are the first editor to point out this situation.

You may be quite sure that we will cooperate in every way with every effort to make the radiophone popular among the amateurs.

Very sincerely,

Lee de Forest.

New York, January 2, 1920.

Loop Multiple Aerial Switch

By John G. Merne, L. M. T.
County Technical Instructor, Leitrim, Ireland.

MANY amateurs who have had the pleasure of persuing Professor Knoll's account of his experiments with loop aerials as related in the August issue of *Electrical Experimenter*, will without doubt be constructing apparatus to receive signals in the manner suggested therein.

This has prompted the writer to offer the following ideas, which if embodied in such a set will give a wide range of tuning, and at the same time ease and simplicity of making adjustments. With the aid of the aerial switch, any loop can be put in action or any multiples of same used and with the use of the circuit switch, each circuit as shown, can be used independently. This arrangement does away with a number of switches and embodies all the actions of same in the function of one switch.

Fig. 1 shows 4 loop aerials at the top of the drawing. Number 1 loop is wound to give, say a wave length of 100 or 150 meters.

No. 2 loop wound to a wave length of 200 or 300 meters.

No. 3 loop wound to a wave length of 400 or 600 meters.

No. 4 loop wound to a wave length of 800 or 1200 metres.

In this way:

Loop 1 would have a ratio of 1.
Loop 2 would have a ratio of 2.
Loop 3 would have a ratio of 4.
Loop 4 would have a ratio of 8.

The aerial switch is so designed that each loop is a separate unit and independent of every other loop, by this means, dead ends are done away with, which is an important factor in wireless apparatus.

When switch blade is on the first stud on the top sector working clockwise, Loop 1 is in action, Loops 2, 3 and 4 out when the switch blade is on the second stud on the top sector, Loop 2 is in action and Loops 1, 3, 4 are cut out. When the switch blade is on stud 3, Loops 1 and 2 are connected; Loops 3 and 4 are cut out. When the switch blade is on Stud 4, Loop 3 is in and Loops 1, 2 and 4 are cut out and so on up to the end of sector.

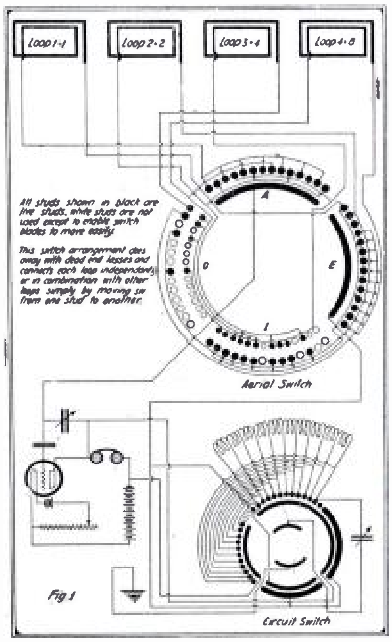
Assuming that the wave lengths of each loop are as follows:

Loop 1	100 meters
Loop 2	200 meters
Loop 3	400 meters
Loop 4	800 meters

Then we have the following combinations of loops:

Loop 1	100 meters
Loop 2	200 meters
Loops 1 + 2	300 meters
Loop 3	400 meters
Loops 3 + 1	500 meters
Loops 3 + 2	600 meters
Loops 3 + 2 + 1	700 meters
Loop 4	800 meters
Loops 4 + 1	900 meters
Loops 4 + 2	1000 meters
Loops 4 + 2 + 1	1100 meters
Loops 4 + 3	1200 meters
Loops 4 + 3 + 1	1300 meters
Loops 4 + 3 + 2	1400 meters

All these ratio changes are brought about by means of aerial switch connections shown in Fig. 1. Keeping the above ratios in mind, we determine the following example:



At the Top of the Drawing 4 Loop Aerials Are Shown, Each One Having a Different Wavelength Range. The Aerial and Circuit Switch Connections Are Also Shown.

Switch on stud	Meters loops in action
1	100
2	200
3	300
4	400
5	500
6	600
7	700
8	800
9	900
10	1000
11	1100
12	1200
13	1300
14	1400

This arrangement makes things very simple as the experimenter knows from the number of the stud covered, the wave length of the aerial loop in action. If loop 1 is wound to 150 meters and the other loops in ratio of 1, 2, 4, 8, the calculations are as follows:

Stud 1	150 meters
Stud 2	300 meters
Stud 3	450 meters
Stud 4	600 meters
Stud 5	750 meters
Stud 6	900 meters
Stud 7	1050 meters
Stud 8	1200 meters
Stud 9	1350 meters
Stud 10	1500 meters
Stud 11	1650 meters
Stud 12	1800 meters
Stud 13	1950 meters
Stud 14	2100 meters

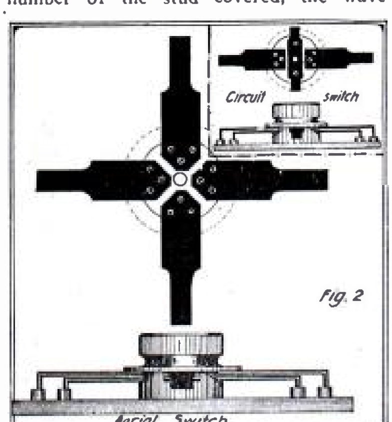
If loops are wound to a larger wave length than those given in the tables, the wave lengths for each stud on the aerial switch can be calculated easily if the ratios of 1, 2, 4, 8 for each loop be adhered to.

Loops can be wound on a form such as described by Professor Knolls on page 328 of the *Electrical Experimenter*. Having constructed the form, wind each coil to wave length required, soak in melted wax and when cold remove the coil from form and tape it up so that the four coils in ratio of 1, 2, 4, 8 can be placed side by side in a flat box on which the aerial switch can be mounted and connections made to loops. This should make a very compact aerial easily carried about and one that can be placed in various positions for experimental purposes.

The circuit switch is shown in Fig. 1 with connections to the loop aerial switch.

When the switch blade is on Stud 1 (in black), working clockwise, the connections are as shown in Figs. 1 and 2, page 328, *Electrical Experimenter*. When the switch moves to Stud 2 and then on to Stud 11, working clockwise, the tuning inductance is in as in Fig. 3, page 328, *Electrical Experimenter*. When the other end of the switch blade comes on to the studs at left-hand bottom side of switch from Studs 1 to 11, the circuit is the same as in Fig. 4, page 328, *Electrical Experimenter*. The apparatus being connected to earth with tuning inductance and variable condenser in the ground circuit.

Fig. 2 shows the construction of the aerial switch, also the circuit switch. The handles are removed in the plan and the metal parts colored black for clearness.



Showing the Construction of the Aerial and Circuit Switches.

In conclusion, experimenters could construct a number of these multiple loop aerials and have same fitted into flat boxes so that various wavelengths could be had when required. Other improvements will suggest themselves to those who are interested in the question of compact receiving apparatus.

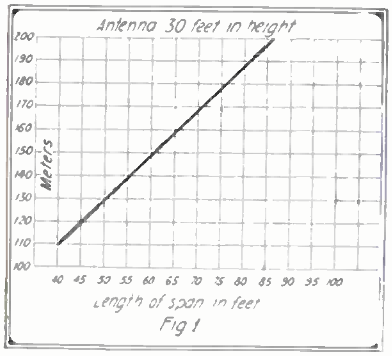
PLANTS AND WIRELESS TELEGRAPHY.

One of the most extraordinary recent discoveries in regard to plants is that they are "conscious" of wireless messages. Experts who have experimented in the matter declare that plants receive and make a response to wireless messages, and that the response can be detected by the newer electrical instruments. The latter are so sensitive that they can detect and register the minutest internal movements in plants.

Designing An Amateur Transmitting Antenna

By E. T. JONES

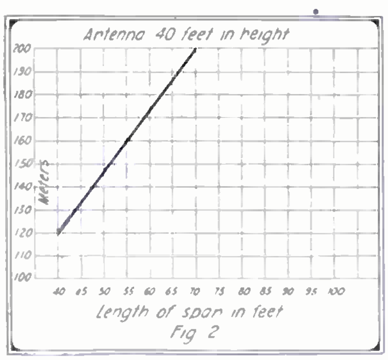
NOW that the Amateurs have acquired the prestige which was forthcoming for some little time, and have most of the "Influential" Engineers and Scientists



With This Direct Reading Graph You Can Easily Design Your Own Antenna.

pulling strings at Washington for their welfare, let them not forget their duty towards these men who have fought and won their battles several times. It is their duty to maintain the high standard which was accorded them when their sacred privileges were at stake; by adhering to regulations and reducing to a minimum the amount of "chewing the rag stuff" which goes on from morn till night.

While the above regulations are the easiest to adhere to, the average Amateur does not know how to tune his transmitter



An Increase in the Height Carries an Increase in the Wavelength As Shown by This Graph.

to the wavelength of two hundred meters as prescribed by law. Columns after columns have been given to the advancement of the tuning of the circuits both open and closed, the advisability of providing high voltage transformers to reduce the amount of capacity required and last but not least the elimination of unnecessary losses which occur from the lengthy leads employed by the amateur to connect up his instruments; however not one single author has to my knowledge advanced information in respect to the correct design of antenna which should go with these short wave transmitters, and therefore, no matter what is done in the operating room proper, best results cannot be obtained unless the antenna is properly designed in respect to its natural period. The average amateur is not satisfied with the antenna which would be highly efficient for the transmitting waves prescribed by law, for his receiving set; as he does not care to be handicapped in this respect. There is then, but one solution and the correct one, *provide a separate antenna for transmitting* and the sky can be considered the limit for that of the receiving set.

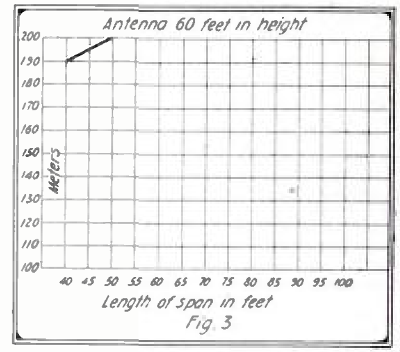
Design of the Antenna.

With the valuable assistance of several graphs which were taken from Dr. Austins' works the Amateur will have before him very valuable assistance which will permit him to construct an antenna best suited for the operation of his transmitting on two-hundred meters.

The antenna is composed of number fourteen bare copper wire and comprises FOUR WIRES spaced two feet apart thruout. The four leads should be twisted together at a point ten feet from the ground and then brought into the sending room.

By referring to Fig. 1, it will be seen that the type antenna described above if raised to a height of thirty feet and stretched to a length of sixty feet the natural period of this antenna will be one hundred and fifty meters. If lengthened to eighty-six feet the wavelength would be—two hundred meters and at this point it would be impossible to insert inductance at the base of the antenna. (The Open circuit Oscillation transformer Inductance.) It would be found that several turns of the usual Amateur helix could be inserted at the base of the antenna if it was reduced to a sixty-foot length as the wavelength at this point is but one hundred and fifty meters.

Fig. 2 shows the wavelength of the same type antenna at a height of forty feet. By referring to this graph it will be seen that if we still desire to employ an antenna sixty feet in length its wavelength has increased to one hundred and seventy-three meters. A raise in the height of the same type antenna but ten feet has caused an increase of twenty-three meters. Therefore as we raise the antenna we will have to



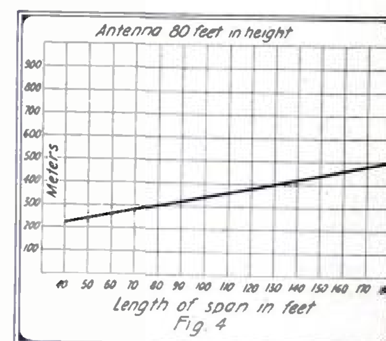
Showing What Happens When the Antenna Is Raised to a Height of Sixty Feet.

satisfy ourselves with a shorter one, for correct and efficient transmission on 200 meter wavelengths.

In order to use this same antenna at a natural period of one hundred and fifty meters we will have to make the length fifty-one feet; exactly nine feet shorter than when the antenna was ten feet lower.

A graph of not much use other than acting as an illustration of what happens to this same antenna, when raised to a

(*Continued on page* 385)



At a Height of 80 Feet a Maximum of 500 Meters Can Be Reached with an Aerial Length of 180 Feet.

無線電報

Perhaps you do not recognize what this means. We'll say it is a mouthful! Next time you get tired of saying "radio" just call it *wu-shien-dien-bao* for a change. Yes, sir, it is the same old wireless, only it is in Chinese this time, and if you don't believe it, we will give you the translation verbatim, for *wu-shien-dien-bao* means "without wires electrical message." We'll say it is descriptive, if nothing else.

And the very next time you get tired of wearing your "tin cans" on your head, do not speak of them as telephone receivers, simply call them *"dien-haw"* which not only sounds nicer but is Chinese as well, meaning "electric talk instruments." How do they get that way, we ask?

Then if you own a "tin lizzy," you will now have to call it *"tsi-shing-cha,"* meaning "self-traveling carriage." (P. S. We forgot to ask our informant what the Chinese call their "self-traveling carriages" when the latter go on strike and have to be "horse traveled" or simply pusht!) We are just now engaged in writing to our Chinese correspondent to find out what a few simple little things such as wavelength, 15-step amplifier, heterodyne receivers, Honeycomb-Litzdraht-variometer-coils, and similar ones mean, when translated into chop-sueyédoise!

P. S.: It just occurred to us that the Chinese probably cannot use Galena Detectors. With such talk (look at headline) the sensitive spot surely would be knocked out.

Clearing Traffic

By "Sparks"

Ketchikan, Alaska.

AMATEUR radio plants are now permitted to open up and transmit to their hearts' content. In view of that fact a few suggestions as to the handling and disposition of amateur traffic may not be out of place. With thousands of new amateurs, who have become interested in the art thru war experience, it is important that the handling of amateur communications should be done correctly and in a business-like way. The habit once formed will tend to a better and more efficient operation.

Let us first consider the matter of calling another station. This station is located within easy communication range. Then let's not have any of the old time methods, which consisted in making four or five attention signs, the station's call ten or fifteen times, "DE" once or twice and adding your own call letters six or eight times, followed by several "Ks," "ARs," etc. Make it a regulation call; the attention sign but once, the station's call three times, "DE" once, followed by your own call letters three times. That's enough for any station who can hear you at all, to know that you are calling him. In cases where the station is almost within shouting distance, or even several miles away if communication is good, even the regulation three calls are not necessary; give him a couple and sign once—make it snappy. Long drawn out calls only show up an inefficient operator and don't serve to clear the traffic. Use consideration, too, in your calling; listen first and see if the other fellow is receiving or is otherwise occupied with another station. He can't handle two stations at once and you only cause unnecessary interference and get the good fellows "down on you" if you persist in mussing up the air. The law calls for a listening period before calling, *and amateurs are not exempt from the radio regulations.* If the station you call doesn't answer after the lawful three calls, don't persist; if he were there he would have heard you. Keep out for a while and let the other fellows, who are in communication, do something.

Now, after you get your man. Suppose you have a couple of messages for him. How you going to get 'em off? Probably something like this: "Hr nr 1 ck 12 ck 12 fm Pittsburgh Pa date to ——" and so on. Where do you find any authority for that form? A common answer I have heard to that question is, "Most of the commercial fellows use it, or something like it." Sure they do, but pity their ignorance. Nothing annoys an operator more than to get a string of stuff such as the above, particularly when he is trying to make a clean copy, probably on a typewriter. Only the other day a well known passenger ship running in these (Alaskan) waters called me. She carries two first grade operators, too, both old timers. Altho only three hours out and coming in strong, he called me seven times, and signed off six. Not only on his first call for recognition but for each acknowledgment thereafter. When he sent me one, it was in a form something similar to the one outlined above. I let him finish and then requested him to repeat the whole thing before acknowledgment. I was copying on a "mill" and trying to make a decent copy as our originals are turned into headquarters. It couldn't be done, so I gathered an idea of the message from his first sending, and using what knowledge I gained from that and following his repetition, managed to get my copy straight. Here double time and a useless waste could have been saved by the sending operator memorizing a certain form, the *right* one, and *using* it. This operator offended further by acknowledging for a

Ye Editor's Translation of the N's, R's, Q's and Miscellaneous Dashes Jazzed Out by an "Op" When He Desires to Raise a Station.

message in this way: "N—— N—— N—— N—— de W—— W—— W—— r r r r nr 1 r r ur nr 1 r r ok r . . .—.—" He left no doubt as to his correct reception of the message, but how foolish.

The handbook of commercial traffic regulations which should be in place on every ship, and copies of which the amateurs can obtain from the government printing office in Washington, contains complete data on correct forms for sending, calling, acknowledging, etc. Get one, fellows, and start your transmitting off right. Jump the other fellow for useless sending, too. Here's a sample of the correct form for sending a message: send nothing else but what appears in the quotation marks, after calling and signing ONCE. "Radio SS PHILADELPHIA 1 NX 24 Twelfth 430pm — . . . — To ————" The word radio is the prefix and shows the count to be radio. Then follows the office of origin followed by the number of the message with no designation "NR." The operator's personal sign should follow next, and every operator should adopt a personal sign as it helps in tracing a message. The check, or number of words next without the prefix "CK," and not followed by the word "Radio" as this has already appeared once (this is a common fault). The date is always spelled out, never say "date"—it's confusing. The filing time should follow the date in figures. As the filing time is seldom re-transmitted over land lines, this may be omitted, and the date followed by the double dash, which indicates a separation of prefix from address, address from body and body from signature. This double dash should always be used as it saves confusion. The designation "To" is permissible in commercial traffic, but in no case should the abbreviation "sig" be used before the signature. The double dash shows that the signature is about to follow.

This Poor Bird Tried to Make a Clean Copy on the Mill. Our Artist Refused to Picture His Thoughts.

Remember, I'm not holding up the government operators as models who use correct procedure, for I've heard very, very few operators of any class, government, commercial or amateur, send a message correct to form. I once received a reprimand in the service for "unofficial communication" and determined then and there that there would be no repetition. I accordingly learned the correct forms for all transmissions, and find it best all round. I sometimes have operators question me on parts of the form as I use it, it is so unfamiliar, to them. Most of the present day operators adopt their forms from what they hear others using and by so doing, they are almost certain to learn the *wrong* way. Learn the right way first and it will soon become a habit. You will find it much easier to copy correct forms and get all the information, than to hunt out the number and check, etc.

In acknowledging a message, call the sending station once without the attention sign, say "R" a couple of times, give the message number followed by your personal sign, your station call letters and "K" if more to come. Thus: "5AZ R R 1 NX 5BR K". The above method of acknowledging being a little long, it is permissible to say merely "RK" when receiving a series, at the end of each message and in giving the regulation acknowledgment, substitute the number of messages received for the individual message number, at the end of the reception. A more detailed account and examples of acknowledging under different conditions, such as when sending alternately etc., will be found in the publications which can be secured by application to the local radio inspectors. All the forms and regulations governing radio communication will be found therein.

Give this matter some thought, fellows, and get going in a business-like way. I'd like to come back into the amateur game and find it aces above where it formerly was. I'm an amateur at heart now, have been practically too, and followed that with commercial work, and finally my present government service, so "know whereof I speak". I thank you.

Rivers have often been accused of forming better paths or channels for radio waves. This has been proven by extensive tests. When it is necessary to communicate with a ship and the two are separated by land but one-tenth the signal is received as when the same ship enters the mouth of the river upon or near whose bank the receiving station is located.

A Case of Nerves

By JULIAN K. HENNEY

ALL day long the steamer *Rollybelle* had been plunging along in the teeth of a half gale which whistled down Lake Huron from the northeast, stirring the water into perfect furor of foam and wash. The ship was a pretty sight in sunlight but tonight she seemed to be trying her best to live up to her name. She was in fact a veritable "holy

Suddenly I Thought I Heard a Rustle at the Door.

roller" and at each lurch of the vessel, the youthful wireless operator longed for the end of the watch that he might be relieved from duty. The screeching of the wind outside and the pitch of the steamer was beginning to tell on his sensitive and nervous nature, and it was with a sigh of relief that he welcomed the second mate to the small radio cabin. Toward midnight the gale seemed to have reached its height—at least young Boyd was unable to think of anything worse—and both men were silent as the minutes hastened on toward the end of the watch. Soon Miggsby, the senior operator, appeared saying that it was quite impossible to sleep owing to the continued roll of the ship, and the three officers decided to sit out the storm.

With the addition of the mate and the First the conversation began to smack off the usual seaman's comparisons and relating of experiences. The mate told of storms that fairly froze Boyd's blood, and Miggsby, not to be outdone, answered in kind and Boyd's hair rose on end accordingly. The small gale through which the *Rollybelle* was then plunging was, of course, only a capful of wind compared with some the mate had weathered, and the first radio man also had a few experiences of his own.

Miggsby was the mystery on board the ship. Why he—a man of forty-odd years—should still be serving on the Lakes as operator of the *Rollybelle*, was unknown. Many were the speculations concerning Miggsby aboard the steamer, many were the unasked questions concerning the reason he should be using his experience and education in the manner he was. The other operator was young, on his first ship in fact, and the stormy weather was none too pleasant for him. He longed for other occupations that were more soothing to the nerves, occupations on land where one was certain of his footing at least.

Talk of storm and gale palled on the man after a time, however, and for some minutes nothing was heard in the small cabin except the wailing and crying noises incident to the high wind. Occasionally Miggsby prest the test buzzer, which emitted a high squeak strangely harmonizing with the noises that came from without. At each gust of the wind and the following heave of the steamer, Boyd looked apprehensively out of the porthole at his side, and then at the mate. The storm was beginning to get on his nerves, yet he was afraid to go to the bunk room. The good natured jokes of the mate were always distasteful to his sensitive makeup.

At length Miggsby broke the silence. "This wind," he said, "reminds me of the last night I spent at Breezy Shoals. The station was situated far out from town on the desolate shores of Cape Breeze where so many wrecks occur every year. It was about this time of the year, or maybe a little later, in November perhaps, and for a week the wind had whistled thru the wires overhead in a perfect gale. Sitting alone in that small cabin was not a pleasant position at any time, but in those long winter evenings the time dragged along at such a slow pace that I could almost keep track of the ticks of the station clock. Its staccato ticktack seemed to break into the monotonous howling of the wind with almost machine gun noise at times, and together with the crackling of the wood fire, was the only thing that kept me from going mad with the desolation of the place.

"On this particular evening, the wind seemed unusually strong and to get away from the repeated sound of ship reports and storm warnings that came to my ears thru the receivers, and the wailing of the gale overhead, I took down a book from the shelf and began to read. Of all the books I should *not* have found was a copy of Poe's stories, but this was the first that came to my hand. Reading Poe was never very soothing to my nerves, and tonight I seemed unable to get away from the thrall of the stories. Hour after hour I absorbed the weird, the fantastic, and the horrible until my head was a great whirl of unsightly shapes, of melancholy sounds, and grewsome sights. At last I began the third or fourth story, 'The Pit and the Pendulum,' I believe, when I noticed that it was time to send the press reports.

"Laying aside the book I started on the nightly schedule of news items, in some measure regaining my composure and accustomed state of mind, steadied a little by the rythmical sending and the close attention I paid to the manuscript before me. The half hour that was consumed in sending out this material was a relief from the enormities which had been flowing into my head, but from the very start of the press I noticed that it was mostly about a murder that had been committed near Haversook, the railroad station from which I came each evening. When I finally finished the sending, I could not throw off thoughts of that terrible affair, and involuntarily I glanced around me when I again picked up the book of Poe. I remember quite distinctly looking out of the small window near the table, but of course at that time of night nothing could be seen except the intermittent flashing of the lonely lighthouse far out on the spit. I did not expect to see anything, but the fact that there was nothing to be seen reassured me in no small measure. The murder story, however, kept coming back to my mind as I went back to 'The Pit and the Pendulum'."

At this point in the story Miggsby stopt and prest the buzzer, its small squeak startling the junior operator so that he nearly fell from his chair. The hardened mate even looked about him with a sort of shiver as he changed the position of his feet, firmly planted on top the condenser case. Outside the wind still howled and mourned alternately, the rigging and stack acting like organ reeds in the high velocity wind. Without much imagination

Then Came a Shrill Cry Again—This Time from the Operating Table.

phantoms could be seen flitting past the porthole thru which Boyd gazed so intently. Around the small cabin the gale seemed to concentrate its fury, and at each gust the men unconsciously moved closer together as tho the cold of the deck were getting into their bones.

"By the time I had found my place in Poe," resumed Miggsby, "all of my former nervous strain had come back. My nerves were keyed to the top notch, and at times I think I almost trembled with sheer fright. I got along to the place where the pendulum is whistling thru the air much like the wind outside, when suddenly I felt that someone was on the step outside. Whether I had heard something, or whether it was a sort of intuition, I don't know, but as the seconds past I became certain that the outer step was occupied. And I was just as certain that my unseen, unknown visitor was trying to get into my station. The hair along the back of my neck felt as tho there were thousands of tiny electric needles jabbing my skin. A cold shiver went up my back; my heart seemed to freeze. But try as I did my eyes would not leave that book. I sat there for an hour it seemed, staring with unseeing eyes at the closely printed page before me trying to figure it all out. In my imagination I thought of the pendulum with its unceasing oscillation, and the painful ticking of the clock served to emphasize my feeling of dread. Then suddenly I thought of that murder at Haversook, and of the murderer still at large.

"To say that I was frightened is putting it mildly. It was not mere fright that crept thru my body with all the stealth of a murderer stalking his victim. It was not a mere feeling of uneasiness, nor was it the cold of the gale getting into my body. It was something, nameless, indescribable. A vague dread, a horrible fear, a senseless feeling that something terrible was impending. It is beyond me to tell you just what was the matter. I cannot express the ex-

(*Continued on page 387*)

RADIO DIGEST

MOTOR GENERATOR FOR VACUUM TUBE WORK.

The greatest drawback to the use of vacuum tube transmitters for long distance work has been the difficulty in getting a high-voltage direct-current generator. A motor generator set operating on 110 volts a.c. or d.c. has been brought out by a well known radio company.

This set gives 200 to 500 volts at 0.2 ampere. At a speed of 1,750 r.p.m. the 48 commutator segments of the generator give a smooth current from which the ripples can be taken out with a small iron core choke and shunt condenser.

The voltage is regulated by a separate rheostat, making it possible to control the input to the tubes and to obtain the proper operating potential. Motor and generator, connected by a flexible coupling, are mounted on a heavy wooden base approximately 19 in. long by 9 in. wide. Rubber feet on the base absorb any vibration.

Now that power tubes are available, a number of undampt wave telegraph and telephone sets have been erected, and others are under way. In some cases audio frequency modulation is used because of the difficulty in heterodyning 200-meter undampt waves. This can be done without any trouble, however, with a rotary tone condenser at the receiving station. A coming article will describe the construction and use of the tone condenser.—*Abstracted from December Everyday Engineering.*

THE MEASUREMENT OF ALTERNATING CURRENT WAVES WITH THE BRAUN TUBE.

By E. Lubke.

This book contains a description of a novel application of the Braun Cathode-ray tube to the delineation of alternating current waves. Instead of the usual method in which the curve of the waveform is directly delineated upon the fluorescent screen of the tube, the cathode-ray beam is employed to ionize the space between the plates of a small condenser mounted on the end of the usual tube. The beam is caused to rotate in a conical path by electromagnetic deflection, so that the instant of ionization with respect to the position in the cycle can be controlled at will by rotating the deflecting coils around the tube. The condenser plates take the place of the contact-maker in the delineation of the waveform by the "Joubert" contact, point-by-point method. Examples of curves are given in the paper. A modified method is also described, and is suitable for frequencies up to several million per second.—*Abstracted from the Jahrbuch der Drahtlosen Telegraphie.*

RADIO STATION OF EILVESE.

By S. M. Sorensen.

An illustrated article describing the wireless station of Eilvese, Hanover which is equipt with Goldschmidt generators. Comparisons are made between the results obtained at this station and at Nauen. The Eilvese equipment is cheaper in installation and in running cost and has an antenna only 250 m. high. The economic operation results from the high efficiency of the apparatus and the method of sending by change of excitation of the generator, so that the machines run light during the pauses between the signs. It is a great advantage that the Goldschmidt system produces waves with practically no harmonics. It has been found possible to increase the power of the station by running several generators in parallel. Great distances have been bridge and messages from Eilvese have been received in Honolulu. The relative strength of signals received in America from Eilvese and Nauen were, under the same conditions, 21.6×10^{-7} and 14.4×10^{-7} amp.—*Abstracted from Elektrot, Zeits., May,* 1919.

VARIATION IN DIRECTION OF PROPAGATION OF LONG ELECTROMAGNETIC WAVES.

By Lieut.-Com. Taylor, U.S.N.R.F.

This paper is the report of the outcome of a study of the properties of an extremely long-wave direction-finder coil, with a view to determining the feasibility of using such long-wave direction finders on large aircraft on long flights, such as, for instance, a transatlantic flight. The use of direction finders for aircraft having been carried to such a very satisfactory conclusion at the Naval Air Station, Hampton Roads, Va., on a wavelength of 2,500 m., it seemed highly desirable to ascertain if it might be possible to utilize for airplane direction-finder work existing high-power stations in Europe in case of extremely long flights. Since all of the transatlantic stations which may be considered to be really high-power stations operate on continuous waves of lengths between 8,000 and 20,000 m., it was decided to build a direction-finder coil at the Naval Aircraft Radio Laboratory, Bureau of Standards, of suitable dimensions for installation in a type F-5-L, type H-16, or type NC flying boat.

In the process of this study comparison was made of the relative accuracy of settings obtainable with the two-coil maximum method and the usual single-coil minimum method. It was noticed that there were very considerable variations in the apparent bearing of the Naval Radio Station at New Brunswick, N. J.—*From Scientific Paper, No. 353, Bureau of Standards.*

RADIO COMMUNICATION WITH ANTENNA AND COIL AERIALS.

The Bureau of Standards, Washington, D. C., have been conducting an extensive research on radio transmission with various types of aerials. As a result of this work it is possible to determine by simple calculation the distance at which a given receiving aerial will receive signals from any transmitting aerial when the current in the transmitting aerial, its dimensions and the distance between the stations are known. The small coil aerial has many advantages, but is usually not as powerful a transmitting and receiving device as the antenna type of aerial. It may, however, have so much lower resistance than the antenna that it is equal to it in transmitting and receiving value. It is shown that a special type of antenna, consisting of two large metal plates, has certain advantages. The fundamental principles of design of radio aerials have been developed. The investigation has opened up a large and most interesting field for further research and progress in the utilization of radio waves. —*Scientific Paper of the Bureau of Standards, No.* 354.

TRANSMITTER RESONANCE.

In a brief manner R. H. G. Mathews explains the importance of resonance between the primary power circuit and the primary oscillating circuit. One of the methods of obtaining this resonance is described as follows: A primary choke coil having an adjustable core is used. In making up such a coil, care should be taken to use sufficiently heavy wire that the factor of resistance is very low, the impedance predominating. In this method the primary oscillation circuit is tuned to the wave desired, using inductance and capacity values as desired, it being considered that it is always desirable on short wavelengths to use as much capacity as possible in order to utilize fully the 1 kilowatt power input allowed by law. The inductance should not, however, be cut down to less than one turn, in favor of increased capacity.

After tuning the primary, the secondary or antenna circuit should be resonated in the usual manner.

The variable core choke coil should now be connected in series with the transformer primary and a wattmeter, voltmeter and ammeter connected in the circuit. A power factor meter may be substituted for the voltmeter and ammeter if available. Adjustment should now be made of the choke coil core, until the power factor is at its greatest value as shown by the formula

$$f = \frac{W}{E\,I}$$

where W = input in watts, E = voltage, I = current and f = power factor.—*Abstracted from December Q. S. T.*

DEVELOPMENT OF LOOP AERIAL FOR SUBMARINE RADIO COMMUNICATION.

By J. A. Willoughby and P. D. Lowell.

In the close of 1917, in the course of experiments made with the object of developing apparatus for the detection of submarines, it was found that radio signals could be received by means of a loop, either in air or submerged in fresh water. The loop aerial arrangement, as finally perfected, consisted of two insulated wires earthed at the extreme ends of the hull of a submarine, carried over suitable supports to the bridge, and thence to the receiving and transmitting apparatus. Communication at sea can be carried on under all conditions more efficiently with such a loop than with ordinary elevated aerials. Also it does not nterfere with submergence. With the submarine submerged any North American or European station could be received as distinctly as on the surface. To receive short waves it is necessary that the top of the loop should be near the surface of the water, whereas a wave of 10,000 meters length can be received with the top of the loop submerged 21 feet. Signals could be transmitted from the loop a distance of 10 or 12 miles with the submarine completely submerged. The range falls to two or three miles with the top of the loop 8 feet to 9 feet below the surface, using 952 meters wavelength. Submergence of the submarine during reception or transmission does not alter the wavelength. With the submarine on the surface a transmission range of at least 100 miles can be obtained with a 1 k. w. spark set even under very stormy conditions. The loop can also be used as a direction finder.—*Abstracted from the Physical Review, August,* 1919.

DETERMINATION OF THE OUTPUT CHARACTERISTICS OF ELECTRON TUBE GENERATORS.

By Lewis M. Hull.

General expressions are derived for the power and current output in terms of static characteristics of a generating tube, and are corroborated by experimental results, obtained with a particular tube.—*Scientific Paper, Bureau of Standards No.* 355.

THIS department is open to all readers. It matters not whether subscribers or not. All photos are judged for best arrangement and efficiency of the apparatus, neatness of connections and general appearance. In order to increase the interest in this department, we make it a rule not to publish photographs of stations unaccompanied by a picture of the owner.

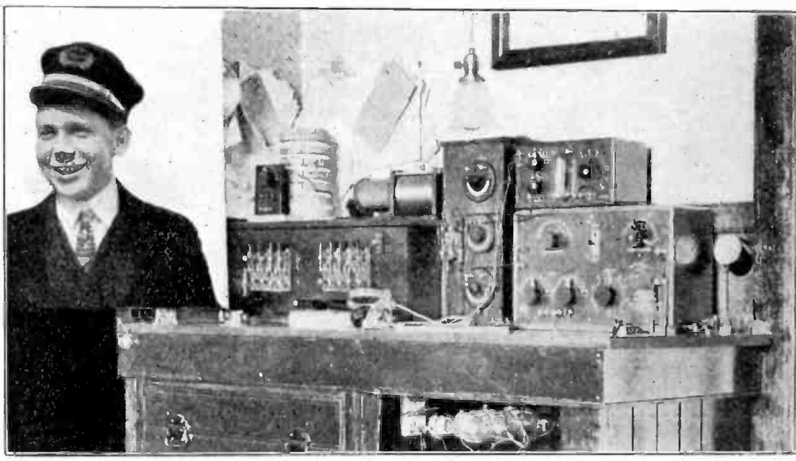
We prefer dark photos to light ones. The prize winning pictures must be on prints not smaller than 5 x 7". We cannot reproduce pictures smaller than 3½ x 3½". All pictures must bear name and address written in ink on the back. A letter of not less than 100 words giving full description of the station, aerial equipment, etc., must accompany the pictures.

PRIZES: One first monthly prize of $5.00. All other pictures publisht will be paid for at the rate of $2.00.

V. G. Mathison's Station

THIS station is located on Unga Island (one of the Shumagin Islands), Alaska. There being no regular commercial or naval station on the island, the station is at present operating under a limited commercial license, enabling communication with Alaskan naval stations. Its call letters are KVI.

The apparatus shown in the photo is all my own handiwork with the exception of the panel on the lower right. The set is, of course, designed for both dampt and undampt wave reception, and has a tuning capacity of more than 20,000 meters.



Ever Hear KVI? Here Is the Station and Its Owner, V. G. Mathison, Who Captures the First Prize of $5.00 This Month.

The lower right-hand cabinet contains a very efficient receiving transformer and loading coil for waves up 1800 meters, and also an aerial condenser with master switch for switching it in shunt or series with the tuner primary. Upon this cabinet is the audion panel. The tall box in the center has three variable condensers and a switch for changing from short to long waves and vice versa. The cabinet to the left contains the long-wave inductances.

A one-half inch coil may be seen on the left hand end of the desk, which also gets its current from the storage batteries. Using this spark coil on the aerial described below I have regularly worked ships as far as twenty-five miles.

The aerial is of four bronze wires; 350 feet long and over 100 feet high and gives excellent results.

V. G. MATHISON,
Haywood, Calif.

Frederick J. Rumford's Station

I have been a constant reader of RADIO AMATEUR NEWS and *Electrical Experimenter* since their first issues, and have been much interested in your various contests for amateurs.

I have an outdoor 4 wire antenna 100 feet long, wires spaced two feet apart. I have also a direction finder and loop aerial which is shown at the left of picture. I can use either aerial by the throwing of a switch. To the extreme left is my portable testing outfit, which is capable of testing low and high tension circuits; also, radio circuits of all descriptions. The receiving cabinet to the right I use for the reception of European messages. Within the cabinet are 4 crystal detectors which I can connect in conjunction with the coupler and loading coil for the reception of messages within a certain aera. I have a 180 degree scale in front for indicating the turning of the secondary on the variometer. All of the instruments including storage battery and cabinet are of my own manufacture. In the receiving cabinet I have a small circuit breaker to protect the audio-tron from being burnt out.

Fred. J. Rumford Is a Close Second. Note the Up-to-Date Loop Antenna.

FREDERICK J. RUMFORD,
26 Dore Street, Boston, Mass.

E. F. Schwach's Station

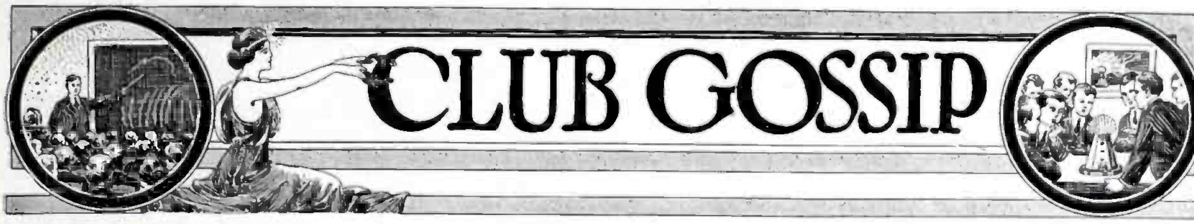
Here is a description of my whole set: From left to right are my Audions—detector and amplifier; next two knobs controlling primary and secondary of 20,000 meter inductance, five taps on each; then comes my loose coupler for short wave work, two knobs with 23 taps, tens and units, on primary, and the two white scales are variable condensers, primary and grid; between condensers is my arc and spark switch, and just below that is a 90° De Forest condenser. In my secondary circuit below are two bakelite 18 point switches for secondary of loose coupler and B battery on right side and necessary telephone jacks for detector, amplifier and extra pair of phones.

"Small, Compact, Yet Efficient" Was E. F. Schwach's Motto When He Designed His Receiving Station.

In front of my cabinet are two pairs of phones, Brandes and Baldwin.

To the right is a 1 k.w. open core transformer, a "Thordarson" rotary, a Murdock sending and receiving switch and Bunnell key with ⅜ in. contacts and in back of my set is a Tungar rectifier and a 6-60-AH storage battery for my audions.

E. F. SCHWACH,
Chicago, Ill.



EXPERIMENTAL SCIENCE AND RADIO CLUB.

The distance is 6,000 miles to Pearl Harbor, yet the Radio Molecules who vibrate in the rarified ozone of room 204 declare they have heard the ukeleles strumming on the beaches of Hawaii through their audions, condensers and phones which are strung thicker than morning glories over the front porch in the summer time. Looking eastward to the sea they have captured messages from the President's ferryboat, the George Washington. They have heard from New Orleans and Annapolis. During State Fair Week, when the club operated under a special license from the Central Department at Chicago, Ill., their messages were heard on the Canadian border and letters were received from other amateurs over the State. Mr. Robert Hall, a former instructor at Harvard, gives regular lectures before the club. Mr. Hall owns a 1 k.w. transmitter which has been heard 1,200 miles away. Cyril Otterholm receives messages every evening from the Atlantic coast. The ban on sending was lifted recently. Already Walter Kannenberg on Thomas Street has established communication with the station at the Y. The chief operator of the club, Mr. James Schultz, has been appointed district superintendent for Southern Minnesota for the H. R. R. L.

All communications should be addrest to Mr. C. J. Otterholm, Y. M. C. A., Experimental Science and Radio Club, St. Paul, Minn.

Members of the Experimental Science and Radio Club Listening to a Lecture by a Prominent Radio Instructor.

RADIO-SCIENCE CLUB OF FOSTORIA.

The Radio-Science Club of Fostoria, Ohio, was recently organized under the supervision of Mr. Lutz, High School Instructor of Physics and Chemistry. The purpose is to study radio and scientific subjects. Officers were elected which include: President, Francis Colligan; Secretary and Treasurer, Marjorie Newhouse, and the Historian, Le Roy Wolfe.

It is the duty of the Historian to keep a record of the talks and experiments that are given each week.

A program committee is responsible for a program including special lectures and treatises upon the subjects under discussion. Each of the twenty-two members are expected to cooperate with the committee in original experiments and research work.

The membership is limited to thirty-five but all who are interested in science are eligible to become candidates for admission.

It is the desire of the members of the club to keep in communication with other radio organizations through the medium of RADIO AMATEUR NEWS.

MARJORIE NEWHOUSE, Sec.

POLYTECHNIC RADIO CLUB

On Sept. 8th, 1919, the Polytechnic Radio Club of San Francisco was organized and at present has a membership of thirty-five. Meetings are held every Friday evening at 8 p. m. in the Polytechnic High School building. The following officers were elected: C. R. Tinsley, President, Lee Brillhart, Treasurer, and Herbert Dodge, Secretary.

Three committees were appointed—Electrical Committee, Library Committee and a Meetings and Papers Committee. The Electrical Committee has direct charge of the apparatus of the club, conducts all experiments, and gives code tests at every meeting. The Library Committee keeps on file all the latest radio magazines and news of interest to the club. The Meetings and Papers Committee arranges the program for the meetings and secures speakers.

An initiation fee of seventy-five cents has been adopted and the monthly dues of the organizaiton are twenty-five cents. To become a member of the club one must attend the Polytechnic High School or belong to the alumni. A sample of the membership card decided upon at a recent meeting is reproduced herewith. Communications from other clubs would be greatly appreciated and should be addressed to the secretary, Herbert W. Dodge, 1038 Ortega St., San Francisco, Cal.

THIS CERTIFIES THAT
John Doe.
IS A MEMBER OF THE
Polytechnic Radio Club
AS SHOWN BY RECORD ON BACK OF CARD
C. R. Tinsley PRESIDENT H. W. Dodge SECRETARY

A Neat Little Membership Card Which the Members of This Club Take Pride In Showing.

RADIO CLUB OF HARTFORD

A meeting of the Radio Club of Hartford, Conn., was held recently in the room of the Automobile Club of Hartford. Mr. Kenneth B. Warner, editor of "Q. S. T." and secretary of the American Radio Relay League, was present and gave a very interesting and instructive talk on "Practical Applications of the Audion". Mr. Warner told something of the theory of the Audion and then showed some of the best circuits for detector, oscillator, and amplifier use. It was also explained why a highly exhausted bulb was more suitable for an amplifier than for a detector. This was the second meeting since the war. It was decided to hold the next meeting some time in January, the secretary to send notices to the members when the date for that meeting was decided upon. A large attendance is expected at the next meeting at which time a number of radio operators who have been in the service either at home or abroad, will tell of their experiences.

MAITLAND STEELE,
Secretary.

SECOND DISTRICT WIRELESS ASSOCIATION.

Notice to Second District Amateurs.

The Second District Wireless Ass'n, which was organized in 1915 is now open for membership. All amateurs of the Second Radio District are requested to join. Our yearly call book containing names, addresses, call letters and power of station of all our members will go to press in February or March—join now.

Address all communications to Joseph E. Engstrom, 100 St. Marks Place, Brooklyn, N. Y.

CENTRAL RADIO CLUB.

The organization of the Central Radio Club was completed recently, with the drawing up of the constitution, by-laws and the election of the following officers: President, Louis R. Helwig; secretary and treasurer, George A. Flett.

The club is composed of members of the Central Y. M. C. A. Boys' Division, numbering at present ten; but all members of the "Y" are eligible to join. The club meets every Saturday evening at eight and soon expects to have an efficient set in operation, under the care of Messrs. Pooley and Usher of the Advisory Committee. All communications should be addressed to Central Radio Club, c/o Boys' Division.

GEORGE A. FLETT,
Sec'y & Treas.

THE NOLA RADIO CLUB

The Nola Radio Club organized on December 27th. At this meeting the following officers were elected: Prof. Auguste J. Tete, President; Arthur H. Kopper, Vice-President; Hubert E. de Ben, Secretary-Treasurer.

Twenty members were enrolled. All members were enthusiastic and a much larger membership is looked forward to.

The main object of the club is to increase the interest in amateur radio communication, which seems to have been lacking in the past. Several members have been doing very good long distance work. These members will help the others greatly in improving their stations and working range.

Through the courtesy of the Nola Radio School we were allowed the use of their school and set.

The station call is 5NO. Anyone hearing this call will greatly favor us by dropping a card to Nola Radio School, 134 Charles St., New Orleans, La.

HUBERT E. DE BEN,
Secretary-Treasurer.

SOUTH SIDE RADIO ASSOCIATION

We are pleased to announce that we have one of the largest Amateur Radio Associations in any city in the U. S. And also our members are all of the live sort. Our President Mr. M. H. Romberg is an ex-Naval Radio Instructor and has been in the game for twelve years, and our Treasurer Mr. D. Myers is an old time Great Lakes operator. The Association has been reorganized and is now known as the South Side Radio Association of Chicago. Any out of town members of other organizations who wish to become connected with a real live radio club will do well to write us.

MARKUS GREEN,
Secretary.

EXPERIMENTERS OF THE BRONX.

Public School No. 23, of Bronx Borough, New York City, now has a club called "Experimenters of the Bronx". This school has quite a large number of radio "bugs" and experimenters.

The club was organized on Nov. 6, 1919. All those boys present who qualified were admitted as charter members. Officers were not elected at the first meeting, but one of the instructors of the school told the boys how to proceed with the club's affairs.

The Club's Aerial is to be 125 feet long and 70 feet high. A set now being constructed by members consists of a large loose-coupler, phones, detector and condenser. Other instruments will be added as needed.

The club holds its meetings in the school every Wednesday.

BLOOMINGTON H. S. RADIO CLUB.

We have recently organized a radio club at Bloomington High School, Bloomington, Ill. The name of the club is Bloomington High School Radio Club.

The club was organized with twenty-three charter members. The purpose of the club is to create more interest in Radio. Any member of the high school is eligible to the club whether or not he has a station. We are putting up a large set at the school.

VICTOR R. SLEETER,
Secretary.

ALGOMA RADIO CLUB

The Algoma Radio Club was formed about three months ago for the purpose of binding the amateurs of this district together and enabling them to improve their installations by contact and discussion with other amateurs. Meetings are held every Friday evening at the Y. M. C. A. and an address is given by some prominent wireless or electrical engineer of this city. We are desirous of getting in communication with other clubs and anyone desiring to communicate with the club will please write the corresponding secretary, Soo, Ontario.

DAVID S. LLOYD,
Secretary.

THE LOWELL RADIO CLUB.

After two years of silence, the Lowell Radio Club renewed its activities at a post-war reorganization meeting held recently in Lincoln Hall, Lowell, Mass. The attendance of pre-war members was augmented by a large and enthusiastic body of new members.

The club which was formed some months before the war, ceased activities with the placing of the ban on experimental communication. The war record of the club is unusual since nearly three-quarters of the members were connected with the radio units of the army or navy, several seeing long service overseas.

Prior to the war, the club had rooms in one of the downtown office buildings and was planning the installation of a modern set. These quarters have been resumed and the club will erect an aerial and install apparatus shortly. Code practice for the junior members is already in operation and theory lectures are in preparation.

Correspondence with other clubs is invited and should be addressed to Lowell Radio Club, Odd Fellows Building, Lowell, Mass.

Success to RADIO AMATEUR NEWS!

W. H. CARNEY, Secretary.

YATES RADIO CLUB

A radio club has been formed in Penn Yan called the "Yates Radio Club."

We started to organize about December 1st and already have ten members. The purpose of this club is, to study wireless telegraphy and telephony and other branches of the electrical field.

We have a complete transmitting and receiving station. We can pick up European stations with the receiver and can cover 50 miles with the transmitter. It is hoped that in the near future a 1 KW transmitter will be installed. The call of the station where the club meetings are held is 8FN. The station has been licensed since October 1st. We already take all the leading wireless magazines. Address all communications to William C. Babcock.

WILLIAM C. BABCOCK,
Secretary.

THE PHILADELPHIA AMATEUR RADIO ASSOCIATION.

The Philadelphia Amateur Radio Association, meeting at 1611 Columbia Avenue, the second and fourth Monday of each month, has now 100 active members on its roll and we are only a few months old as an Association.

With an attendance of 79 at the last regular meeting we were surpised with a visit from Lt. Mackay, Radio Officer in charge at League Island, (N. A. I.), who informed us that his station has no amateur on the Black list to date. In appreciation of our strict observance of the 200 meter law and several minor rules of courtesy, starting January 1, 1920 at 8:45 P. M. Philadelphia Navy Yard station will send Amateur broadcast code messages using the code employed at N. A. H.

Officers in the club elected to serve for one year are President, Dr. G. M. Christine; Vice-President, M. Ferris; Secretary P. Hoby of 1902 N. 11th St. Interesting programs are arranged for each meeting with the following technical speakers: Mr. Stuart Ballantine, Mr. W. Benson, Mr. M. Ferris, Mr. S. S. Harris, Mr. L. Damon, Mr. Delke, and others of prominence in Philadelphia radio work.

At the last meeting Mr. Cadimus, 3rd District Radio Inspector, told of the Department of Commerce relation to the amateur. Lt. Mackay spoke of the local naval station's attitude toward local amateurs; Mr. Patterson gave drawings for a new coil winding machine for home use; Mr. Harris spoke on "Fundamentals of Alternating Current"; Mr. Benson discussed "Is Impact Transmission Practical for Amateurs?" Mr. Delke took up Honey Comb Coils vs. Pancake Coils; Dr. Christine read the club magazine.

Members agreed to stop sending at 10 P. M. so that long distance signals can be heard without difficulty.

ALBANY RADIO CLUB TO INSTALL RADIOPHONE

A powerful radio telephone plant will be erected in Albany, according to plans made by the members of the Albany Wireless Club. The radio operator on the destroyer which was at Albany recently sent a telephone call to all radio operators in Albany to attend the club meetings, which take place in the Young Men's Christian Association the first and third Tuesday of each month. The plan met with such success that the club has arranged for the telephone's erection in the Y. M. C. A.

The following officers have been elected: President, E. C. Fashodt; vice-president, W. Stein, and secretary and treasurer, K. B. Hoffman.

AMATEUR RADIO CLUB OF BALTIMORE

A new organization which is expected to bring together all of the amateur radio operators of this city, and which will be known as the Amateur Radio Club of Baltimore, was formed on October 25. The purposes of the club are to bring the radio amateurs of Baltimore and vicinity into closer relationship, so that their individual experiences and experiments may be discusst for the advancement of the science of radio, to instruct all amateurs in the observance of the rules set for them by the United States Government, and to reduce questionable radio methods to a minimum. Rules and regulations for the guidance of the club have been adopted and monthly business meetings will be held.

Since the government takes particular interest in assisting amateur radio clubs, it is contended by those back of the local organization that all who affiliate will have access to valuable information which they otherwise could not obtain.

Junior Radio Course

THE previous lessons have clearly shown that radio impulses are propagated in the form of waves, likewise we explained the meaning of wave-length. In this lesson we will take into consideration the various *forms of waves*.

By forms we mean the *shape* of the waves as they move along. Supposing we could take a photograph of them, we would see that they are similar to water waves. We are now going to deal with the various forms which these waves can and do assume. Just as water assumes various forms, as when frozen it becomes ice, when heated it passes off into vapor, so with waves; they also have their distinct characteristics, relative to their shapes.

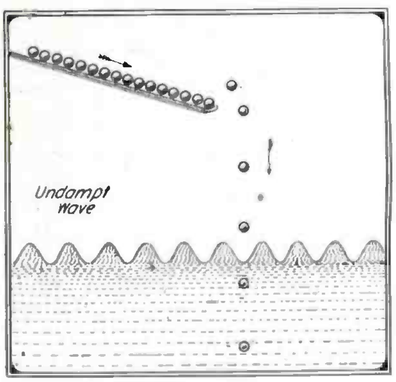


Fig. 1—By Dropping Marbles at Rapid and Equal Intervals Undampt Waves Are Produced.

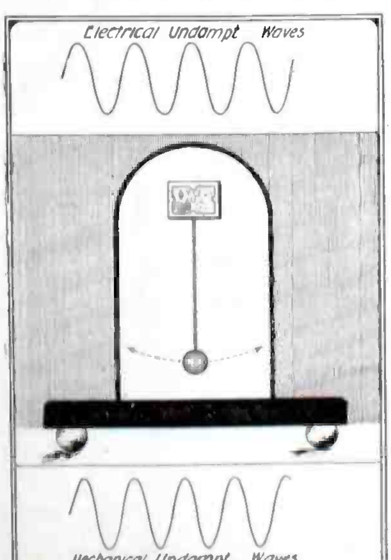


Fig. 3—A Pendulum Covered by a Bell Jar as Shown Swings Freely.

They do not change physically as the water does, but nevertheless vapor is water, and a wave is a wave, altho its shape and movement may be different.

Starting with the *undampt* wave form, let us first see what the meaning of undampt is. Supposing we were to return to the pool of water so often described in our previous chapters and procure a large number of marbles of the same size, shape and weight. By means of an incline, see Fig. 1, we now drop one of these marbles into the pool of water and immediately a set of ripples, or waves is set up from the center point, where this marble was dropt. Each wave now forms a complete circle and the number of these circles resulting directly from the dropping of the marbles into the water, we shall call *a train of waves*. In other words, the entire number of waves set up by the dropping of one marble into the water constitutes *the wave train*.

Supposing now, that we could accurately and with precision drop one marble after another into the water so that the second marble will start its series of waves *immediately* after the first wave (formed by the previous marble) has gone thru *one up and one down motion*. The second wave now sets up its series of trains as well. We drop a third and a fourth, in exactly the same position as before, and we will find that one wave train after another will continue to go out from the starting point without decreasing in height, inasmuch as each wave is formed by a marble of exactly the same size and weight as its predecessor. See Fig. 1. These waves continue to come on, and on, as long as we do not cease dropping marbles into the water. In other words, we are *constantly supplying energy*, which causes these waves to be formed continuously. There is nothing to hinder them, and hence *they are undampt*. The word undampt itself means—not checked, not deadened. Anything which has a tendency to check may be called a damper. Thus we know that as long as we have a constant source of energy coming in at distinct intervals, the waves will go on interruptedly, one forming its movement exactly in line and in step so to speak, with the one proceeding. Let us remember now that the waves are being formed one right after the other by the constant dropping of the marbles into the water, each one, of course, making its own wave train, but each train *exactly in step* and coming close upon the one which has just left. These are then undampt waves.

Suppose we take another example. We have a clock, unmounted with just its pendulum hanging down and swinging freely. Over it we place a large glass bell jar. The pendulum will be seen to continually sway on and on, as long as the clock is wound up. In other words, we are constantly supplying energy to prevent that pendulum from ceasing its undulations. This energy is being applied at the critical moment, so that it will not in any way retard the movements of the pendulum, but keep it going at the same speed and the same height of swing.

So in radio, we can have waves which are constantly being generated, and which waves will continue to come on and on, one right after the other with exact precision, just as the pendulum in the clock, or as the waves in the water.

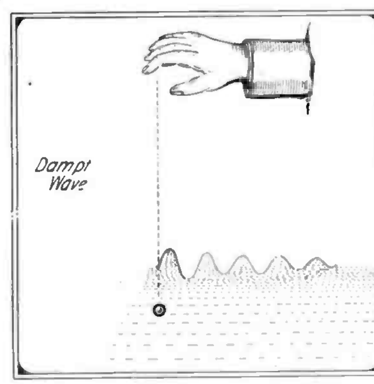


Fig. 2—A Marble Dropt in the Water as Shown Creates a Dampt Wave.

Supposing now that we were to fill water into the bottom of this bell jar where the clock is still going, its pendulum swinging along with absolute freedom of motion. The water coming into this jar will now have *a retarding effect* on the pendulum. It will tend to stop it, the pendulum gradually decreasing its steady to and fro mo-

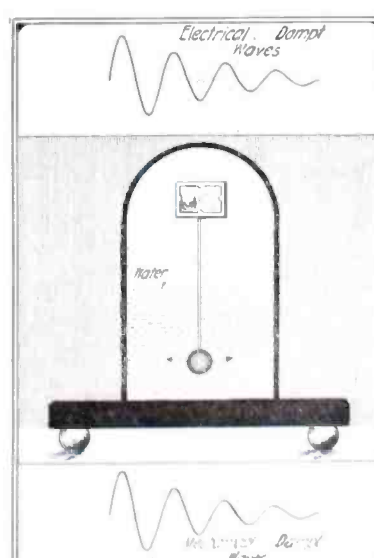


Fig. 4—Here the Pendulum Is Retarded or Dampt by the Water in the Jar.

tion, finally stopping entirely. We start the pendulum once more, under the same conditions, and it gradually ceases its oscillations again. The water friction is too great to allow a free motion of the pendulum which will always tend to stop. It restrains the movements and hence *dampens the vibrations* of the pendulum. The water, it will be observed, is the *resistance* offered to the swinging pendulum.

Let us again repair to the pool of water and discontinue the dropping of the marbles with the regularity which we used in the first experiment. This time we only drop one pellet into the water; a train of waves is set up and it dies out. We drop another and note the same results. This time the *waves have been dampt* by the action of gravity, the cohesive action of the water, or anything else which you might believe to be the cause. Nevertheless, the waves do die out, becoming gradually smaller and smaller, the same as the movements of the pendulum died down when the water reached it, and it had to buck against a resistance. We have now what is known as a dampt effect. There is nothing to continue the waves one after the other. They are given a start, only to die out shortly.

Exactly so with radio. In dampt wave formation the wave is given a full start, but it meets with resistance and inasmuch as there is not enough energy being supplied to overcome this constant resistance, it loses out and gradually dies away, to be replaced a little later by another wave. This, of course, takes place at remarkable velocity, one wave coming closely upon the other, but still its characteristic is the same as the example quoted above. In a future chapter we will take up the resistance which a wave meets with, in discussing the differences again briefly, under spark gaps. The resistance is mainly in the circuit just as the pendulum movement was stopt in the jar by the water.

QUESTIONS FOR THIS LESSON.

Question 1—What is the meaning of wave form?

Question 2—How does an undampt wave look?

Question 3—Give a similar instance of undampt wave formation by some simple physical principle.

Question 4—What is meant by undampt wave in radio?

Question 5—How does a dampt wave differ from an undampt wave in (1) its form, (2) its constancy of vibration?

Question 6—Illustrate the formation of a dampt wave by a simple mechanical experiment.

Question 7—What causes damping?

Facts About the Bordeaux Station

Within six months France will possess a wireless station capable of sending messages everywhere on the world's surface. This station, now nearing completion at Bordeaux, will have sufficient power to reach all stations within a radius of approximately 13,000 miles.

The Eiffel Tower station and the immense government station at Lyon have been France's important stations thruout the war. The Eiffel Tower was able to send messages up to a distance of 3,500 miles, while the new station at Lyon had an average range of about 7,000 miles.

An average of 10,000 words per day have been sent out from Lyon thruout the war. It was from this station that many parts of the world were kept informed of the war's progress, even the far east getting its western front news from this station's messages which were picked up in Shanghai, and there given to the local papers.

The Bordeaux station has been jointly constructed by Americans and French. When General Pershing arrived in France he requested a station which would enable him to keep in touch with the United States at all times, regardless of bad atmospheric conditions. The Bordeaux site was immediately suggested by the French government and work begun under the direction of General Ferrie of the French telegraphic service. Nearly 1,000 French and American soldiers were assigned to the task of constructing the immense station.

In actual electrical power supplied the antenna the capacity of the Bordeaux equipment will be five times as great as the Eiffel Tower and three times as great as the Lyon station. Fully 500 kilowatts will be available. This will be far the greatest electrical force ever devoted to the launching of wireless news.

The famous German station at Nauen, heretofore the most powerful in Europe, will be greatly outdistanced, both in sending distance and in daily capacity. The Bordeaux station will be able to send fifty words per minute, or a total of 72,000 per day. The great capacity will be made possible by the employment of special equipment heretofore confined to wire telegraphy.

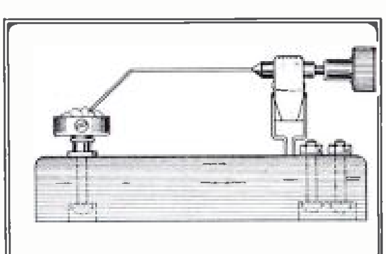
Sixty men will be needed to maintain and operate the station. They will work in four shifts, keeping open a continuous twenty-four hour service.

Junior Constructor

SIMPLE CRYSTAL DETECTOR.

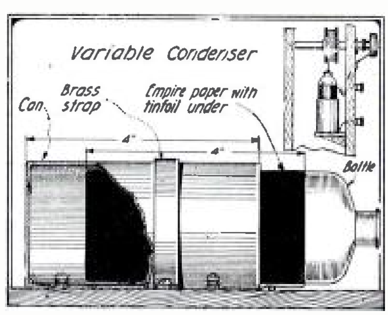
Here is a small wireless detector which I made of very little material. Procure a cup from an old dry cell, two brass machine screws and a battery binding post. A heavy magazine clasp with the long end bent into the shape of a tube is fastened in a hole 1/8" in diameter drilled in the base. The knob is an old auto switch plug key. A piece of copper wire is then soldered to the shank of the knob. Refer to the drawing for other details. This detector was made for use with Galena.

Contributed by HARRY WARDRUM.



A Crystal Detector Permitting Ease of Adjustment May Be Constructed as Shown. Note the Use of the Magazine Clasp.

EASILY CONSTRUCTED VARIABLE CONDENSER.



Note the Simple Construction of This Variable Condenser. A Method Is Also Shown for Mounting on a Panel.

In a late issue of RADIO AMATEUR NEWS, I saw an article on the construction of variable condensers. I have made an instrument very similar but much cheaper and easier to construct. I have tried it out and it "does the work."

First procure a tin can about 2" by 4" and a glass bottle to slide in and out of it easily. The bottle should be about 6" long. Solder a wire to the end of the can as in A. This goes to one binding post.

Prepare the bottle as follows: Shellac the bottle to within 2" of the mouth, and wrap one layer of tinfoil around. To the tinfoil at the upper end, solder a piece of No. 24 insulated copper wire. This should be about two ft. long. From the tinfoil bring it around the curve at the top of the bottle and bind it at the neck. Make a spiral of the remainder of the wire. The end of this wire goes to the other post. Cover the tinfoil with one layer of Empire cloth. Mount the condenser on a suitable base as shown in the diagram.

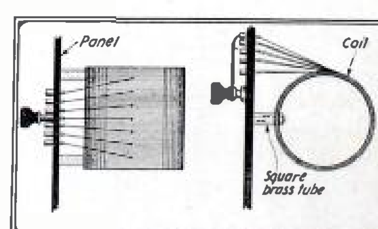
Condensers of this sort may be mounted in cabinets as per illustration. When completed, this makes a very efficient instrument.

Contributed by
VICTOR R. SLEETER.

TO MOUNT COILS ON A PANEL.

Here is a simple way to mount coils on a panel.

A piece of square or round brass tubing is used to hold the coil away from the panel and when the machine screw is tightened up the coil will be held very rigid. Coils mounted on panels in this manner are very efficient.



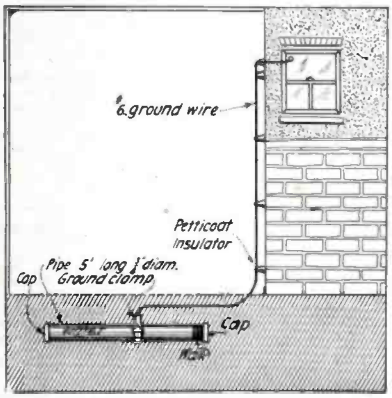
Coils Mounted in this Manner add to the Efficiency of a Receiving Set.

Contributed by
STUART A. HENDRICK.

A SHORT GROUND.

In order that amateurs living in the country or outlying parts of the city and not having access to water pipe to ground their receiving and transmitting sets, the following short ground was designed. The writer installed and found it practical and furthermore it was passed by the Massachusetts State Board of Fire Underwriters.

This ground consists of a short piece of pipe five or six foot in length and three-quarters or one inch in diameter. Thread both ends of the pipe; on one end a pipe cap should be screwed on securely, first white-leading the threads. The pipe should then be filled with water within three-quarter inch from end; sealing wax to be melted and poured in open end of pipe.



Try This Ground if You Have No Access to a Water Pipe. It Is Practical and Should Give Good Results.

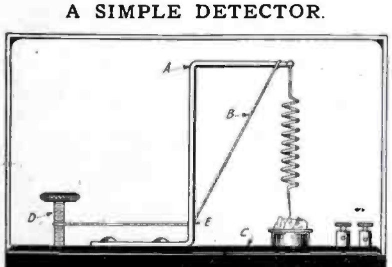
Then screw pipe cap on the open end. The short ground is now ready for use.

The ground wire must be no smaller than No. 6 insulated wire, to be fastened to mast or building with petticoat insulators. After running ground wire to place of ground, solder the wire to a ground clamp and securely fasten ground clamp to pipe already made. A trench must be dug in earth two foot deep and long enough to take pipe, the pipe to be placed in trench and covered with earth and tamped down.

This ground saves the amateur the trouble and expense of running wire to the nearest pond or creek.

Contributed by RALPH G. DICKIE.

A SIMPLE DETECTOR.



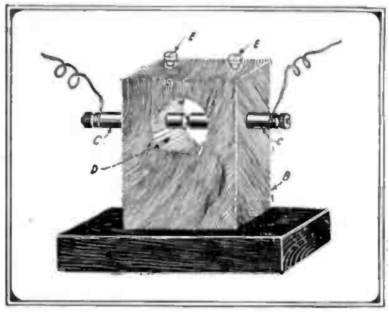
This Amateur Designed a Detector so That the Pressure on the Crystal Is Controlled by a Wire and Thumb-Screw.

This is a detector suitable for the bug who lacks the tools required for making most detectors. A is a piece of flexible brass strip screwed to the base C. B is the adjusting wire soldered to A and running thru the hole E and fastened to the screw D.

By turning the screw D it pulls the wire, thus pulling down the strip A and adjusting the catwhisker on the mineral.

Contributed by H. RICHARDSON.

A NOVEL SPARK GAP.



A Couple of Zincs, a Wooden Block With a Few Holes In It and You Have a Neat and Simple Spark Gap.

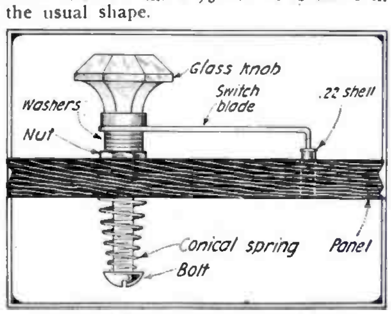
Here is a drawing of a spark gap which has given very good service, and cost almost nothing to make. The drawing explains itself so further details are necessary.

A and B are made of hard wood which has been dipped in boiling parffine. D is a hole ¾" in diameter. C C are battery zinc electrodes secured from old batteries. Two small set screws E screwed in from the top hold the electrodes in place. Connections with the electrodes are made as shown.

Contributed by
FREDERICK H. GRAENING.

GLASS SWITCH KNOB.

A glass drawer knob is procured at a hardware store. The blade is made from brass and is 2 in. x ⅝ in. It is made in the usual shape.



A Type of Switch Using a Glass Knob.

The contact points are 22 caliber rifle shells.

The diagram explains other features.

Contributed by EUGENE M. RIEL.

HIGH FREQUENCY BUZZER.

Perhaps one has noticed on the market, the various high priced buzzers. They all work with a steel reed as an armature instead of a soft iron one. It is difficult to get a suitable piece of thin steel and the razor blade shown in illustration provides an excellent substitute.

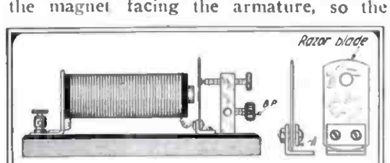
The magnet is wound with a No. 32 wire, and the base is made of wood or bakelite. The razor blade is held in place by the piece of brass bent in the shape of A in the illustration. Two screws hold the blade tightly.

Solder a piece of nickel to the pole of the magnet facing the armature, so the armature does not stick. Also fasten a piece of platenoid on the razor blade.

This can be taken from an old bell armature.

The blade should be very stiff, and when the whole is assembled and connected to a battery, a fine high pitched sound is produced.

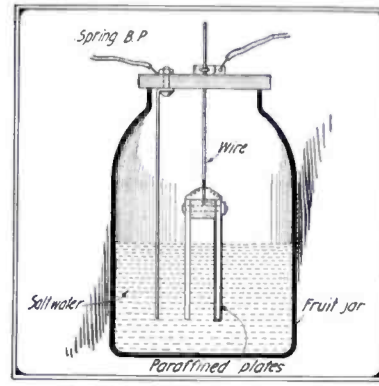
Contributed by
JOSEPH SAMUELOWITZ.



A Razor Blade Used as the Armature Causes This Buzzer to Give a High Frequency Tone.

AN EMERGENCY VARIABLE CONDENSER.

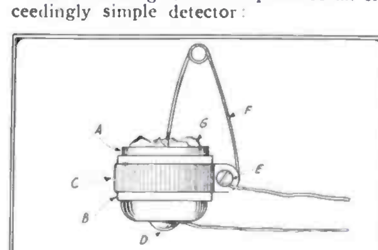
Have you ever wanted a variable condenser "imejatly" if not sooner? The author has and this is his solution to the problem. Take a quart fruit jar, fill it half full of salt water and fit a wooden cover to it. Then fasten to a block of wood some thin metal strips as shown in sketch. Also fasten to this block a large wire to act as a support. When this is completed the "plates" are dipped in shellac or paraffin. This coating acts as an insulation and dielectric. A small hole is bored in the cover to pass the wire thru. A spring binding post is slipt on the wire to make connection with the plates and to hold them at the desired depth. Another wire is immersed in the liquid to make the other connection. Lowering or raising the plates changes the condenser capacity. —Contributed by E. D. PAPKEE.



A Make-shift Variable Condenser.

A SAFETY PIN DETECTOR.

The following is a description of an exceedingly simple detector:



A Real Silicon Detector, Using a Safety Pin for Simplicity.

A is the metal end of a cartridge fuse, B a strip of mica 1/16 around the cup, C a strip of brass forming a ring over the mica and tightly clampt by E, D one lead soldered to cup, E a binding post holding C and safety pin, F a safety pin and G a piece of silicon.

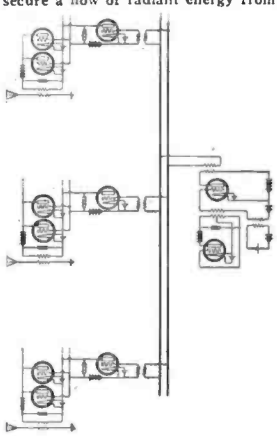
Contributed by HARRY ROSENBERG.

(*Editor's Note.*—Try the base of a broken electric light in place of the cartridge fuse end. Fasten the brass strip near the top so that the whole may be screwed into a lamp socket.)

Directive Sending System

(No. 1,301,644, issued to O. E. Buckley.)

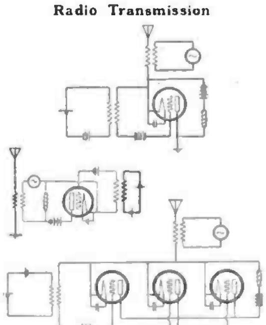
The object of this invention is to secure a flow of radiant energy from



the transmitting station principally in certain definite directions. This object is accomplisht by making use of the fact that a number of sources of wave radiation, spaced equally along a line and all oscillating with the same constant frequency, tend to produce by interference a flow of energy principally in one or more definite directions. The power radiated, instead of being approximately uniformly distributed in direction, as in the case of a single source of radiation, will be concentrated in certain definite directions.

In order that the novelty of this invention may be appreciated, it is necessary to point out that a number of independent oscillating antenna, not controlled from one source of power and not otherwise connected with one another, cannot be maintained in synchronism and in phase. Further, it is not practically possible to supply with power from one central source a number of antennae separated by the distances here contemplated, for that would involve transmission of high frequency power of large amount over a distance of several miles.

Radio Transmission



(No. 1,301,525, issued to H. J. Van Der Bijl.)

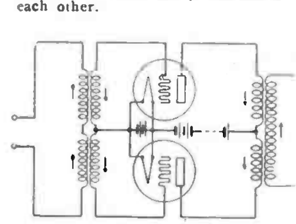
This invention provides a method in which it is not necessary that the primary source of modulating waves shall handle directly all the modulated power required to be radiated from the antenna. This method depends upon the fact that an electromotive force impressed upon the input circuit of a thermionic amplifier of the "audion" type produces an apparent change in the impedance of its output circuit; in particular, a change in electromotive force impressed upon the input circuit, resulting from a change in impedance in a local circuit associated with said input circuit, causes the impedance of the output circuit of the amplifier to vary in such a way as to produce therein much greater changes in power than take place in the above mentioned local circuit. The thermionic amplifier in this case acts as a magnifying device for changes of power in the local circuit, and on account of this property a primary source of modulated power, capable of handling only a small amount of power, may be used to produce much larger changes, for example, in a transmitting antenna.

Vacuum Tube Repeater

(No. 1,313,406, issued to R. C. Mathes.)

This invention provides a method and means for maintaining the potential of the grid or control electrode which is momentarily negative at a relatively high value, thus compensating for the lowered potential of the control electrode which is positive.

This object is attained in the form of the invention shown herein, by coupling the control electrodes to the source of received impulses by means of two separate transformers non-industively related to each other.

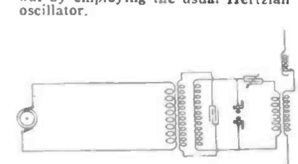


Radiosignaling System

(No. 1,304,296, issued to Charles Le G. Fortescue.)

It is recognized that, to render the receiving apparatus of a radio system most effective, the impulses impressed upon the receiving circuit should occur at the rate of approximately 1,000 impulses per second, which corresponds to the frequency or pitch of a tone of good audibility.

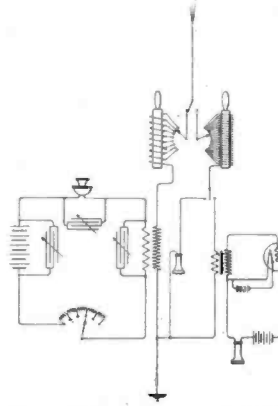
An object of this invention is to provide means for accomplishing the aforementioned results, whereby radiations that are only slightly damped may emanate from the antenna of a wireless sending station. At the same time, the wave trains projected into space may be produced at a high rate and uniform frequency in order to insure the production of a uniformly pitched and audible note in a distant receiving station. The inventor accomplishes these results without using a high-frequency alternator but by employing the usual Hertzian oscillator.



Wireless Transmission of Energy

(No. 1,315,197, issued to Earl C. Hanson.)

This invention relates to the transmission of energy by means of

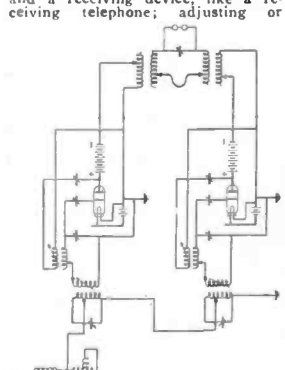


electro-static and electro-magnetic induction from place to place without the use of wires or other conducting members. It differs essentially from previous attempts at such transmission in that it employs waves at audio frequency rather than the common type of waves which are of radio frequency. The audio frequency electro-static and electro-magnetic waves are those having a frequency within the range of the human ear, this frequency being below ten thousand cycles per second.

Apparatus for Eliminating Static Effects

(No. 1,306,170, issued to E. E. Butcher.)

This invention comprises the use of an antenna circuit containing adjustable inductance and capacity; two local oscillating circuits each containing adjustable means for causing said circuits to generate or exhibit high frequency oscillations, means for associating said circuits with a third circuit containing adjustable inductance and capacity; and a receiving device, like a receiving telephone; adjusting or



tuning said two local circuits to frequencies above audibility and respectively different, and said third circuit to a frequency lower than that characteristic of either the antenna circuit or the two local circuits referred to and within the range of audibility.

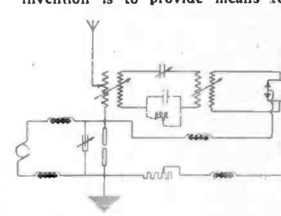
There is provided an antenna containing adjustable inductance and capacity and two local oscillating circuits of substantially identical arrangement; each of these circuits contains an oscillation generator, like the well-known vacuum valve adjusted to generate high frequency, sustained oscillations, above audibility; these two circuits are so adjusted as to avoid establishing by their characteristic frequency a conjoint note, that is, any note due to their coupled co-operation upon a third circuit coupled with said two local circuits. This third local circuit includes means for tuning and is tuned to a lower frequency than that characteristic of either of said first named local circuits.

Arc Transmitting System

(No. 1,309,778, issued to O. C. Roos.)

In the systems which are energized by substantially continuous oscillations such as those developed by an oscillating-arc circuit oscillations developed in the antenna are generally not simple harmonic but consist of a fundamental and various multiples thereof, the higher of which if reinforced by antenna resonance are generally of considerable amplitude.

The existence of these higher harmonics imposes a limitation to efficient selective transmission and it is therefore the main object of this invention to provide means for absorbing the higher harmonics so that the transmitted electromagnetic waves will be substantially simple harmonic. A further object of the invention is to provide means for

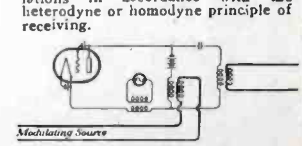


rectifying such higher harmonics and for utilizing the energy of the resulting unidirectional impulses to assist the main current in feeding the arc.

Translating Circuits

(No. 1,312,433, issued to John R. Carson.)

This invention has for one of its objects the provision of a translating arrangement in which there is no input or controlling circuit as distinguished from the output or controlled circuit, the functions of the two circuits being combined in a single operating circuit associated with the translating device. Another object of the invention is to produce a translating arrangement of this character which may be used either for modulating high frequency oscillations in accordance with signal variations, or for detecting the signals imposed upon high frequency carrier oscillations, by the interaction of the modulated oscillations with a local source of oscillations in accordance with the heterodyne or homodyne principle of receiving.



$100 RADIOPHONE PRIZE CONTEST

ONE of the most disappointing features of Radio Amateur Progress at present is the seeming lack of interest in the Radiophone.

The Editor of this publication has always taken the stand that the ultimate goal for all radio enthusiasts lies, without a shade of doubt, in radio telephony.

The reasons are so obvious and so convincing; while not one single argument can be found against it. Radio telephony is the one and only solution out of all the many Radio amateur's troubles, to wit:

With Radio Telephony, interference with Government and Commercial stations is practically done away with at one stroke. Consequently and logically, the radio amateur will at once be placed in a safe and dignified position. He will not be bothered as in the past and present with anti-amateur legislation. *But American radio amateurism will surely perish if its future rests upon radio telegraphy.*

With Radio Telephony no codes need be mastered. You talk, that's all.

With Radio Telephony, the length of time required to send a message is from 1/10 to 1/20 shorter. Consequently more traffic can go on for a given time than now.

With Radio Telephony, the tuning is infinitely sharper and better, consequently less interference. With Radio Telephony, radio amateurism will become truly great—of a national scope. Where there is one radio amateur telegrapher today, one hundred will grow in his stead the moment practical radio telephony is here. Everyone will use the radiophone! The farmer, the business man, country folks, motorboats, autos, etc., etc.

Now the curious and surprising thing is that the radiophone has been with us for some years past. There is nothing new about it, no secrets, no patents that need bother any amateur. Then why don't we use this wonderful invention to the very limit. It will surely boom Radio Amateurism more than any one thing in this world ever can or will. We have all the tools, so where is the hitch?

Now, the Publishers believe in the truly wonderful future of the Radio Telephone. They will stake their reputation—nay, if necessary their all—on their conviction. They will spare no expense, leave no stone unturned, to make American Radio Amateurism one of the world's greatest institutions. And Radio Amateur Telephony will be the keystone to this edifice.

With this in mind the Publishers wish to bring out the best from the ranks of our amateurs, the best being of course radio telephone transmitting instruments. Any modern radio receiver is capable of receiving either radio telegraph or radio 'phone messages. We are concerned here, only with the instruments that *send* the messages.

The Publishers therefore offer prizes of $100 in gold for the best articles on a practical radio telephone outfit. America's foremost radio experts will act as judges of this contest. As every one of the judges will pass upon the manuscripts submitted there can be little doubt that all contestants will be treated fair and impartial. Furthermore, we feel certain that this contest will not only bring out the very best there is in the American amateur, but that it will lift the new art to an unknown and undreamt of level.

PRIZES OF $100 IN GOLD

First Prize	**$50.00**
Second Prize	**25.00**
Third Prize	**15.00**
Fourth Prize	**10.00**

Here are the men who will act as the judges of the contest. A distinguished array of the best radio talent in America:

Dr. Lee de Forest, Ph.D., Inventor of the Audion.

Dr. Greenleaf W. Pickard, Inventor of the Crystal Detector.

Dr. Louis Cohen, Ph.D., Radio Expert and Inventor.

Fritz Lowenstein, Radio Expert.

H. W. Secor, Assoc. I. R. E., Associate Editor, Electrical Experimenter.

H. Gernsback, Editor, Electrical Experimenter and Radio Amateur News.

RULES OF THE PRIZE CONTEST.

The set to be described may be of the vacuum tube type, the arc type, the quenched or other spark type. Or it may have embodied in it new features not known at present. The important part is that the set must have been actually built, that it either is in use now or has been in use. "Ideas" or patent descriptions are strictly excluded from this contest. It is also obvious that, insofar as this contest is conducted chiefly to bring out NEW ideas, commercial radio telephone outfits as now sold by several makers, are excluded from the contest.

It is necessary to state what instruments are used, and if certain instruments have been bought, the make must be stated. The transmitting distance of the radio-phone should be given, i. e. the record distance covered with the set. A complete diagram of connections, neatly executed in ink, is to be furnished. A good photograph (not smaller than 5 x 7") giving at least two views of the set is necessary. A photograph of the builder is required.

The sizes and the kind of wire used in the construction must be given, as well as the dimensions of the principal parts. More than one outfit may be entered by a contestant. The contest is open to every one (radio clubs included), except manufacturers of wireless apparatus. The manuscript should not be longer than 1,500 words. 1,000 words are preferred. All prizes will be paid upon publication.

The contest closes in New York April 12th, and the first prize-winning article will appear in May, 1920.

Address all manuscripts, photos, etc., to "Editor Radiophone Prize Contest," care of this publication.

In connection with the above contest, it grieves us to announce that our second $100 Radio Prize Contest: "An Ideal Sending Outfit," was abandoned for the reason that of the several manuscripts received, none complied with the most important rule, viz., the actual building of the outfit, and its proof—the required photograph of the set. The manuscripts were therefore returned to the respective authors.

The Publishers.

THIS Department is conducted for the benefit of our Radio Experimenter. We shall be glad to answer here questions for the benefit of all, but we can only publish such matter of sufficient interest to all.

1. This Department cannot answer more than three questions for each correspondent.
2. Only one side of the sheet should be written upon; all matter should be typewritten or else written in ink. No attention paid to penciled matter.
3. Sketches, diagrams, etc., must be on separate sheets. This Department does not answer questions by mail free of charge.
4. Our Editors will be glad to answer any letter at the rate of 25c for each question. If, however, questions entail considerable research work, intricate calculations, patent research, etc., a special charge will be made. Before we answer such questions, correspondents will be informed as to the price charge.

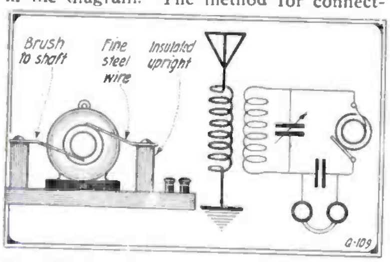
You will do the Editors a personal favor if you make your letter as brief as possible.

TIKKER FOR UNDAMPT WAVES.

(109) C. L. Kesley, Missouri Valley, Ia., asks:

Q. 1. Will you please describe a tikker used as a detector?

A. 1. A type tikker which may be very easily constructed by an amateur is shown in the diagram. The method for connecting same in a circuit is also shown. This form of detector is adjusted by the speed of the motor, and by the pressure of the wire on the disc.



The Tikker Used as a Detector for the Reception of Undampt Waves. The Metal Ring and Motor Shaft Are Not Insulated.

Q. 2. Would one of these be of help to amateurs out here where we hear NAA and coast stations all night, yet cannot hear them in day time using galena?

A. 2. The tikker is a very sensitive form of detector, and you should be able to hear NAA and all other undampt stations within range very readily.

RADIOPHONE HOOK-UP.

(110) Fernando A. Wessell, 300 Broad Street, Red Bank, N. J., asks:

Q. 1. Would you kindly give me a hook-up for sending wireless telephone with an audion bulb?

A. 1. The hook-up is herewith given.

Q. 2. How to make an audion bulb out of a six volt carbon filament bulb, and where can such a bulb be bought.

A. 2. The November issue of RADIO AMATEUR NEWS contains information regarding the experimental audion bulb, constructed from a small six volt bulb. This type of bulb may be obtained at almost any automobile supply house.

USE OF GRID BATTERY.

(111) K. Gerdin, Floral Park, N. Y., wants to know:

Q. 1. In your July issue you published in the "Radio Digest," a diagram for audion amplification before the signals reach the audibility circuit. Kindly inform me of the use of the grid battery.

A. 1. The grid battery is used in this circuit to impress a positive charge upon the grid. This tends to render the tube operative for amplification.

Q. 2. Please give me data concerning the construction of coil M which induces current into circuit L C.

A. 2. The coils M consists of an ordinary audio-frequency transformer which are sold in the market at the present time.

Q. 3. Where could I obtain Radio Pamphlet No. 40, U. S. Signal Corps, from which the article was taken?

A. 3. This book may be obtained from the Bureau of Standards, Washington, D. C. Price 55 cts.

TICKLER CIRCUIT.

(112) Maurice K. Bretzfelder, New York, N. Y., asks:

Q. 1. Will coils L4 and L3 in Figure 1 act as a regenerative coupler and will this circuit receive dampt and undampt waves?

A. 1. Yes, this is the ordinary regenerative circuit.

Q. 2. Will the circuit shown in Figure 2 (the Ultra-Audion circuit) receive undampt waves?

A. 2. Yes.

Q. 3. Please give data for coils L3 and L4 in Figure 1.

A. 3. Wind 40 turns of No. 28 CC wire into a coil 3" diameter. Make another coil in the same manner and connect them as shown in the diagram. Lay one on top of the other on the table. If they are to be mounted in a cabinet, arrange so that the coupling may be varied by the turning of a knob.

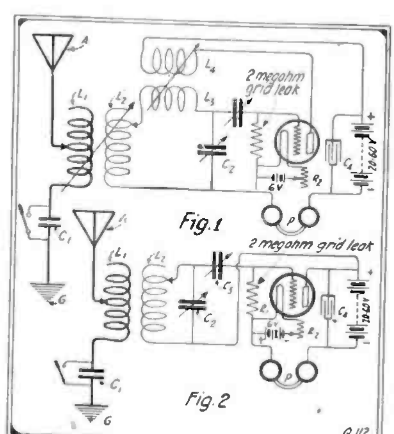
GOVERNMENT RESTRICTIONS.

(113) Irwin P. Stephens, St. Charles, Mo., desires to know:

Q. 1. What would be the natural wavelength of an aerial composed of five wires, eighty feet long, fifty feet high, fifty foot lead-in, wires spaced one foot apart.

A. 1. 300 meters.

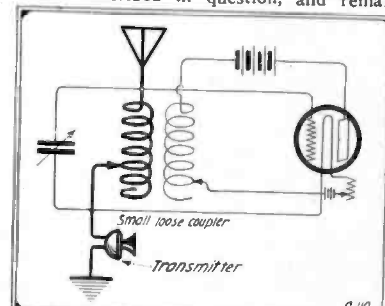
Q. 2. Are the restrictions of the government on sending stations based on the natural wavelength?



The Tickler and the Ultra-Audion Circuits. Both Permit the Reception of Undampt Waves.

A. 2. No. The restrictions are based on the total wavelength of the oscillation inductance, lead-in and the antenna.

Q. 3. Could I use the undampt transmitter described in your October issue of RADIO AMATEUR NEWS, page 162 with the aerial described in question, and remain within the government limit of restriction?



A Radiophone Transmitter Hook-Up in Which an Ordinary Loose Coupler Is Used.

A. 3. Yes, by inserting a condenser in series with the primary of the oscillation transformer and the antenna or ground.

LOOP AERIAL TRANSMISSION.

(114) Dorris L. Sargent, Harrisburg, Ill., asks the following:

Q. 1. Can I use No. 14, bare, aluminum aerial in making a loop aerial? If so, would it require more or less turns of wire?

A. 1 Yes, No. 14 bare wire may be used. The same number of turns will be satisfactory.

Q. 2. Can one send with a loop aerial?

A. 2. Transmission has been successfully accomplished with a loop aerial.

Q. 3. How many miles and how many meters should be able to receive using the following:

Six foot square, loop aerial with 20 turns, No. 14 bare aluminum wire, single slide tuning coil 11 inches long, 3½ inches in diameter, galena detector, fixed condenser 1/20 M.F.D. cap and double pole seventy-five ohm receiver arranged as in Fig. 1, enclosed.

A. 3. You will probably have very little success using a loop with the instruments you mention. An audion detector and a one or two step amplifier are necessary for even fair results.

SPACING OF WIRES.

(115) M. M. Mitchell, Ravenna, Ohio, wants to know:

Q. 1. On page 62 in the August RADIO AMATEUR NEWS there is a table of the spacing in inches of the loop aerial, the way it says is 1-9 inches and 1-4 inches, etc. Does this mean ⅛ of an inch and ¼ of an inch or does it mean 1 to 8 inches?

A. 1. This was due to the printer's error and should read one-quarter inches, seven sixteenths, etc.

(Continued on page 388)

MURDOCK
No. 55
RADIO RECEIVERS

2000 OHM COMPLETE DOUBLE SET $4.50

3000 OHM COMPLETE DOUBLE SET $5.50

Variable Condenser No. 368, .0005 mfd. $3.75

Fixed Condenser, No. 358 $0.70

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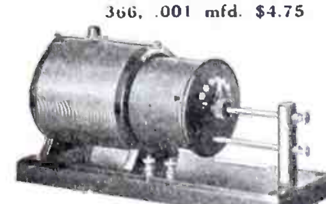
combines the desirable qualities of good design, excellent materials, and efficient operation to an unusually high degree.

Moreover, it is priced so reasonably that it gives the experimenter the "most for his money."

A copy of our latest bulletin will be sent free to those interested in good apparatus.

Variable Condenser No. 366, .001 mfd. $4.75



Receiving Transformer No. 344 $9.00

WM. J. MURDOCK COMPANY

50 Carter Street
CHELSEA, MASS.

509 Mission Street
SAN FRANCISCO

Static Elimination by Directional Reception

By GREENLEAF W. PICKARD

(*Continued from page 34*)

diam.) copper wire, with the turns spaced apart 30 cm. This loop was in the form of a long low rectangle, 30 meters long, and 6 meters high, the lower part of the loop being about 4 meters from the ground. The plane of this loop was approximately northeast by southwest, that is, it was in the great circle bearing of the more important European stations. This coil aerial was tuned to the desired wavelength by series inductance L_3 and capacity C, a fixed coil L_3 of 22 millihenrys being used in most of the work. The open antenna of this combination consisted of the conductor of the loop itself and a connection to earth at G by way of a coupling coil L_1 of 22 milli-

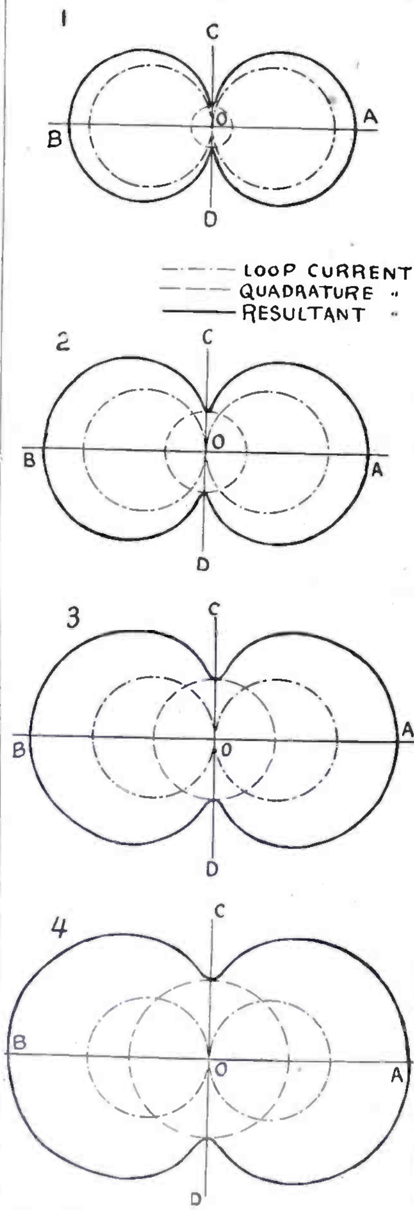


Fig. 22.—Showing the Degeneration of the Ideal Figure-of-Eight Reception Curve Into an Hour-Glass Shaped Figure.

henrys inductance, a variable inductance L^2 for tuning this open antenna circuit, and a variable resistance R, and was tuned to the same wave-length as the loop. The coils L_1 and L_3 were quite closely coupled together, and coil L_3 rather more loosely coupled to the secondary or detector circuit S. This secondary circuit, as shown in Fig. 21, employed the static coupled audion circuit due to Lieut. Eaton of the U. S. Navy. Two steps of audio frequency amplification were usually employed, in addition to the circuit shown, and the normal signal strengths from Rome, Lyons and Carnarvon were about 1,000 times audibility. The resistance R was found to be an important element of the circuit, and in its absence the results were decidedly inferior. The amount of resistance required was surprisingly large, being about 3,000 ohms.

The operation of this circuit is sub-

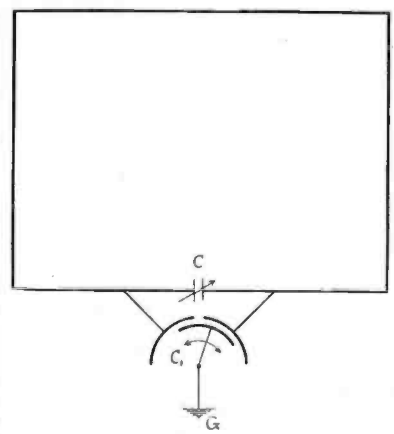


Fig. 23.—Here the Loop is Balanced to the Ground by a Three-Plate Variable Condenser.

stantially as follows: As it is a development of the circuit shown in Fig. 16, and consists of a combination of a loop and an open antenna, with the currents added in phase in the secondary circuit, it has a reception surface which is essentially like the upper half of Fig. 20, with a maximum reception only on the horizon in the direction of the distant transmitter. Static pulses from any direction other than that of the distant station itself are either received weakly or not at all if it happens to originate to the rear of the system. Reaction between the open and closed circuits, with resultant complex wave formation, is prevented by the high damping of the open circuit, which with 3,000 ohms inserted is practically aperiodic. The reason why so large a resistance can be used in the open circuit and still have substantial equality of open and closed circuit current is due to the fact that a loop of the dimensions employed is much less effective than an open antenna of the same height at long wave-lengths. The currents from the open circuit, reduced to the same amplitude as those in the loop by the inserted resistance and degree of coupling, are shifted thru 90°

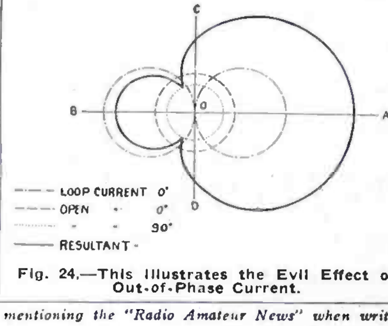


Fig. 24.—This Illustrates the Evil Effect of Out-of-Phase Current.

in phase by the transfer from the open to the closed circuit by way of the coupling, between L_1 and L_3, and hence are added in phase in the loop circuit, and then transferred, by the coupling between L_2 and S, to the secondary circuit. It will be seen that the change in phase accomplished in the original circuit of Fig. 16 by a phase adjuster in the form of a variable artificial

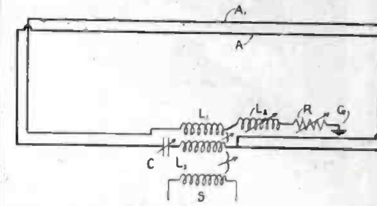


Fig. 25.—In This Circuit a Second Loop A1 Is Used Closely Coupled with the Main Loop A2.

line, is here done by the simple expedient of coupling together tuned circuits.

The performance of this circuit may be judged from a typical set of audibility meter readings taken by the writer, which are tabulated below:

Time	Station	Loop alone		Loop+Open	
A.M.		sig.	stat.	sig.	stat.
11.25	Nauen	2500	800	400	60
.35	"	5000	1500	3000	800
.45	"	3000	1000	400	120
.50	"	5000	1500	—	—
12.00	"	3000	1500	—	—
P.M.					
2.35	"	1000	1000	250	60
.40	"	—	—	1000	200
3.10	Carnarvon	1000	4000	600	600
.15	"	1500	5000	600	160
.25	"	800	5000	200	80
.30	Nauen	1000	5000	250	80
.35	"	1000	4000	600	160
.37	Carnarvon	1000	5000	600	160
.41	"	1000	4000	500	160
.55	Nauen	1000	5000	300	80
4.00	"	600	2000	300	60

The static intensities in the above table were taken in each instance over a period of five seconds, and no attention was paid to the clicks, which were of several times the intensity of the grinders. It will be noted that during the forenoon, with strong signals and weak static, the system had little effect. But during the afternoon, with weaker signals and much stronger static, the improvement in the ratio is rather striking. As a matter of fact, the circuit of Fig. 21, during periods of severe static, enabled the solid, uninterrupted copying of stations which would on the ordinary circuits be so broken up as to be unreadable.

Continued use of this circuit at the Otter Cliffs station developed the fact that the earth connection of the open antenna was not attached symmetrically to the aerial, the result being that a certain amount of current in the open circuit was flowing directly thru the loop and coil L_3, of course 90° out of phase with the loop current. This tended to decrease the sharpness of the unilateral reception, and hence the degree of static elimination. As this effect is often present in the simple loop or coil aerial when used for direction finding, it may not be out of place to briefly explain it here.

Considering only the horizontal plane

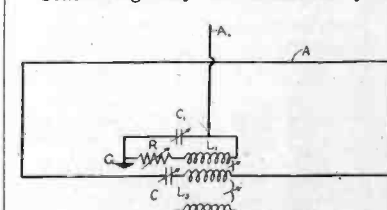


Fig. 26.—The Simplest Solution and the One Which Gave the Best Results from the Combination of Vertical Open Antenna and the Loop, Is Shown Here.

reception of a simple loop aerial, with a certain unbalanced capacity to ground (either by way of unbalanced leads or unsymmetrical construction of the loop itself), it is obvious that the system will act as a combination of loop and open antenna, with the currents added together, not in phase, but in quadrature. As a result of this, the currents will add together irrespective of their direction, with the result that the ideal figure-of-eight reception curve degenerates into an hour-glass shaped figure, the breadth of the neck depending upon the amount of open antenna current. This degeneration is shown in four steps of increasing open antenna current in Fig. 22. The remedy for this trouble is a simple one, and consists in balancing the loop to ground, as by a three-plate variable condenser, in the manner shown in Fig. 23. By turning this loop thru 180° in its own plane, so that the terminals of the loop come out on top, a material advantage results in direction finding. As the points of highest potential are thus removed as far as possible from the earth, the loop is much less affected by surrounding grounded objects. Of course, this method is at its best with a single turn loop, altho improving a two-turn loop.

A simple loop may also suffer from open antenna current which is neither in phase with the loop current, or in quadrature therewith. This sometimes happens in short wave working with loops of considerable inductance, that is, of considerable conductor length. It also happens with the circuit of Fig. 21, because the two open antenna effects, one in phase and the other in quadrature, may be considered as one current. For graphical analysis, it is simpler to keep these currents separate, and this is done in Fig. 24, which illustrates the evil effect of out-of-phase current. This is also an unbalance effect, and may be eliminated by suitable construction or by the three plate condenser arrangement of Fig. 23.

A more bothersome effect in simple loop working arises from a displacement current across the turns of the coil aerial, added to an open antenna current resulting from unbalance. Inasmuch as the displacement current across the turns of the coil gives a cosine characteristic like that of the loop itself, but displaced by 90°, the resultant characteristic of the system suffers distortion which is particularly noticeable at the minimum points at right angles to the loop. The writer had intended to treat this at some extent, but the interesting paper of Capt. Blattermann, which issued after this paper was written, makes this unnecessary. It is sufficient to say that, with the exception of the displacement current effect (which can be obviated by using a pancake rather than a solenoidal coil aerial) proper balancing of the loop, either by construction or by the three plate condenser, is all that is required.

An interesting modification of the circuit of Fig. 21, due to a suggestion by Mr. J. A. Proctor, was tried out at Otter Cliffs, and found to reduce the unbalanced open antenna effect. This circuit is shown in Fig. 25, and differs only from the circuit of Fig. 21 in that the ground connection from the right hand end of coil L_1 is taken by way of a second loop, A_1, closely coupled with the main loop A. Unbalanced current in the loop A is opposed by current in the loop A_1, with the result that there is a certain cancellation of effect, and a sharpening of the directional action.

But the simplest solution, and the one that has given the best result from the combination of vertical open antenna and loop, is shown in Fig. 26. This differs only from Fig. 21 in that a separate open antenna is used, and the loop circuit remains entirely insulated. A typical performance of this circuit (which had a loop of approximately

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the same dimensions as that of Fig. 21) is given below:

Time	Station	Open alone		Loop alone		Loop+ Open	
P.M.		sig.	stat.	sig.	stat.	sig.	stat.
1.45	Nauen	2000	4000	300	600	300	60
.54	Hanover	400	1500	100	500	200	80
2.38	"	400	1500	150	500	300	100
.44	Nauen	800	6000	200	500	300	80
3.10	"	200	800	300	800	400	80
.18	Lyons	100	1000	150	500	150	40
.27	"	200	2000	150	1000	200	60
.52	"	300	1500	100	500	150	50
7.14	Carnarvon	300	1500	150	600	150	80
.28	"	400	4000	300	1000	400	100
.40	"	400	3000	200	800	300	100
8.26	Lyons	400	1500	150	500	300	100
.57	"	400	1500	200	1150	300	150
9.11	Carnarvon	100	800	100	800	150	60
.20	Lyons	600	8000	200	1500	150	100
.32	Carnarvon	?	8000	?	1000	150	100
.37	Lyons	300	1500	100	600	100	60

One of the striking things in the above tabulation is Carnarvon at 9.32 P. M. Neither on open antenna or on loop, taken singly, could sufficient signal be heard to measure on the audibility meter. But on the combined loop and open antenna, the signal was well above the static in intensity.

The adjustment of the combined loop and open antenna, in either of the forms shown, is quite critical, the best unilateral reception being when the loop and open antenna currents are equal. In Fig. 27 is shown the result of combining different ratios of open and loop current. The uppermost reception curve is the horizontal plane characteristic of an open antenna, with no loop current. The second curve represents equal amounts of open and loop current, and is a cardoid.

The third figure represents the addition of two parts of loop current to one of open, while the fourth shows pure loop reception. It will be seen that the vector O-A, in the open antenna, in either of the forms creases uniformly as loop current is added to open current, until the ratio is one to one. Any further change in this ratio, increasing the proportion of loop current, decreased the vector O-A, the reception being only at a maximum when the ratio is unity. Similarly, the amount of reception from the direction O-B decreases steadily as loop current is added to open, being zero when the ratio is unity. Any further change, increasing the ratio of loop to open, results in increasing the amount of reception from O-B.

The writer here wishes to emphasize the fact that the results above tabulated are in no sense exceptional for his system of the combined loop aerial and open antenna, nor were they taken under "freak" conditions. These combined loop and open circuits have been in daily operation, summer and winter, over a period of nearly two years at Otter Cliffs, and have proven consistent performers. During the summer of 1918 the Otter Cliffs station circuits gave unbroken copying of the European stations at times when all other Atlantic coast receiving points were helpless. In fact, altho a large amount of interesting experimental work was done at various points on the Atlantic coast, it may now be definitely said that the above-described circuit, in the installation at Otter Cliffs, was the only static eliminator that played any part in our war use of transatlantic radio communication.

An interesting and as yet unexplained matter is the marked predominance, at least on the northern Atlantic coast of static originating on the western or southwestern horizon. In all probability, this direction of origin accounts for some of the elimination observed on the above circuits. The writer also has a certain amount of evidence which tends to show that this effect is confined to the immediate neighborhood of the coast, and that it vanishes a short distance inland.

As a result of the writer's study of the three-dimensional characteristics of various aerial combinations, many novel and useful arrangements have resulted. While a detailed showing of these arrangements will be given in a later paper, a brief description of one of them may be of interest here. Examination of Fig. 20 will show that if this figure is turned thru 90°, so that the vertical plane C-Z-D-N becomes the horizontal plane, a very favorable reception surface results. No energy would be received from the zenith, and but very little from the rest of the hemisphere, until the horizon was reached. Even on the horizon, reception would only be at a maximum along one line, and zero at right angles thereto. In order to turn the reception surface of a circuit thru 90°, one has only to turn the circuit itself thru this angle. In Fig. 28 is shown the circuit of Fig. 26, turned thru 90° in the plane of the loop. Examination of Fig. 20 will show that the circuit of Fig. 28 eshould be placed in a vertical plane 45° from the bearing of the distant station for best reception. It is best to remove this circuit somewhat from the earth's surface, in order to prevent distortion of the open antenna characteristics. Ordinarily, if the lower part of the loop is elevated some five or six meters from the ground there will be no appreciable distortion.

The writer gives below a typical extract from the performance log of this circuit. The loop A (Fig. 28) consisted of seven turns of No. 16 B. & S. copper wire (1.3 mm. diam.) spaced 10 cm. apart in a solenoidal coil, 30 meters long, 7 meters high and with the lower conductors of the loop about 4 meters above the ground. The open horizontal antenna A_1-A_2 consisted of a single wire 50 meters long, with a variable condenser C_1 inserted at its center. The coils L_1 and L_2 were of 20 millihenrys each, and the resistance R was 1000 ohms. Preliminary tests having indicated that the

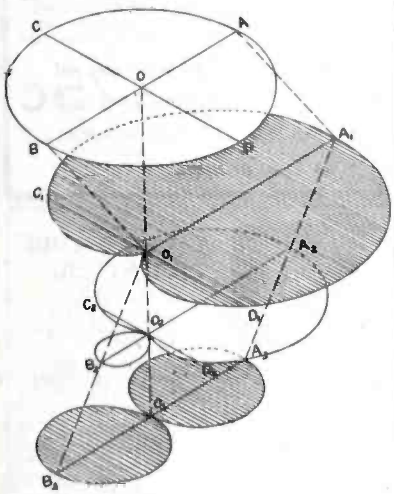
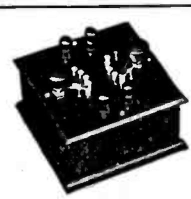


Fig. 27.—The Result of Combining Different Ratios of Open and Loop Current.

open antenna received materially less energy than the loop, the resistance R was removed from the open circuit, and placed in the loop. The secondary S was then coupled with L_1 instead of L_2, as shown in Fig. 28, and the following readings were taken:

Time	Station	Loop alone		Loop+ Open	
P.M.		sig.	stat.	sig.	stat.
3.45	Nauen	150	300	50	15
.58	"	300	600	60	5
3.14	Lyons	100	500	30	8
.28	Nauen	800	3000	200	10
4.12	Carnarvon	100	500	40	5
.25	"	100	600	60	8
.32	Nauen	200	1000	80	6
.58	"	100	600	80	10

In conclusion, the writer wishes to acknowledge the valuable assistance and cooperation of Mr. J. A. Proctor, and the aid so freely given by Mr. Alessandro Fabri,



whose helpful enthusiasm and encouragement will long and gratefully be remembered.

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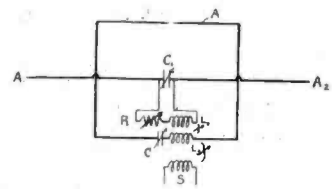

Fig. 28.—This Shows the Circuit of Fig. 26 Turned Thru 90° in the Plane of the Loop.

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RADIO INTEREST IN THE SOUTH.

W. B. Downey, radio inspector of the bureau of navigaton, department of commerce, was in Birmingham recently on a tour of the southern states, in which the government is making an investigation to ascertain how much interest there is in this section in radio service. Mr. Downey examined a number of radio operators who had served in this branch of service during the late world war in the United States court room at the federal building and found them very enthusiastic over this work.

Only two cities in Alabama were visited by Mr. Downey—Mobile and Birmingham—and he stated that about 100 men had been examined in North and South Carolina, Georgia, Florida and Alabama.

There were before the war a large number of radio stations all over the country, according to Mr. Downey, but during the war all of these were dismantled at the request of the government, but now all amateur stations may be reinstated, while other radio stations must be licensed by the government. He did not find as much interest in Mobile as he expected.

TWENTY MILLION DOLLAR RADIO COMPANY FORMED

An American and international wireless operating system that is designed to link the countries of the world in exchanging commercial messages, which is announced to begin business in the United States and throughout the Americas, Hawaii, Britain, France, the Scandinavian countries and China and Japan, has been effected through interests of the General Electric Company of Schenectady, under the name of the Radio Corporation of America. The United States corporation and a subsidiary operating company for general service in Central and South America will have a total capitalization of $20,000,000.

The new organization is planning to cooperate both with the Government and national commercial interests, and to meet the suggestion by Federal authorities that American trade shall have free and independent communication with South and Central America as well as with other foreign and more distant trade centres.

The Radio Corporation has been greatly strengthened through its connection with the General Electric Company, by reason of which it will have available for its use the valuable wireless apparatus recently developed by the General Electric Company, the principal device being already known as the Alexanderson high-frequence alternator.

Radio stations, which the corporation is waiting for the Government to relinquish control, are the transmitting depot at New Brunswick and the receiving station at Belmar, N. J., which will be used for the British service; Marion, Mass., and Chatham, Cape Cod, sending and receiving for Scandinavian service, and Tuckerton, N. J., for sending and receiving from France, Hawaii, Japan and China operations will be conducted from Balinas and Marshal, near San Francisco.

AMATEUR RADIOPHONE CONCERTS.

Listening by means of wireless telephone to a selection of music played by a phonograph has become the Saturday evening amusement of 400 owners of wireless receiving sets living in Pittsburgh, Pa., and environs.

Several weeks ago Frank Conrad, who has a private laboratory at Penn avenue and Peebles street, took his phonograph over to his wireless telephone transmitter, put on a record and started the music.

That started the concerts. Every Saturday night since 400 ears have been glued to wireless telephone receivers, listening to Conrad's renditions. Conrad stated that he is using four vacuum valves to transmit the music, and employs a spark transmission of 900 cycles frequency.

The music is heard, it is said, in exactly the tones rendered by the phonograph record.

OTTER CLIFF STATION

After every receiving station on the coast had tried to get into communication with Stavanger, Norway, the Otter Cliff station of the U. S. radio service was the only successful one. This station is now receiving an average of 20,000 words a day, which is more than any three stations on the Atlantic coast are doing. It is planned to make this station the largest and best equipped on the Atlantic coast.

UNITED STATES WIRELESS STATIONS.

The government shore wireless stations numbered 135 on June 30, 1918, of which 88 were in continental United States, 20 in Alaska, 19 in the Philippines, three in the canal zone, two in Hawaii and one each in Porto Rico, Guam and Samoa. The government ship stations total 470.

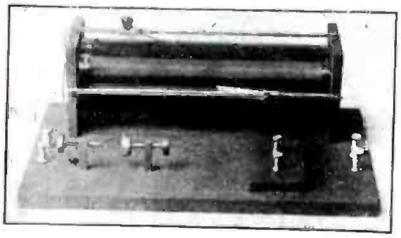
Radio Telephone on Mount Hood

By C. M. ALLEN

(*Continued from page 336*)

of energy required when talking; only a small fraction of this energy is required for receiving. The problem of furnishing power for the set on top of the mountain was rather a hard one on account of the difficulty in packing the storage batteries up and down the mountain. It is planned to overcome this trouble by installing a wind-driven motor generator charging plant on top of the mountain this year. While the details of such an oufit have not yet been worked out, the available wind velocity records indicate that there will be ample power from this source. It is planned to have the outfit entirely automatic in operation, with the wind motor of such size as to permit its being readily removed and stored when the station is not in use. On account of the high charging rate required by the Edison type of storage battery, it may be necessary to use a lead battery, altho it would not stand the rough usage as well as the Edison. In this event it is probable that they would have to be removed to a suitable station for the winter months to prevent freezing. Wind motor power may be used for driving charging generators at lower stations also, altho it is probable that either a gasoline engine or water wheel will be more satisfactory.

It is planned to continue the tests as long as the season will permit, with the view of securing all of the information possible in regard to the type of sets most practical for Forest Service use, and demonstrating their successful operation at a few at least of the points where wireless is needed. Further investigations will be made to determine the shielding effect of timbered areas, high ridges, etc., and to what extent tree antennae may be used, also with the view of developing a more satisfactory method of sending call signals. While the tests are only about half completed, the results obtained so far have been satisfactory, as previously stated, and it is believed that a consideration of some of the possibilities in connection with the use of wireless apparatus, particularly the telephone, is justified. At present it will probably be of most value as an auxiliary to the wire lines, in providing a reliable means of communication between the wire line centers of distribution and inaccessible points so located that the construction and maintenance of wire lines is not physically or economically practical or possible. The Forest Service has spent thousands of dollars in the construction of some telephone lines extending thru isolated regions, in order to secure communication with distant stations, for the proper working of the fire protective organization. In some cases these lines have to be practically rebuilt each year, and used only two or three months during the fire season. Eventually the wireless telephone may take the place of many of these lines, or it may connect the Forest Supervisor directly with some of the distant points on his Forest. For instance, a fire chief on the Okanogan National Forest could sit at his desk in Okanogan and talk directly with the foreman in charge of a fire crew on a fire in the northwestern part of the Forest where there are no wire telephone lines. This can be made possible thru the use of a 100-mile range portable pack horse wireless telephone set that it is planned to develop. It is possible, too, that the ever-present Ford may be equipt with wireless telephones, using an antenna with telescope masts, which would permit the driver on patrol duty to report a fire to his chief without stopping his car, or possibly talk to an airplane doing patrol duty overhead.



An Ideal Receiving Set
By URBAN WORNER
(*Continued from page 342*)

that they can be heard with the phones lying on the table. It is not only on long waves that this set shows such results, but also on 200 and 600 meters. Ships lying in the harbors of Tampico, Mexico, and Progreso, Mexico, are copied very often without difficulty. Amateurs from all over the country (before the war, of course) have been copied with a fair degree of signal strength. This set also is very sensitive to wireless telephone signals, which have been heard on several occasions.

I operate this set purely for its scientific and instructive value. Radio, in my opinion cannot be surpassed by any other science. It has opened a new field to me, namely, the experimental field. It has taught me to be patient, to be careful, and to be ever watchful of how the world is steadily going forward. Again it gives me pleasure; and pastime found in my own house, and I am sure there is no better place.

RADIO CONTROLLED AIR TORPEDOES NEXT.

Aerial torpedoes in the form of pilotless airplanes guided by wireless will play their part in the next war, members of the American Society of Mechanical Engineers of New York City were informed by Colonel E. A. Deeds, of Dayton, O.

This development was far advanced during this war. The fuselage, laden with high explosives, will drop as a plummet, hitting a target the size of a city accurately.

A Sensitive Amplifier

By RAY T. FOSTER

(*Continued from page* 350)

Now place a battery and your phones to the other two binding posts and you are ready to tune in, although before you tune in it is best to use your buzzer and adjust the carbon in the cup to such a level that it will give the loudest signals. It will be seen that when current comes from the detector circuit the magnets will act on the iron strip which in turn causes the brass pin to vary the contact with the carbon in the cup. If a bridge circuit such as described by Mr. Benson in a previous issue is used it will perhaps increase the efficiency to some extent, or a small telephone induction coil could be placed in the circuit with the phones and the battery.

A circuit is shown in Fig. 3 wherein the amplifier is used in connection with an audion detector.

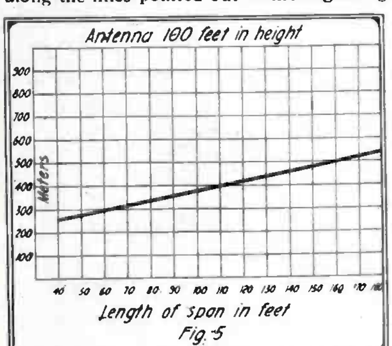
Amateur Antenna Design

By E. T. JONES

(*Continued from page* 358)

height of sixty feet, is shown in Fig. 3. Here it is seen that an antenna of the foregoing type only forty feet in length has a natural period of one hundred and ninety meters.

Figs. 4 and 5 will prove of value to those desirous of finding the natural period of their receiving antennae if constructed along the lines pointed out in the beginning



Wavelength and Span Curve for Antenna 100 Feet In Height.

i. e., four wires number fourteen spaced two feet apart.

If the Amateur uses these graphs in designing his transmitting antenna he will be taking one more step towards better cooperation in the widespread endeavor to cut down interference from amateur installations.

JAPAN HAS NEW STATION.

The new high-power Japanese wireless station at Tokio, which will communicate directly with a radio station on the Pacific coast of the United States, will be completed soon. Trial exchange of messages will be made at once with the American Pacific stations, and if satisfactory results are obtained the radio station will be opened to the public for acceptance of messages.

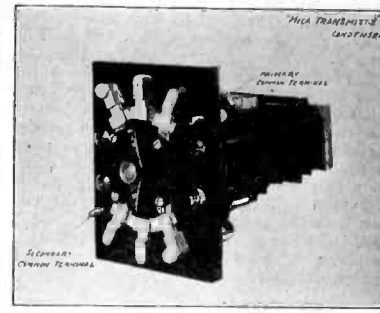
WANTS RADIO STUDENTS.

Efforts are being made by the local army recruiting office to recruit a number of men for the army school located at Little Silver, N. J. The school is for the training of men in the radio and wireless telegraphy divisions of the army.

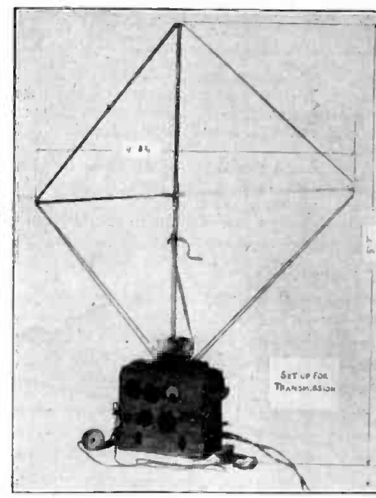
The Priess Loop Set

(*Continued from page* 334)

packing swells when oil reaches it, thus effecting a tight joint. The stuffing box is adjustable. The condenser will withstand 4,400 volts effective.—(Photographs by courtesy of Wireless Specialty Apparatus Co.)



Here Is Shown the Mica Transmitting Condenser of the Priess Set. Note the Switch Arrangement.



The Loop Transmitter Set Up Ready for Use.

Article No. 3 in our February issue will describe the receiving section in detail with detail photographs.

A Case Of Nerves

By J. K. HENNEY

(*Continued from page* 360)

treme terror into which I soon found myself."

Miggsby shuddered as tho the recollection of the affair were proving too much for him. Boyd huddled closer to the huge mate and seemed to be trying to avoid the eyes which so earnestly sought his own. The unusual paleness of their faces contrasted strangely with the glow of the small lamp over the operating desk. The seething waters outside seemed never to recede, the whistling of the wind thru the rigging seemed to be increasing in violence. At the end of a few minutes of silence, the whistle announced the end of the watch, its earsplitting roar only aiding the feeling of dread that seemed to be filling the boy's heart. He wanted to get away, to get into his bunk and to pull the covers tightly about his ears, but the large eyes of the mate seemingly commanded him to remain.

"I don't know how long I sat there," said Miggsby, "never daring to take my eyes from the book. The obvious thing of course was to get my revolver, walk to the door, and to face my nocturnal visitor. Yet as the minutes fled I realized more and more that it would take an almost superhuman effort to do anything except sit there, never moving, hardly thinking in my stupor of fear, until the unknown person came in and finished me off. I realized soon, however, that something must be done to put an end to the strain and relieve my mind of its foolish fancies. Suddenly I thought I heard a rustle at the door, and in my disordered mind's eye I thought I heard the door knob slowly turning. My terror became acute. Then a horrible scream came to my ears. I jumped to my feet in abject fear. I looked square at the door and saw nothing. Far on the other side of the cabin the flickering light of the fire cast an everchanging series of weird and fantastic shapes on the wall. My eyes could see nothing there. Then I glanced across the room and under a table littered with magazines and message forms, I thought I saw something moving in the dense shadows. Then came that shrill cry again, this time from the operating table. I realized that somehow my strange visitor had entered the room, and was in some terrible anguish huddled up under the table. My nerves gave way entirely and I rushed away from the place with the speed and aimlessness of a demented person. I must get as far as possible from the awful thing at the station. Out into the night and gale I rushed, I knew not where."

Miggsby was silent. Boyd and the mate sat on the edge of their chairs, their eyes gazing fixedly at the darkness under the operating table. Neither spoke for some time. Perhaps they were afraid to disturb the spell that Miggsby had cast upon them. Perhaps they imagined that the unseen presence of the radio station would invade the *Rollybelle* if they broke the silence. Finally the mate's curiosity conquered.

"Well?" he queried.

"Well," said Miggsby with an odd smile and a shrug of his shoulders, "I guess that's all. It was only a case of nerves. The cries I had heard were the death signals of the freighter Pleiades. She sank a moment later with all hands. I was fired for leaving my post. That's why I am here."

JAZZ MUSIC BY WIRELESS TELEPHONE

Amateur wireless operators in many cities are being entertained by jazz music and grand opera sent out from the United States navy station at Chicago, Ill.

I Want To Know

(*Continued from page 370*)

WAVELENGTH OF LOADING COIL.

(116) Walter C. Dux, Memphis, Texas, asks:

Q. 1. Please give me the wavelength of a loading coil 30 inches long and 4 inches in diameter wound with No. 28 S.C.C. magnetic wire.

A. 1. Approximately 10,000 meters.

Q. 2. Also could I receive undampt with the same loading coil, 5,000 meter loose coupler, two .001 mfd V.C.'s, an audiotron bulb, fixed condenser and a pair of 2,000 ohm phones with a four-wire aerial No. 4 gauge, 110 feet long and 40 feet high.

A. 2. Yes.

Q. 3. Also what is the wavelength of my aerial.

A. 3. 400 meters approximately.

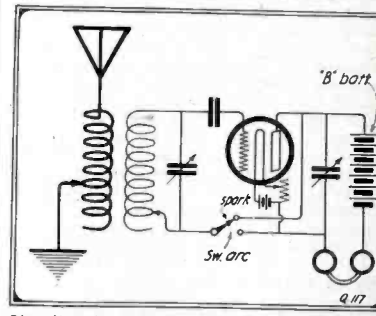
MEANING OF MEGOHM.

(117) Henry Chung, Honolulu, Cahu, asks:

Q. 1. What is the wavelength of my aerial, which is 60 feet long and thirty feet high, and consists of four strands of No. 12 bare copper wires?

A. 1. Approximately 250 meters.

Q. 2. Will you hook up the following apparatus: 3,000 meter loose coupler, 2 43 plate condensers, 1 fixed condenser, pair of 2,000 ohms receivers, 4 volt storage battery, Marconi vacuum tube detector rheostat?



Circuit Using a Two-Point Switch to Change from Spark to Arc.

A. 2. Hook-up given herewith.

Q. 3. Can you explain the word megohms to me?

A. 3. The prefix mega means 1,000,000. Therefore a megohm is 1,000,000 ohms.

LOOP AERIAL.

(118) Stewart W. Smith, Warren, Ohio, wants to know:

Q. 1. Can a loop aerial be used to receive messages from a station which is using both aerial and ground, without having a ground connected to the instruments?

A. 1. Yes, a loop aerial may be used to receive messages from any radio station. No ground connection is necessary when receiving with the loop.

Q. 2. Can a loop aerial be used for transmitting purposes?

A. 2. See question 114 elsewhere on these pages.

GRID CONDENSER.

(119) Clifford G. Fick, Sioux Falls, S. D., asks:

Q. 1. Whether there would be any advantage in using a De Forest Variable Condenser of .0005 mfd. capacity for a grid condenser on a Marconi "Vt," over an ordinary fixed grid condenser?

A. 1. There is an advantage in using a variable grid condenser although some authorities do not agree in this matter.

MAGAZINE Prices Slashed

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BIG SPECIAL TO "WIRELESS BUGS"

Radio Amateur News	$1.50
Electrical Experimenter	2.00
Wireless Age	2.00
Q. S. T.	1.50
Everyday Engineering	1.50
Wireless World (London)	2.75
	$11.25
Big Special to You	**$10.**

Combination	Regular Price	Our Price
Radio Amateur News $1.50, Electrical Experimenter 2.00	$3.50	3.00
Radio Amateur News $1.50, Wireless Age 2.00, Electrical Experimenter 2.00	$5.50	4.75
Radio Amateur News $1.50, Wireless World (London) 2.75	$4.25	4.00
Radio Amateur News $1.50, Scientific American 5.00, Everyday Engineering 1.50	$8.00	7.00
Radio Amateur News $1.50, Boy's Life 2.00	$3.50	3.10
Radio Amateur News $1.50, Popular Science 3.00	$4.50	4.00
Radio Amateur News $1.50, Boy's Magazine 1.50	$3.00	2.50
Radio Amateur News $1.50, Everybody's 2.00, Delineator 2.00	$5.50	4.25
Radio Amateur News $1.50, American Magazine 2.00, Women's Home Companion 2.00	$5.50	4.25
Radio Amateur News $1.50, Wireless Age 2.00, Illustrated World 2.00	$5.50	4.75
Radio Amateur News $1.50, St. Nicholas 3.00	$4.50	3.75
Radio Amateur News $1.50, Boy's Magazine 1.50	$3.00	2.50
Radio Amateur News $1.50, Today's Housewife 1.00	$2.50	2.00
Radio Amateur News $1.50, Popular Science 3.00, Electrical Experimenter 2.00	$6.50	5.75

Club No.	Magazine	Retail Price Single	Special price With (Radio Amateur News)
60	Adventure	$3.00	$4.25
40	American	2.00	3.25
35	Boy's Life	2.00	3.00
25	Boy's Magazine	1.50	2.50
70	Century	4.00	4.75
45	Christian Herald	3.00	3.50
	Conquest (London)	5.75	4.50
	Cosmopolitan	2.00	3.25
	Country Gentleman	1.00	2.25
100	Country Life	5.00	6.25
60	Current Opinion	3.00	4.25
40	Delineator	2.00	3.25
30	Designer	1.50	2.75
40	Everybody's	2.00	3.25
35	Etude (For Music Lovers)	2.00	3.00
35	Field & Stream	2.00	3.00
	Good Housekeeping	2.00	3.25
	Harper's Bazar	4.00	5.25
	Hearst's Magazine	2.00	3.25
35	Illustrated World	2.00	3.00
	Ladies' Home Journal	1.75	3.00
	Literary Digest	4.00	5.25
60	Metropolitan	$3.00	$4.25
27	Modern Priscilla	1.50	2.50
	Motor	3.00	4.25
	Motor Boating	2.00	3.25
	Munsey's Magazine	3.00	4.25
20	McCall's Magazine	1.00	2.25
45	McClure's Magazine	2.50	3.50
70	Outing	4.00	4.75
20	Pathfinder	1.00	2.25
40	Pictorial Review	2.00	3.25
60	Popular Science	3.00	4.25
50	St. Nicholas	3.00	3.75
	Saturday Evening Post	2.00	3.25
95	Scientific American	5.00	5.75
75	Scribner's	4.00	5.00
	System	3.00	4.25
15	Today's Housewife	1.00	2.00
35	Wireless Age	2.00	3.00
40	Woman's Home Companion	2.00	3.25
60	World's Work	4.00	4.25
50	Youth's Companion	2.50	3.75

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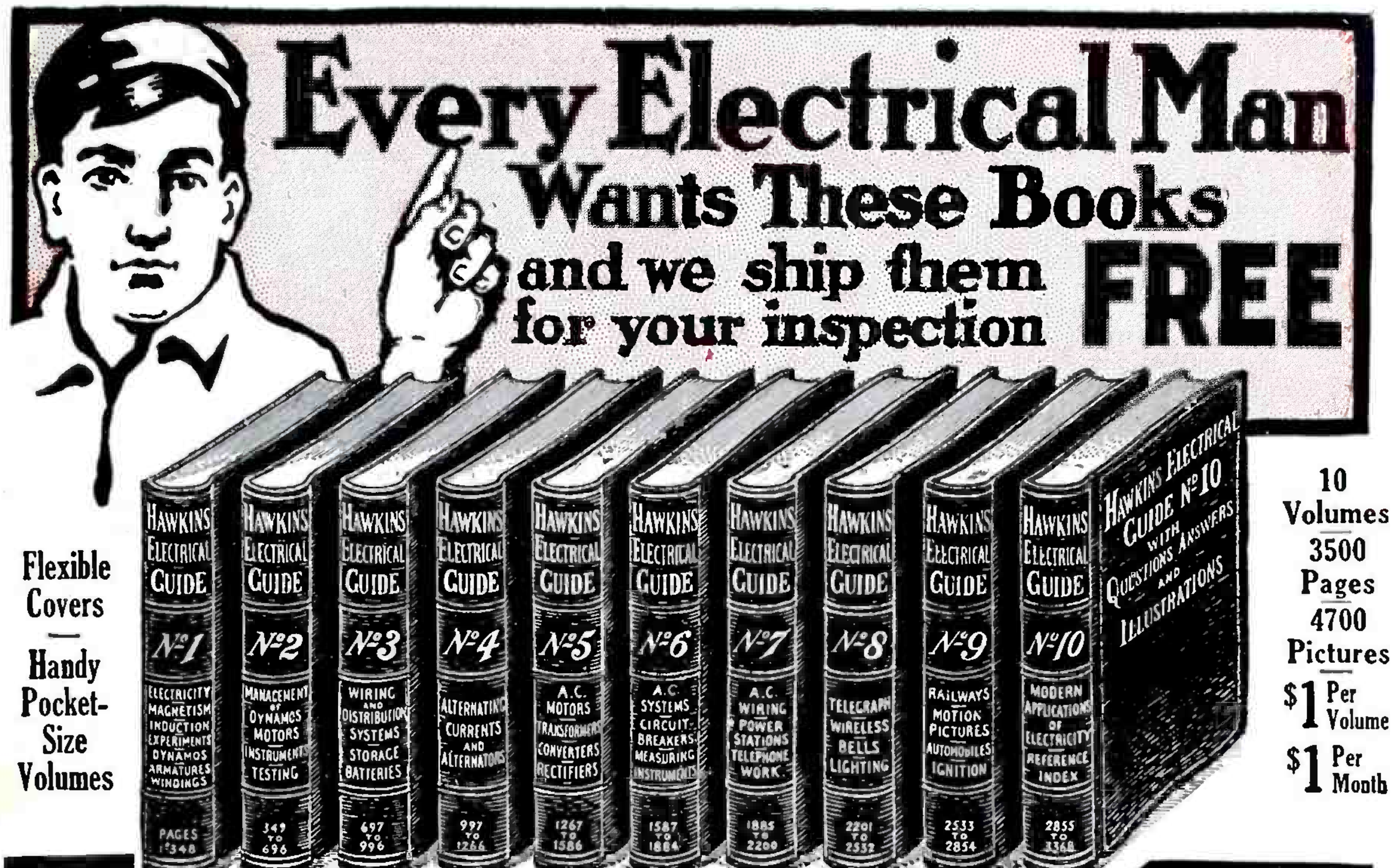

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