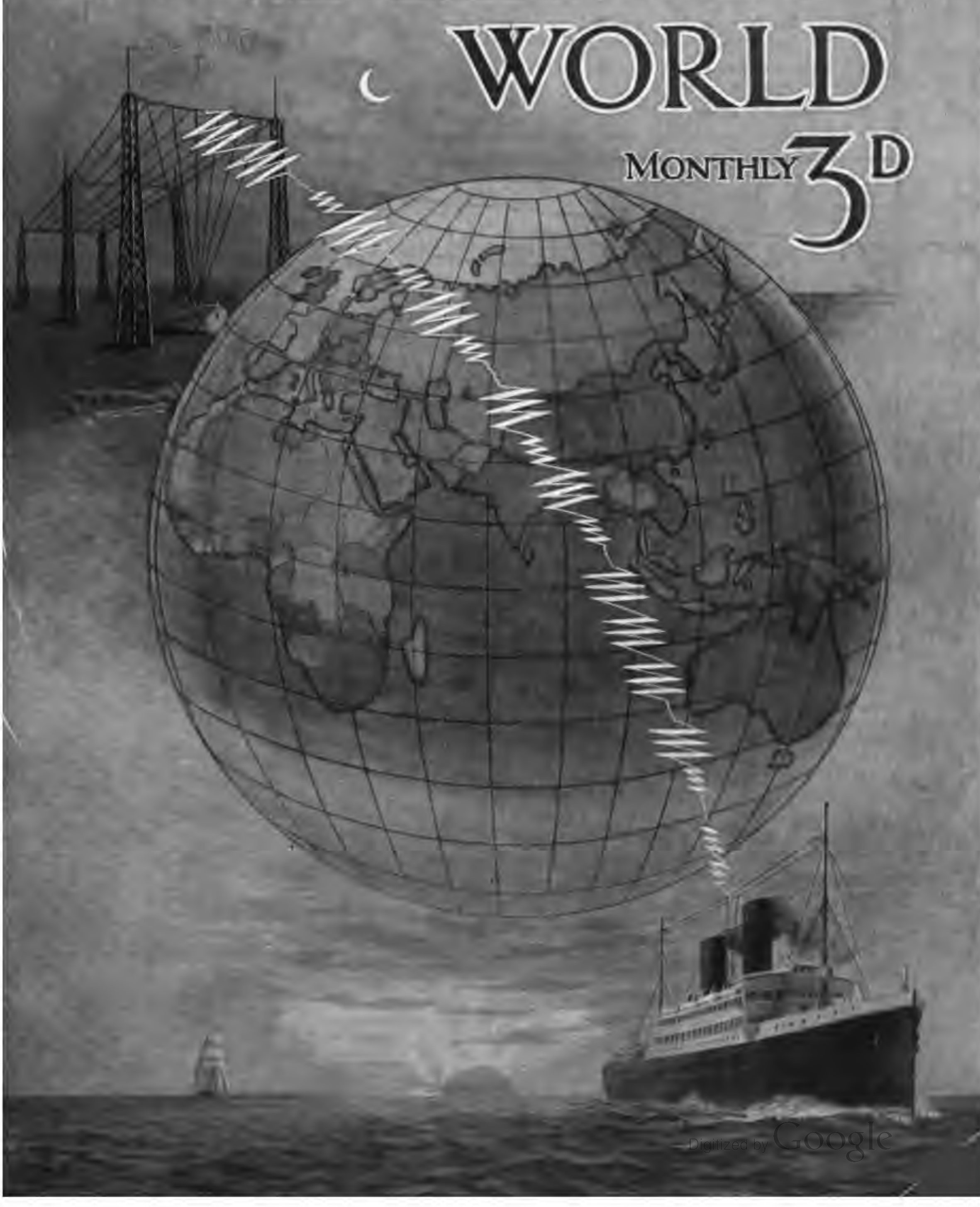
WIRELESS WORLD

MONTHLY 3D



THE WIRELESS WORLD

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VISCOUNT FRENCH AND WIRELESS TELEGRAPHY

On December 18th Sir John French issued his valedictory Order of the Day to the British Army in France after a close association extending over sixteen months of crowded events. The language employed is worthy of the occasion, and a great deal is contained in the simple words addressed to every unit under his power, "I thank them all." Amongst those, included in the distinguished Englishman's farewell appreciation, is the army of *wireless telegraphists*, with whose good work Sir John has been much impressed, and whose efforts in the general working of the vast organisation under his command have been adumbrated in our pages, but cannot be dealt with in detail until after the cessation of hostilities.

It is interesting to reflect that in 1867, when our great military hero was serving as naval cadet on the *Britannia*, James Clark Maxwell read his famous paper before the Royal Society, laying down the theory of electro-magnetism and predicting the discovery of the electrical waves which are now used in radio-telegraphy.

In regard to this early connection of our British soldier with the Navy, some of our readers will probably remember that a young *German* contemporary, Heinrich Rudolph Hertz, who early turned his attention to the development of Maxwell's electro-magnetic theory, became (in 1883) *Privat Docent* at Kiel University contemporaneously with the first decade of French's military career. Wireless telegraphy, which employs what is still often known as Hertzian Waves, has become an essential part of the organisation of all navies; but, whilst that of French's Motherland is employing it in all the "Seven Seas," German naval radio-telegraphy is still confined to the neighbourhood of Kiel.

Simultaneously with General French's first command in South Africa in 1889, the British War Office adopted the Marconi apparatus for use in the field, and six electricians left England in November for South Africa, taking sets of apparatus with them. On the sun-baked veldts this new branch of British military science demonstrated its utility, and the staff and sets of apparatus supplied by the Marconi Company were ultimately transferred to the Navy. They thus formed the nucleus of that vast wireless organisation which now renders possible the manœuvring of fleets in a way utterly undreamt of in olden days.

We do not wish to "labour" the connection; but we believe that the few points, above referred to, suffice to indicate that the development of Viscount French's military efficiency and his gloriously strenuous career have coincided with the forward march of the science which plays a large and ever-increasing part in the manipulation, as a coherent whole, of the vast numbers of soldiers who take part in a modern campaign. The latest addition to our British peerage has witnessed at once the growth of British armies from a few thousands to millions of men, and simultaneously with this the development of the practical application of a science which, invaluable in peace time, is absolutely indispensable for handling the gigantic armies used in modern warfare.

MAJOR C. G. C. CRAWLEY,
R.M.A., M.I.E.E., F.R.G.S.

Personalities in the Wireless World

MAJOR C. G. C. CRAWLEY, R.M.A., M.I.E.E., F.R.G.S.

IN our issue of May, 1915, we were enabled to put before our readers a portrait and biography of Commander F. G. Loring, R.N., who holds the important and responsible position of Inspector of Wireless Telegraphy at the General Post Office, London.

The subject of our illustration, Major C. G. C. Crawley, R.M.A., M.I.E.E., F.R.G.S., acts in the capacity of Deputy Inspector of Wireless Telegraphy at the General Post Office and so is brought very closely into touch with Commander Loring, to whom he has rendered considerable assistance in connection with naval wireless. He early nurtured a desire to acquaint himself with matters pertaining to radio telegraphy and his life has been almost exclusively devoted to matters in connection with it.

As early in the history of wireless telegraphy as 1903 he was engaged at that particular work on behalf of the British Navy. On account of the present war we are unable to say anything with regard to the working of radio telegraphy or its application to the needs of the moment, but we can say that those who are engaged in it find their time fully occupied and possess very little leisure in which to indulge in anything else, either in the nature of work or hobby. Major Crawley held this position with distinction until 1913.

Desiring to widen his scope he entered the service of the Post Office, where he remained until the outbreak of war in August, 1914. Immediately on this calamity overtaking the country he was lent to the Admiralty for wireless service, his services being of the greatest value.

Major Crawley became so expert in the science that for six years he was employed as Experimental Officer and Instructor of the Naval Wireless Schools, and for over three years as Wireless Telegraph Officer on the staff of Admirals afloat. Some years ago the subject of our illustration was made a member of the Institute of Electrical Engineers, and in this connection it is interesting to note that Mr. (now Senatore) Marconi was one of his nominators for membership. About the same time also he became a Fellow of the Royal Geographical Society.

During his career Major Crawley has been present at most of the demonstrations of various systems of wireless telegraphy given for the Admiralty, and more recently for the Post Office, and has always been in close touch with the developments of commercial as well as naval radio communication.

His work at the Post Office was largely in connection with the British Imperial Wireless Scheme, and it was he who selected sites for several stations.

Although the incident possesses no wireless interest, yet it is gratifying to note that Major Crawley received the Royal Humane Society's testimonial for saving a boy from drowning, and it affords us very great pleasure to make mention of this gallant act.

The Special Problems of Aircraft Wireless—II.

By H. M. DOWSETT, A.M.I.E.E.

The Aircraft Aerial.

THE aerial seldom departs from the simple form of a single weighted wire uncoiled from a reel mounted on the edge of the balloon or airship car, or aeroplane frame, and hanging clear in space. The wire may be bare stranded copper or bronze, copper-plated stranded steel, or copper-braided hemp. To simplify and speed up tuning, the reel may be fitted with a counter, and the wire painted say every ten or twenty feet.

The free balloon is carried by the wind, and its aerial therefore hangs almost vertical, Fig. 1 (*a*).

An airship aerial encounters greatest air resistance at its bottom end, and least where it is attached to the car. It therefore has the shape shown in Fig. 1 (*b*) (see diagram on page 651). An aeroplane aerial travels against the full resisting force of the air, and therefore takes either the shape shown in Fig. 1 (*c*) when weighted with a heavy bob, or the shape Fig. 1 (*d*) when weighted with a light bob.

Trailing wires affect the speed and manœuvring of aircraft. An airship will be little influenced by a single hanging aerial wire, but in the case of an aeroplane an aerial disturbs its equilibrium. A weighted aerial, Fig. 1 (*c*), will completely alter the flying characteristics of a machine, and this alteration will depend considerably on the point of attachment of the aerial fitting to the frame. For this reason the more vertical type of aeroplane aerial, which should be more efficient for transmission, is less used than the horizontal type which has less influence on speed, manœuvring and stability. It is obvious that the larger the machine and the more powerful its engines the less will its stability be affected by the vertical type of aerial.

The wire may be fixed to the reel by a

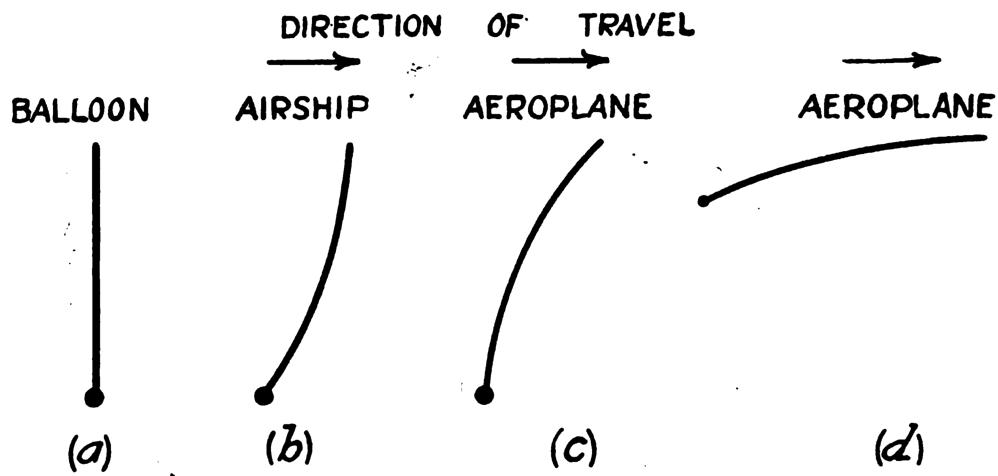


Fig. 1.

safety catch, so that should it foul any ground object it comes away, or it may be inset at intervals with breaking points at which the wire parts under a given stress, say 20 lbs., or again it may be of such a section that its own breaking strain is low enough not to require such safeguards. On some aeroplane sets the wire runs off the reel between the jaws of spring cutters which can be worked automatically by the pilot at an instant's notice to avoid accident when suddenly landing, vol-planing, or when engine trouble develops.

Aircraft Balancing Capacities.
The Free Balloon.

Fig. 2 shows the essential parts of a free balloon. A balloon of 40,000 cubic feet contents, may have a metal valve line and metal ripping cord instead of the usual hemp, the valve and valve seating may be of metal instead of wood, the valve spring is steel, the wooden hoop is bound with steel wire, and the grapnel is of iron. But none of this metal work is suitable for use as balancing capacity. If the valve line were to be used, by adding an aerial to its lower end, the danger from atmospheric electricity due to charge on the wire in the gas bag—and particularly where it enters the gas bag—would be increased.

Suppose the whole balloon envelope were to be metalised. Then the internal metal parts would be screened against atmospheric charge, maximum capacity would be obtained, and minimum ohmic resistance, all good and useful qualities. But the resulting period of oscillation would not be the greatest obtainable from the balloon considered simply as a supporting surface for a capacity, and this is a point of prime importance as the shortest working wave-length is considerably greater than the natural wave of the largest free balloon aerial system.

The natural wave emitted by a conducting sphere on which the charge oscillates from pole to pole has a length 1·4 times the sphere's diameter; whereas a single thin wire equal in length to the sphere's diameter will emit a wave of twice its own length.

A metalised balloon of the size mentioned above, and therefore having a diameter of 42·5 feet, should respond fundamentally to a space wave of 59·5 feet (18 metres), whereas the natural wave of its valve line—neglecting that part of it which is outside the gas bag—should be 85 feet (26 metres), and the natural wave of a single wire laid on the envelope from the valve to the neck should be 119 feet (36 metres).

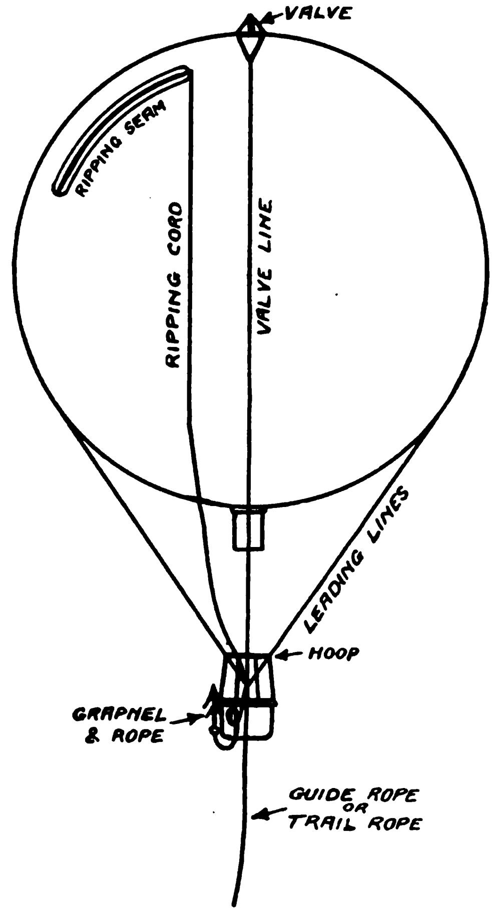


Fig. 2.

These wave-lengths would be a little more than doubled if the balloon capacity provided only half the oscillator as it would do in practice, the other half being the hanging aerial, as the aerial would have the effect of slightly increasing the balloon capacity.

The balloon envelope may be covered with a fairly wide wire mesh instead of a continuous conducting surface, without losing an appreciable amount of its effective capacity. A 6-inch mesh on a balloon of 40 feet diameter, for instance, would not reduce it by more than about 2 per cent.

All the above facts require to be borne in

Fig. 3.

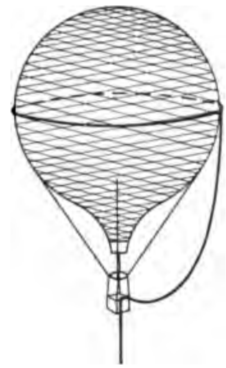


Fig. 4.

mind when considering the relative value of the different arrangements of balancing capacity which have been used at various times, and are illustrated in the figures which follow.

Fig. 3 represents a fairly close approach to a metalised balloon. A number of wires follow the leading lines to the net, a large number of other wires being laced through the net and extending over the whole envelope from the car to the valve, forming a wire cage to which is connected all the metal balloon fittings (Meyenburg). Obviously only small gauge wire could be used for this purpose, about No. 20 S.W.G. (1 mm. diameter) as minimum weight is always a first consideration.

The short wires are supposed to act as a balance for a short aerial, and the long wires as a balance for a long aerial, but the difficulty of obtaining a sufficiently large balancing capacity for the usual working wavelengths cannot properly be met, and in practice in order to get an extended range of reception, it is often found better to use a much longer aerial than the length equivalent to the counter capacity—a long trailing aerial being also much more practicable from a balloon than from an airship or aeroplane. As a result, the balloon receiver is seldom placed at the current antinode of the aerial system, it is usually much nearer the node, this disadvantage, however, being compensated for by the sensitiveness of the modern detector.

Fig. 5

Fig. 6.

A very simple capacity arrangement, one of the first to be tried, is shown in Fig. 4. A single thin bare wire was threaded through the meshes of the net at the balloon's equator, thus forming a ring, and a connection was dropped from this ring to the car (Ludewig). An objection raised against it was that,

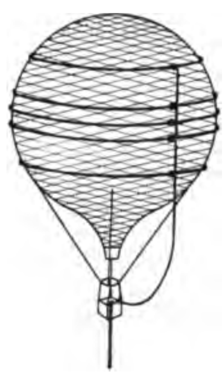


Fig. 7.

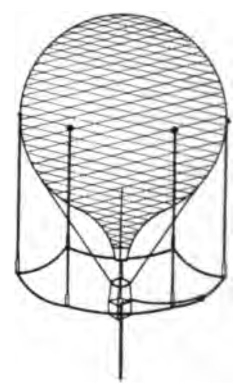


Fig. 8.

under strong atmospheric charge, the single thin wire of the ring would be likely to brush, and ignition of the gas which escapes from the mouth of the rising balloon and mixes with the atmosphere might follow.

Fig. 5 shows a much safer arrangement. A loop of insulated wire No. 20 S.W.G. was fixed to the net, about 6 feet away from the valve at the top, and hanging plumb from the equator downwards, the ends being brought into the car. The top attachments were strips of rubber.

In case of necessity—as, for instance, in a charged atmosphere—the loop could be dismantled by gently and steadily pulling at it until the rubber strips gave way. The loop was also supported by a light cord and pulley so that it could again be hoisted back on to

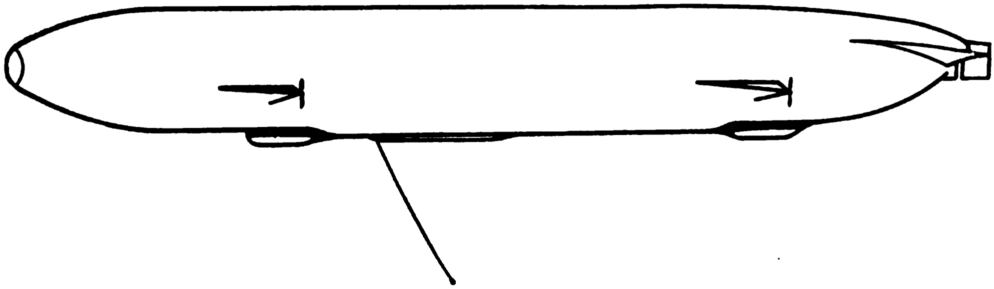


Fig. 10. Zeppelin with Trailing Aerial (*see page 648*).

the envelope, although not to its original spread-out position (Mosler).

Fig. 6 shows two single rings of No. 20 S.W.G. fixed round the balloon, the top one at the equator, the other 4·5 feet below it. Six wires connect the rings together and lead down to the receiver in the car (Huth). The danger from brushing is reduced by the use of many wires, and this arrangement gives a useful value of capacity.

Another arrangement used is shown in Fig. 7. Three wire rings were fixed on the balloon equator, and two other rings 6 feet above and below respectively which were of insulated wire—the insulation serving to protect the balloon fabric—were connected by a common lead to the receiver (Lutze).

All the above methods of fitting balancing capacities on balloons have been designed and used only for the reception of signals, they were recognised as unsafe for transmitting purposes.

Fig. 8 shows a balancing capacity suitable for transmission which appears to have been used with success, the aerial high tension currents introducing no fire-risk to the balloon. A wire ring hung on porcelain insulators with a slight sag, was supported at about the level of the car by six light cords suspended from the balloon equator round which they were equally spaced. A lead was taken from the ring to one side of the transmitter, the other side being connected in the normal way to the trailing aerial (Ludewig).

An obvious improvement introducing no additional risk would be to extend the ring into a small cage, by adding short lengths of vertical wire between the insulators and the wire ring.

Finally, in order to put them in true perspective, it may be worth while to give a rough estimate of the range of capacity and resonance wave-lengths of these various balancing capacities, treating each as a half oscillator, the other half being the trailing aerial.

Thus, a metalised balloon of 40,000 cubic feet contents would have a capacity of about 660 c/ms. and a wave-length of about 40 metres. When fitted with the arrangement shown in Fig. 6, a capacity of about 260 c/ms. and a wave-length of about 150 metres, and when fitted with the arrangement shown in Fig. 4, a capacity of about 216 c/ms. and wave-length of about 180 metres.

(*To be continued.*)

WIRELESS AT BOWES PARK.

AN amusing piece of information has just come into our hands. A youth of 17 at Bowes Park has attained to a certain degree of proficiency in wireless telegraphy, and before the war possessed a radio-apparatus. The neighbours declared that they quite recently heard the wireless spark, the sound emanating from the house where the young man resides. On reaching home one evening he was met by the police, who informed him that they were armed with a search warrant, and prepared to arrest him in order to defend the realm. They did not actually search the place, however, being convinced by the boy's explanation and disclaimer. He told the constable that he had invented a new type of motor-horn with a novel musical note, and that possibly this was the noise which had been mistaken for the wireless spark. The police took their departure, with the explanation that they were bound to investigate all rumours or complaints, whether well or ill-founded.

Digest of Wireless Literature

ABSTRACTS OF IMPORTANT ORIGINAL ARTICLES DEALING WITH WIRELESS TELEGRAPHY AND COMMUNICATIONS READ BEFORE SCIENTIFIC SOCIETIES.

ILLUSTRATIONS FOR TECHNICAL ARTICLES.

Many contributors to this magazine display somewhat insufficient knowledge of what is required for illustrating their articles, and for this reason we think some notes from an article by Mr. H. A. Miles, in the *Post Office Electrical Engineers' Journal*, will prove of assistance to our readers.

Mr. Miles commences by pointing out that several important factors have to be considered in the matter of illustrations. Blocks or lantern slides may be prepared from line drawings or photographs. Prints for the latter purpose should be from clean, sharp negatives, and on glossy P.O.P. bromide or gaslight paper. A bromide print is often used as a base on which to prepare a line drawing. The necessary photographic details are outlined and other work executed on the print with waterproof black ink, after which the photographic image is bleached out. This affords a simple method in cases where the complexity of the subject or the draughtsman's want of time or skill renders impracticable the preparation of an elaborate perspective drawing. The majority of illustrations are, however, prepared from line drawings in the usual way.

The preparation of a drawing necessitates the expenditure of a considerable amount of time and trouble, and unless proper care be taken initially the work may require altering, touching up, or re-drawing before it can be of use. The writer says that he has therefore compiled a few hints which, coupled with the essential amount of technical skill in draughtsmanship, will, he hopes, enable anyone to attain a satisfactory result. Artists, draughtsmen, and their near relatives, the authors, are from the first trained carefully to take a very one-sided view of things. Were they to forget this, and decorate both sides of the paper, their work would in all probability go to swell the contents of the editorial wastepaper basket.

The material on which drawings for reproduction are prepared should be smooth and white—either "Turkey Mill" paper or "Bristol Board" will give the best results, but bluish (not yellow) tracing linen may be used if a tracing offers any great advantage over a drawing. Only the blackest inks should be employed. All drawings for reproduction should be prepared to an enlarged scale, but the breadth of the lines and size of the lettering must be proportionately exaggerated so as to bear subsequent reduction. Illustrations for articles in this magazine should preferably be drawn about twice the size they would probably appear.

The art of drawing successfully for illustrations is one not easily acquired. Bold, striking effects, unfettered by a multiplicity of dotted lines representing hidden details, are best, and though shade lines are a distinct advantage if used judiciously, they can, if employed unwisely, obscure rather than elucidate details. A good maxim is never to introduce an unnecessary line or to omit one which is needed.

* * *

A KEYBOARD OPERATED RECEIVING SET.

The November issue of the *Wireless Age* contains an article from the pen of Mr. Austin C. Lescarboura, in which he describes an apparatus brought out by a New York inventor for the purpose of simplifying the operation of a wireless receiver. Whether or not the operation is really simplified by the complicated apparatus described in the article we will leave our readers to judge from the description given.

The writer commences by saying that although wireless receivers of to-day are comparatively simple, yet the equipments in common use have not yet reached the stage where they can be employed by folk generally, as have the telephone, the telegraph—in the form of the stock quotation machine—and other inventions. A New York inventor has now evolved a wireless receiving set in which all the operations are controlled from a simple keyboard. No longer is it necessary to manipulate a varied collection of sliders, handles, switch-levers or delicate detectors. Instead, the unskilled can sit before the cabinet and press the different keys that control the several operations.

The automatic receiving set, as it is called by its inventor, Mr. Walter Goodchild, represents a number of mechanical movements applied to wireless apparatus, closely following standard practice. The mechanical movements are controlled by electromagnets, the circuits of which are regulated from a keyboard. The set comprises essentially an inductive tuner, extra inductance coils for the primary and secondary circuits, primary and secondary variable condensers, a fixed detector that requires no adjustment, a fixed condenser, telephones and other accessories found in standard receiving sets. The apparatus is contained in a compact cabinet, and controlled from a keyboard of ten keys located in front. The relative values of primary and secondary inductance on the loose-coupler coils, the loading coils, the coupling and the primary and secondary condensers are constantly indicated by a number of dials and movable pointers. It is asserted that the set will tune to 12,000 metres, and that every tuning operation, from the minimum to the maximum value, can be accomplished in twelve seconds.

The ten keys of the keyboard are divided into five groups, each consisting of an "In" and an "Out" key. Both keys perform the same function in the opposite manner. Thus depressing a certain "In" key will increase inductance, and depressing the corresponding "Out" key will reduce inductance in the particular circuit. The first step in operating the set is to make the coupling as tight as possible. This is accomplished by pressing the "In" key of the first group. Then follows the rough adjustment of the primary and secondary circuits by means of the loading coil keys. Fine tuning is then carried out with the variable condenser keys, the necessary coupling being adjusted by the "Out" key of the first group.

The inductive tuner of the set is ingeniously constructed. It consists of four flat spools, two of which are fixed and two movable. The latter are mounted on a framework that can be driven forward or backward by means of a spiral drive that is rotated in either direction by pressing the "In" and "Out" keys of the first group. Thus the coupling of the tuner is readily varied. The primary and secondary consist of two spools each, an active spool and an auxiliary or inactive spool, which are mounted on axles so that they can rotate. The winding is in the form of a flat copper ribbon of almost the same width as the groove in the spools. The under side of the ribbon is coated with insulating enamel. When the "In" button of the second group is depressed the two primary spools rotate, so that the ribbon unwinds from the auxiliary spool on to the active spool, thus putting in more inductance in the primary circuit. Pressing the "Out" button causes the spools to rotate in the opposite direction, removing the winding from the active spool on to the inactive spool or auxiliary spool. The same action takes place in the secondary spools.

The connections with the copper ribbon are effected in a novel manner. The inner end of the winding is connected to the shaft of the spool, while the outer end of the active winding is connected by means of a spiral brass belt that fits into the groove, and also serves to guide the ribbon. The brass belt passes over a metal pulley which connects with a binding post.

The driving of the spools in either direction and the altering of the coupling are effected by means of a small motor and friction clutches. Individual motors work the two variable condensers in a similar way. The inductances are altered by a ratchet movement worked by electro-magnets, the studs being put in or out of circuit one at a time. The motors are normally at rest and only come into action when the keys are depressed. Thus on pressing the "Out" key of the coupling device the coupling will get looser and looser until the key is released. A rectifying detector that requires no adjustment and cannot burn out is used, so that the operator is not troubled in this connection. Dials provided with movable indicators are located in front of the cabinet, so that the relative amount of the coupling, loading coils and loose coupling inductance and primary and secondary capacity may be determined at a glance.

In our opinion an operator who knows enough of practical wireless to judge which key to depress and which capacities and inductances to vary when he desires to receive certain signals surely is sufficiently skilled to adjust an ordinary receiving apparatus. However, opinions on this point will probably differ.

* * *

INSTALLATION AND WORKING OF STORAGE BATTERIES.

The importance of keeping the storage battery of a wireless installation in good condition cannot be overestimated. In a paper recently read before the Association of Supervising Engineers, Mr. R. Rankin gave some sound rules, which it would be well for many wireless operators and engineers seriously to study. Some of these rules we reproduce herewith.

1. *Do Not Discharge below the Limits Specified by the Makers.*

It must not be assumed that an engineer can put his battery on load at any time and at any current it will carry unless it is at the time in a fit condition. What a battery can do at any time depends on what it has already done at that time. In this respect it differs from a generator. If it is intended to use a battery at unexpected or irregular times steps must be taken to have it as far as possible always ready in a charged condition. If this is arranged, even a small battery will deal with emergencies which would very much overtax a generator of the same normal rating, the overload capacity of a battery in current being enormously high.

2. *Do Not Have the Battery in a Discharged Condition Longer than is Unavoidable.*

3. *Make Sure that Every Charge is a Full One.*

4. *Unless for Special Reasons Charge Only at the Specified Rate.*

If the discharge is always continued until a definite total voltage is reached, and if the switchboard voltmeter is reading high, the battery may be overdischarged on every discharge, and the effect will be disastrous. Cells slightly lower in capacity than those in the body of the battery will get into bad condition, and will never get a chance to pull round again.

5. *Do Not Predetermine the Charge as a Definite Percentage of the Discharge.*

6. *Attend to Defective Cells at Once.* If low or sick cells are not attended to at once each discharge will bring them into worse condition, and if the trouble is not attended to and removed the cells may be ruined. It may be observed that the amount by which they are out of line with or lower than the others need only be small to give trouble of this sort a beginning. Where cells are properly charged, however, the usual excess charge is sufficient to level up small inequalities in the condition of the cells, but if a few of the cells are allowed to get very low in condition, and the battery as a whole therefore seems low in capacity, nothing but harm can result from overcharging the whole battery on their account.

7. *Check Periodically the Accuracy of the Instruments.*

8. *Keep the Level of the Electrolyte Above the Tops of the Plates by the Addition of Pure Water only.*

* * *

A NEW TYPE OF SPARK-GAP.

The *Electrician* in a recent issue published a translation of a paper by B. Thieme on "An Adjustable Prism-shaped Multiple Spark-Gap." The usual quenched spark and explosive gaps for wireless telegraphy, says the writer, are far from being all that is desired, owing to their rapid deterioration; in fact, the attainment of a pure quenching and impact excitation is practically impossible with the irregular burning away of the sparking surfaces such as generally occurs. It is impossible to avoid burning away the sparking surfaces in the course of time, and the question arises how it is possible to provide for such wireless stations as have, with no reserve of spare parts, to remain at sea for long periods, or, like meteorological stations, have to get along without skilled assistance.

Cylindrical spark-gaps, consisting of silvered copper cylinders provided with means of rotating the discs, are known, such rotation being for the purpose of surmounting the difficulty of the eating away of the electrode material. Such gaps, of which several are used in series, often give good service, but even in their case the spark fairly easily eats into the metal, and then remains fixed at the spot thus affected, so that the quenching effect after a short period of use is mostly very small. The cause of this is to be sought in two directions—namely, first the curvature of the cylinders, due to which the sparks are compelled to pass only at the immediately contiguous edges of the cylinders, and there is a very small area; and secondly, the fact that the separation of the cylinders is never absolutely the same, so that at various places on the sparking line a field of different strength is set up, which behaviour also does not contribute to an enhancement of the quenching effect.

In the author's attempts to produce a spark-gap possessing all the advantages he commenced by employing for his cylinder gap cylinders provided with tungsten coatings, and eventually the cylinders were made entirely of tungsten. These spark-gaps, which have been more fully described in the *Zeitschrift für Technische Physik* (Vol. 2, page 5, 1914) are, however, designed mainly for what may be called technical stations, while the author is concerned, in the present case, more particularly in providing a spark-gap suitable for all purposes, which should not only be as simple as possible to produce, but which could be used for various loadings and different sending methods.

The electrodes were for this purpose no longer cylinders, but were made in the form of prisms; a regular octagonal prism proved the most practical. Several such prisms are connected in series. By laying the prisms on a plane surface parallelism of the sparking surfaces is secured. When, after long-continued use, the sparking surfaces get eaten away, the whole lot of the active prism surfaces can at once be renewed by the simple expedient of lifting them out of their seating and turning them one-eighth of a revolution (the amount of one face).

For the different purposes for which they are to be used the separate prism surfaces can be coated with different materials; the arrangement thus allows for a wide range of adaptability.

In cases where the load may be at times very different from that at other times it is not proposed to adjust for such loads by means of short-circuiting one or more of the gaps, the prisms can be made with unequal sides, so that surfaces of greater or smaller area are opposite to one another (for the purpose of securing low spark decrement).

For adjusting the sparking distance, each pair of prisms is made into one unit, the axes being fastened together, though insulated from one another; each such pair can be interchanged, and can be shifted with respect to the other prism units, perpendicularly to the axial direction and the axial plane. In this way a fine adjustment of the electrode separating distance is obtained by mechanical means in a very simple manner, so that in order to obtain the lowest possible damping the length of the separating spark-gaps can be shortened, even whilst sending is being carried on, to near the limit of the quenching action. The advantage of such an arrangement is obvious. The mechanical micrometric adjustment has the advantage that the irregularities in the electrode separation are almost entirely obviated. As a result of this adjustability the station is in any event capable of handling a larger output.

ANOTHER LITTLE PROBLEM.

On page 661 of this issue we give particulars of a novel prize scheme in which readers both at home and abroad can participate. Meanwhile, we have pleasure in presenting the following little problem which is typical of the class which we desire to receive, and which we are sure will afford much amusement among wireless amateurs and their friends.

Given two steel rods exactly alike in appearance, you are told that one is a magnet. How would you tell which piece is the magnet if you had nothing with which to suspend the rods, no point to poise the rods upon, no other pieces of iron or steel to attract, and no instruments of any kind?

The above problem, the answer to which will be published in the February issue, is submitted by Electrician H. Christie, R.N., of H.M.S. *Bonaventure.*

The Trans-Pacific Service

Further Notes on the Honolulu Station

SUPPLEMENTING the interesting article which we published in our October number, we have now received further data and some new photographs relating to the wireless stations at Hawaii. These, we think, will interest both the general reader and the expert who watches with satisfaction the extension of the ever-growing network of great stations for long-distance radiotelegraphic communication.

In the Hawaiian Islands there are two Marconi stations, one for transmission, and the other for reception, thus following the modern practice of separating the transmitter and receiver in large stations, so as to enable duplex working to be adopted.

The transmitting station is located at Kahuku, the northernmost point of the Island of Oahu, about thirty miles from the city of Honolulu. It is on a strip of low land a mile wide, lying behind coral reefs. Directly south of this strip the mountains rise to considerable height.

The prevailing winds are from the north and catch the salt spray made by the waves dashing on the coral reefs, carrying it over this narrow strip of land to such an extent that scarcely any vegetation has the hardiness to withstand the onslaught.

The receiving and operating station is located at Koko Head, about nine miles west of Honolulu on the south-west corner of the island. This section is on the lee of the island, and is protected from heavy winds by the mountains to the north. The country here is productive, vegetation luxuriant, and withal has a beautiful location.

At the transmitting station the power house is a building of steel and concrete fireproof construction throughout. It is divided into three parts: to the left is the power generating and containing boilers, smoke stack, economisers, turbines, condensers, etc.; the centre portion consists of discharger rooms, the ceiling of which forms a gallery for the wireless apparatus, such as oscillation transformers, inductances, switch keys, etc. The left end of the building is the electrical condenser room. In the boiler room are two 302 H.P. boilers,

View near Honolulu.

Power House (note Insulators on 32 Aerial Wires).

oil fired, supplying superheated steam to turbines of the high-speed geared type for the main units and low-speed direct-connected turbines for the auxiliary units.

The fuel oil to supply the boilers is brought from California in tank vessels, and loaded at Honolulu into tank cars on the Oahu railroad. This road follows the westerly shore line of the island to a siding at the plant. The oil is pumped from cars into two large storage tanks of sufficient capacity to contain a month's supply.

There are three main generating units of 500 H.P. each, one on the San Francisco circuit, one on the Japan circuit, with the third as a spare. These are turbines geared to 300 K.V.A., single phase, 2,000 volt revolving field alternators so located that their extension shafts extend into the discharger rooms to drive synchronously the disc dischargers. Two 125 H.P. turbines directly connected to 100 kw. D.C. 125 volt generators supply current for excitation auxiliary motor feed and lighting. From each main generator the current is raised in five transformers to the condenser charging voltage. From these transformers the current is carried up on to the wireless gallery over the discharger rooms. Here are located choke coils and low-frequency tuning coils, and busses leading to the discharger below to the oscillation transformer and condenser room.

The primary of the oscillation transformer consists of a coil of three turns about 4 feet in diameter. The dischargers are of the rotating-disc type with air-blast quenching. These can either be driven synchronously on the shaft of the main generators or synchronously by separate motors. They are enclosed in sound-proof rooms made with double walls, the space between being filled with a sound insulating material.

An observers' station is made at one end of the gallery, from which point of vantage the engineer on watch has an unobstructed view over the engine room, wireless gear and the condenser room.

The condenser room has two banks of condensers, each consisting of 384 units, and of 3½ mfd. capacity. These are fed by a radiating system of busses so arranged that the current path to every tank in the room is exactly the same length, thus assuring that each tank takes its proportionate share of the total load.

The construction of the units of this bank is noteworthy. They consist of stoneware tanks, each with thirty-one glass plates hung between zinc sheets so arranged in a hard fibre carrier that if a glass sheet breaks the entire contents of the tank can be lifted out as a unit and a new set of plates substituted with a minimum of delay. The broken sheets can then be replaced at leisure.

As the station is made for two-way working it is equipped with two aerials, each starting from the power house, the San Francisco aerial extending south-west and the Japan aerial to the east. Twelve masts, each 300 feet high, support the San Francisco aerial. They are arranged in two rows with cross wires joining the tops of each pair. From these cross wires hang insulators supporting the thirty-two silicon bronze wires, each 4,500 feet long, which forms the aerial system. The masts supporting the Japan aerial are similar to the other set, of the same number and arrangement. However, each mast is 450 feet high, and the aerial wires are each 5,000 feet long.

The extremely important matter of a good ground connection has been met by making a continuous ring of zinc plates around the power house, and to this connecting a system of wires buried in the ground parallel to and under the aerial system of each set of masts.

The masts of these stations are of the Marconi type of pressed steel sections bolted together and erected from the base of concrete. The novel feature of construction is the arrangement of guy wires and their connection. To support one of these larger masts requires 12,500 feet of 1-inch diameter steel cable of exceptional tensile strength. The difficulty of the guying problem arises from the necessity of breaking up the lengths of wire at frequent intervals with porcelain insulators. This must be done to prevent absorption of the energy of the wireless waves by the guys, which would occur if any length was long enough to have a period of vibration approximating the wave-length of the transmitting station, or an even division of the wave-length. All energy thus absorbed is lost to any practical work.

The insulators used are of the guy strain type, and capable of carrying a load of 50,000 lb. Every effort has been made to keep the elastic extension of the guys as low as possible. If this extension amounts to only a small percentage of the length of the guy, the mast will vibrate in high winds and exert excessive strain on the guys.

To accomplish this all splices of the rope have been done away with, and the connections at the mast, anchors and insulators made of specially designed bridge sockets which give a perfect and straight pull and develop the full strength of the rope. This is not possible when using any system of

Condenser Pit, Honolulu Station.

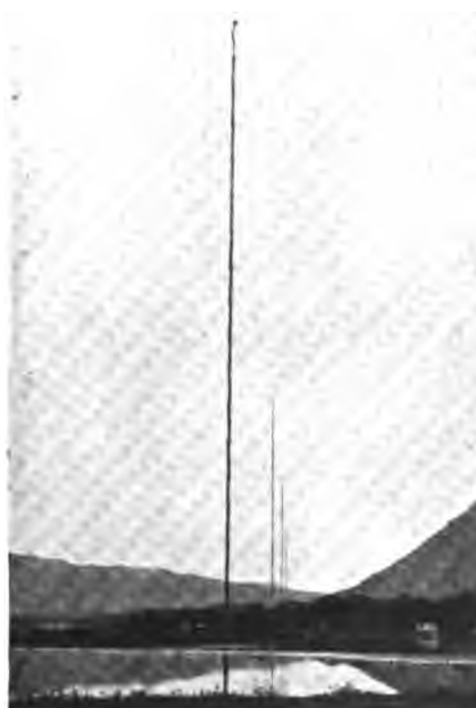
Native Type in Hawaiian Islands.

splicing, and it also permits the use of a rope with a steel core, thus adding about 15 per cent. to the strength for a given diameter of rope. Further, the style of connections used permits the use of a rope of large strands, which not only stands the ravages of the weather better, but also has much less elastic extension than a more flexible cable.

The location of the station at Kahuku is responsible for rapid deterioration of steel due to rust. To combat the ravages of the climate special precautions have been taken. It is found the best paint available has a very short life here. The guys are being protected by painting and serving with a layer of Russian spun yarn. A machine has been developed which will sand-blast any scale or old paint from a guy, give it a good coat of paint and wind it with the spun yarn all in one operation. All that remains for permanent maintenance is a coating of Stockholm tar occasionally. Such a covering is impervious to moisture and the cutting effect of sand and salt spray driven before the wind at Kahuku.

Ordinarily the operating is done at the receiving station at Koko Head, and the transmission effected over a land telegraph line connecting the receiving and transmitting stations. In case of trouble it may be preferred to receive at Kahuku, so an extra two-wire aerial is supported on one line of masts and led to an auxiliary operating building fully equipped with receiving apparatus.

The stations are somewhat distant from a populated or built-up district, so that it is necessary to furnish residences and living quarters for all the operators and employees.



Honolulu Station Masts.

At Kahuku is a small hotel to accommodate about twelve operators, and a cottage for the engineer in charge, and one for the chief turbine engineer, and at Koko Head is an hotel to house about thirty-five operators, with a cottage for the manager and chief operator. The design of all buildings was controlled by a fundamental consideration of providing a permanent type of construction with a minimum charge for maintenance. Fireproof buildings were therefore built of concrete and tile throughout. The roofs are carried by structural steel, on which rests red vitrified roofing tile. The only wood in the buildings is that which occurs in the interior trim and the window and door frames. The residences are of the bungalow type, with five rooms and bath, including living room, dining room, kitchen, two chambers, and bath. At the receiving station, on a basis of thirty-five men, the hotel will provide a room for each man with about one-third of the rooms of larger size than the others, and having private bath attached. Billiard room, card room, reading and writing rooms are also provided. A refrigerating plant, with cold storage room and refrigerators and means to manufacture ice for domestic purposes, are also provided.

On account of the isolated locations complete water supply and sewer systems are necessary. At Koko Head the water supply is from wells which contain a small percentage of salt. This water is satisfactory for ordinary purposes, but is not potable, and it has therefore been necessary to install distilling apparatus to provide drinking water. All buildings are electrically lighted, and no expense has been spared to make each station as modern and comfortable as is possible.

The aim of the company is to build up a staff which will be contented and loyal. As an aid to this end tennis courts have been built and book and magazine clubs started, also means provided for the men to carry on experiments in wireless work. The desire is to have the force live together as a family, helping each other in education, and to rise in value to themselves and to the service.

At the receiving station is the controlling centre of the system. Here enter the land lines from Honolulu and Kahuku. Operators receive the messages from Honolulu and prepare Wheatstone tape for the automatic transmitters or operate manually the sending key, which in turn actuates the high-power relays at Kahuku. Another set of operators receive the incoming signals and messages.

Another View of Masts.

Mountain Scenery near Honolulu.

The type of receiving apparatus is the same as that used in all of the Marconi long-distance stations, and need not be described here.

To obtain power to operate pumps, ice machine and also furnish current for lighting the hotel and cottages a small power plant has been erected at Koko Head. A crude oil engine of the Diesel type, of 50 H.P., runs a D.C. generator. Storage batteries are provided to carry the load when the engine is shut down, and are of sufficient capacity to run all the equipment for eight hours. One important use for this current is to operate the land operating line between the operating building and the transmitting station.

NEW PRIZE COMPETITION.

OUR readers will remember that in the November issue of this magazine we published an interesting problem relating to the resistance of a wireless cube, and in the Christmas number printed the answer. Since then we have received numerous letters from home and abroad, even from warships at sea, most of them enclosing answers and all testifying to the interest which the problem has aroused. This month we are publishing another problem, the answer to which will appear in the February number. In order still further to exercise the wits of our readers it is our desire to publish other problems, and we therefore offer a prize of ONE GUINEA for the best problem similar to those above referred to. The following conditions must be adhered to:—(1) ALL COMPETING PROBLEMS TO REACH THIS OFFICE BY THE LAST DAY OF FEBRUARY. (2) The Editor reserves to himself the right to publish without payment any or all of the competing problems, but in all cases of publication the name of the reader submitting the problem will be acknowledged. (3) No problem will be considered which is not accompanied by the fully worked-out and correct solution. (4) Competitors must write at the top of their letter-paper the words, "Problem Competition," and no correspondence will be entered into regarding any attempt submitted. (5) Each competitor must fill in and attach to his letter the Competition Coupon printed in this number. (6) The Editor's decision must be accepted as final.

[Under this heading we propose to publish each month communications from our readers dealing with general engineering matters of various kinds in their application to wireless telegraphy, and we would welcome criticisms, remarks and questions relating to the matter published under this heading. We do not hold ourselves responsible for the opinions and statements of our contributors.]

Troubles of a Tropical Wireless Station.

IN the Christmas number we wrote in these columns of the troubles experienced at a snow-bound wireless station. This month we propose to touch upon some of the difficulties which confront the wireless engineer in tropical regions.

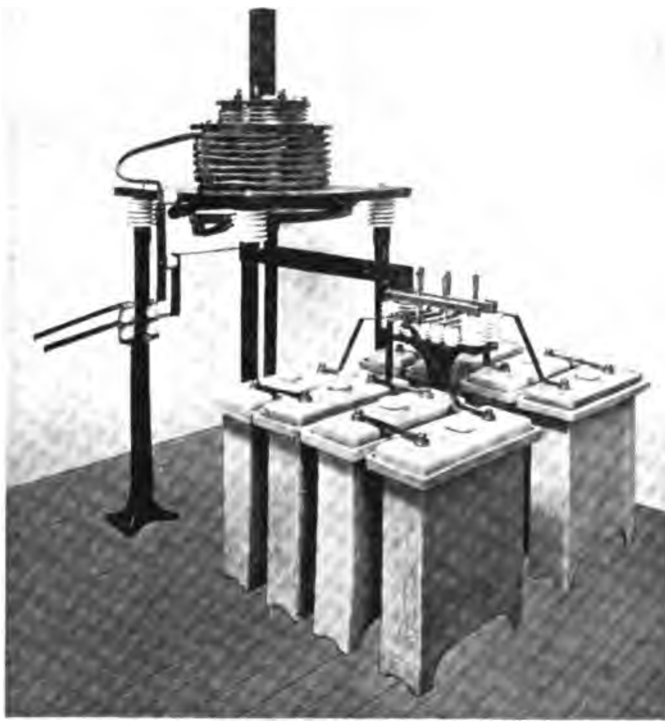
Perusal of the many articles which have appeared in this magazine concerning stations erected in such places as the banks of the Amazon, the Amazon forests, and Bolivia, will have shown our readers that foremost among the many problems is that of transport. Almost without exception a wireless station must generate its own electric current, and this requires that a power plant, consisting either of a boiler and steam engine, or else of an oil engine, be put down. A large station will, of course, require several boilers and duplicate engines, and in many cases the transport of these heavy pieces of machinery presents difficulties only to be overcome by the greatest ingenuity and labour. The erecting engineer may consider himself fortunate if he has a railway running near the spot where the station is to be built, for in this case most of his transport troubles will be readily overcome. In very many cases each piece of machinery has to be carried across country, through jungles and morasses—even over mountain chains.

With regard to the site of a tropical station, this has often to be chosen in forest land and other places where dense vegetation abounds. Recruiting native labour is no easy task for the man in charge, and when a sufficient number of men have been collected together, the work of clearing the site may occupy many weeks. Often a lengthy clearance has to be made from the nearest river to the site, so that the stores and machinery can be brought up as required. In the case of one South American station, where the site was some sixty feet above the river level, an inclined plane had to be cut down the face of the cliff and a short length of track laid in this before the large boilers and parts of machinery could be brought from the barges below.

Steel masts to support the aerial system are almost universally used nowadays, and in any case wood masts, subject as they are to ravages of insects, cannot be erected in many localities. Careful painting at the commencement and frequent renewals of paint afterwards are necessary in the tropics to avoid trouble from corrosion, for the wide differences in temperature between day and night and the frequent mists arising from the marshy lands play havoc with all metalwork not carefully protected. All metal stays have to be similarly treated, otherwise rapid rusting may set in and the stays snap, with consequent disastrous results to the masts.

In the interior of the station numerous minor points need attention. Although commercial wireless apparatus is made sufficiently strong and robust to stand usage in both hot and cold climates, it must not, of course, be unduly exposed to adverse circumstances. Ebonite, for example, if placed in a position where the rays of the tropical sun can fall upon it for hours at a time, will undoubtedly suffer. Wood, too, if exposed in certain conditions will be liable to warp, and so it is one of the aims of the erecting engineer to see that everything is adequately protected.

Porcelain insulation is now largely used where rubber and ebonite are liable to perish. Our illustration shows a portion of a wireless transmitter where this substance is largely used and in which wood casing is conspicuous by its absence.



Portion of Wireless Transmitter.

Such points as the construction of mosquito doors and the precautions necessary to guard the staff against the many little worries of tropical life, scarcely come within the scope of this article, but nevertheless need most careful attention. An adequate supply of stores must always be kept on hand, for it often takes many months for supplies to come out from England. For this and other reasons a well-equipped workshop is a feature of most land stations abroad.

At times it is necessary to overcome strong prejudices of the natives, who are liable to think that the roaring of the spark is the voice of the Devil, and occasions have arisen when the native labourers have suddenly developed hostility from causes difficult to discover. Floods and storms may come upon the busy workers just when such trouble is unexpected, and forest fires may turn the labour of months into a smoking mass of twisted iron and wreckage, so that the work of the wireless engineer in tropical regions is not unattended by risks. We are always glad to hear from readers who have experienced and overcome special difficulties in foreign climes, as this magazine reaches all parts of the globe, and a few notes from a worker in one foreign region may be of special interest and value to another reader in a similar region many hundreds or even thousands of miles away.

AN APPRECIATION.

THE following is an extract from a letter we have received from an air mechanic in the Royal Naval Air Service :—

"I have taken in THE WIRELESS WORLD "for two years, and although I am in the "R.N.A.S. I shall still continue, for in my "opinion it is the very best. If it had not "been for THE WIRELESS WORLD I am "afraid I should never have known any-"thing about wireless, so I will take this "opportunity of thanking you and "your magazine and wishing it every "success."

CORRESPONDENCE

The Calculation of Inductances.

The Editor, THE WIRELESS WORLD.

DEAR SIR,—I thank "Formulæ" for his letter of criticism, and am in entire agreement with him as to communication being the soul of progress, and think that more use might be made of the Correspondence columns of THE WIRELESS WORLD with more advantage resulting to readers.

In many cases querists in various technical and semi-technical periodicals were referred to the formula $L=l\ (\pi DN)^2$ (or in other words that the inductances of different lengths of a uniform solenoid were directly proportional to the lengths), which was obviously absurd, as a few minutes' practical experiment would demonstrate.

Others were referred to some mysterious formula in which a multiplying constant varying between 1 and 3 was included, without any clear instructions how to fix its value under different conditions.

It was in endeavouring to find something more definite that the values of "F" were worked out, and it was unfortunate that the limitations of the formulæ had not been stated with the formulæ.

The article in question was written in June, 1914, long before the most interesting "Instructional Article" was published in the May, 1915, WIRELESS WORLD.

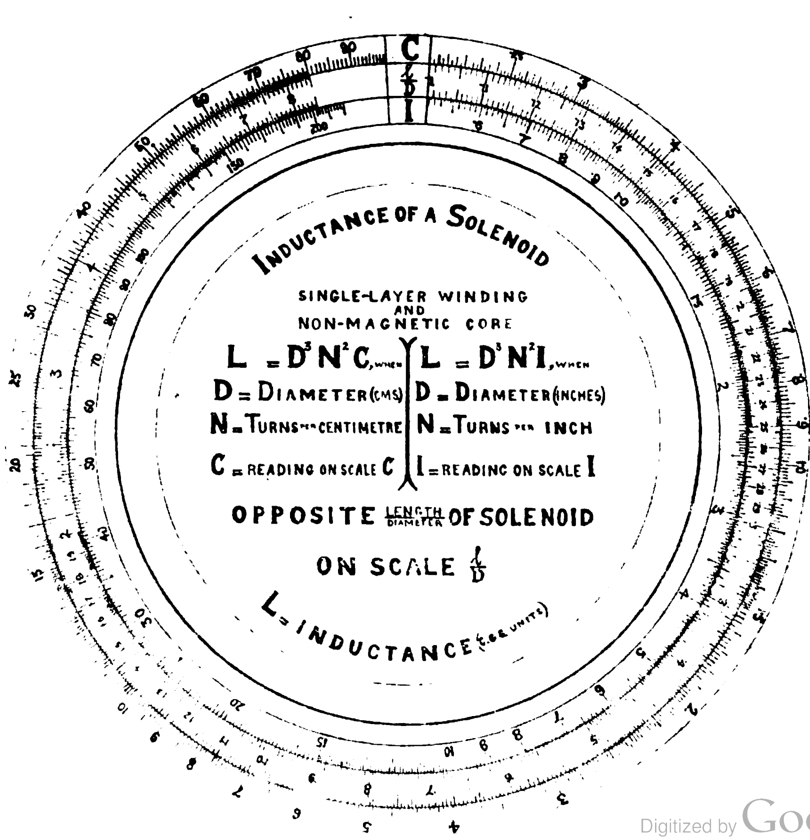
If the formula $L=(\pi DN)^2\ lK$ be factorised thus: D^3, N^2, $\frac{\pi^2 lK}{D}$, the values of the latter factor can be tabulated, when calculation would be considerably simplified.

This has been done in the accompanying circular diagram, and, as the table of values of "K" was not accessible, it is based on the worked out inductances in the table on p. 124 of the May, 1915, number.

If care is taken in reading off the scale values, there should be no difficulty in obtaining a result correct to the formula with an error well below ½ per cent., a sufficient degree of accuracy for all ordinary work.

Yours, etc.,

SAMUEL LOWEY.



Wireless Telegraphy in the War

A résumé of the work which is being accomplished both on land and sea

WE have heard a good deal in the course of the present war concerning "Secret Wireless Stations," but much of what has appeared on the subject in the general Press would hardly seem to warrant serious attention. Secret installations, however, do certainly exist in sober reality, and Sir Cecil Spring-Rice, the British Ambassador to the U.S.A., recently made a communication to Mr. Lansing with reference to a secret German wireless station operating in a suburb of Portland, Maine. British ambassadors do not move in such matters without serious cause for so doing.

* * *

We referred in issue Number 31, of October last, to the model little British campaign in Mesopotamia. The expedition consists of one of those amphibious undertakings which have for very many years formed a speciality of British forces. The paddle-wheel steamers, which constitute the main feature of the naval side, have *not* been captured, as recently claimed by the Germano-Turks. They once plied with passengers in these same waters, and—says Lt.-Col. Sir Mark Sykes—"waddle along with "a barge on either side, one of which con-"tains a *Portable Wireless Station*, whilst "the other transports bullocks for the "traction of heavy guns ashore." Our readers will note with some interest the incidental mention of wireless as natural, and, indeed, indispensable, to the equipment of a modern expeditionary force. An extremely amusing and informative description ends with the following paragraph :

"And this fleet is the cavalry screen, "advance-guard, rear-guard, flank-guard, "railway, general headquarters, heavy "artillery, line of communication, supply "depot, police force, field ambulance, aerial "hangar, and base of supply of the Meso-"potamian Expedition."

* * *

The following extract from a graphic story contributed by a Royal Naval Reservist illustrates the fact that the possession of wireless apparatus, which usually ensures safety, may, under abnormal circumstances, tend in the opposite direction.

Our "handyman" was taking part in the advance up the Tigris above referred to and narrates how, when they were forcing their way past a bend in the river :—

"During the afternoon the Turks sighted "our masthead and *wireless*, and we had to "retire and cut our masthead down, as the "Turks were dropping their shells pretty "close to us. At daybreak on Septem-"ber 27th we all started off to attack with "our batteries on shore and with the gun-"boats. The Turks were ready for us, for "they had quite as many guns as we had, "and four of them were a little bigger. We "had a very lively time for a few hours, but "as usual our gunboats kept creeping up "closer and closer until it got too warm for "them. Then they ran away and left their "guns."

* * *

Our esteemed contemporary the *Yorkshire Post* recently called attention in its causerie columns, appearing under the heading of "Cigarette Papers," to what the writer not unjustly calls the "Wonders of Wireless." Taking as his text the "dis-"tinguishing mark of the Admiralty formed "by the wireless installation crowning its "roof," our contemporary runs through the whole history of the signalling systems, which have for so many centuries centred in the British Admiralty. He starts with the beacons which heralded the approach of the Spanish Armada, and traces the various developments right through to the present-day wireless organisation. The enemies' systematic organisation of wireless "enabled "Berlin at the start of the war to speak "direct to Windhoek, in Damaraland, with "only one relay. But, thanks be to God "and to General Botha, Berlin can do so "no longer!"

* * *

The same lesson of the supersession of all other means of signalling by the science identified with the name Marconi will be found in the November issue of the *United Service Magazine*, where an extremely interesting article on the "Evolution of Flag Signalling in the Royal Navy" is ushered in with the remark that "many of the "functions of flag signalling, even for "harbour work, are in process of being "superseded by a method of communication "more suited to rapidity and secrecy, to "wit: *Wireless Telegraphy.*"

* * *

In our issue of May, 1915, we published an interesting account of the Marconi wireless station at Soller, in the beautiful old Spanish island of Majorca. The operators there recently picked up a wireless message from the Italian liner *Verona* reporting that a large submarine with two periscopes was pursuing her at a speed of fourteen knots. The *Verona* is a large Italian liner with a displacement of over 5,000 tons, plying between Genoa and New York, so that it can be easily understood that the wireless operators who received the message were keenly desirous of finding out what the result might be. Soller station received no confirmation of the pursuit, and was left in doubt concerning the fate of the steamer sending the wireless for some little time. Subsequently, however, private information came to hand which conveyed the fortunate intelligence that the liner succeeded in escaping from her German pursuer under cover of a thick fog.

* * *

Von Tirpitz, from his secret lair in the neighbourhood of Kiel, sometimes indulges in vaporous boasts as to the powers of the German Fleet. He never, however, ventures to put these vaporisings to the test of action, although the British leave him, of set purpose, ample opportunity of so doing. The British sea-dogs proudly boast, "We have not bottled them up—not by any means." But what they have done is to provide that, the moment they show themselves outside their own barriers, *wireless* flashes news to Britain's naval commanders,

Royal Flying Corps out Route Marching.

Royal Flying Corps Erecting Mast.

so that the British Fleet, which lies at moorings in wide and deep though sheltered waters, are certain to be ready for their Teuton foes ere they can issue from their narrow canal and form in battle order. "Der Tag" has been indefinitely postponed.

* * *

We publish in these pages three illustrations of the Royal Flying Corps, whose members are actually engaged in fitting themselves for taking part in the great fight against barbarism and *Kultur*. An important part of their training consists of instruction in "Wireless Telegraphy," and those whose avocation or pleasure takes them, nowadays, along the Strand have become quite familiar with the sight of large numbers of these young men passing to and from Marconi House for instruction in this branch of their duties. Our illustration on page 668 shows the examination of a pupil in the work of transmitting and receiving wireless telegrams; that on this page depicts the field work of erection and dismantling of wireless aerials; whilst on page 666 we see a detachment of the corps out for a route march. From these illustrations our readers will gather a very fair idea of the general appearance, training and uniform of the gallant R.F.C.

* * *

Gradually the great network of German plots and intrigues which have so long permeated the United States are being dragged to light. The American Press is taking a huge and well-justified delight in this mission. It was not long ago since we chronicled in our own pages the history of the abuse of neutrality which culminated in the taking over of the Sayville station; and a trial of historic interest has been successfully conducted in the courts of the United States by the Assistant Public Prosecutor of the American Government. The *Providence Journal* has taken a large part in the elucidation of these stealthy plots, and recently published a copy of a *wireless message*, dated September 5th, addressed to a large bank in New York. The message came ostensibly from a Berlin commercial institution, but in reality emanated from the German Foreign Office, and ordered the payment to Herr Albert of two million dollars. Bribery and corruption on such a gigantic scale are rare in the world's history, but instances of a similar nature have occurred before. The innovation in this instance consists of the fact that, cut off from all other direct communication, the Berlin Government is obliged to conduct its operations by means of *wireless telegraphy*.

* * *

A White Paper issued at the end of November contains interesting correspondence respecting military operations in the Western Pacific opened by an extract from a telegram from Mr. L. Harcourt, Secretary of State for the Colonies, in August, 1914, to the Governor-General of Australia, suggesting that the Australian Government might be willing and able to seize the German Wireless Stations at New Guinea, Yap, in the Marshall Islands, and Mauru on Pleasant Island. Australia accepted the commission and proceeded to carry it out. The published correspondence deals with the progress of the operations of the Expeditionary Force, and the principal human difficulties appear to have been caused by native snipers posted high up in coco-nut trees. Despite all obstacles the Expedition was successful in seizing the *Wireless Station* at Rabaul, New Briton, where the British flag was duly hoisted with picturesque naval and military ceremonial. The correspondence also deals with the capture of the German Wireless vessel *Komet*, and it is interesting to note that, in a war lamentably free from the amenities of chivalry, Dr. Haber, late Governor of German New Guinea, wrote the following testimonial to the courtesy with which he was treated by the British Commander :—

" I may add the expression of the hearty " gratitude which all of our party owe to you " for the courtesy and attention bestowed on " every one of us. I will, of course, be glad " to report to my Government all about the " fair and courteous treatment received by " us from all under your command, and I " hope that my statements will help to " ensure full reciprocity, in case an oppor- " tunity for it should be offered with regard " to British subjects. I take the liberty of " wishing you every further success in your " important command."

* * *

The capture of the German warship *Komet*, just referred to, was marked by several interesting points. She was but a small vessel of 977 tons used for scouting purposes,

Royal Flying Corps—Examination of a pupil in transmitting and receiving.

fitted with wireless and armed with one quick-firing gun. In pre-war days she served as the yacht of the Governor of German New Guinea, but after the outbreak of hostilities was transferred to the German Navy. On "information received" Colonel Holmes, British Administrator in New Guinea, despatched Lieutenant Commander J. M. Jackson in charge of the armed yacht *Nusa* to effect her capture. The *Nusa* herself was a prize taken from the Germans, and on the principle of "set a thief to catch a thief" proved eminently successful. A wireless message reporting the movements of the Australian Fleet was picked up (which was shrewdly surmised to have emanated from the *Komet*), and following up the clue, the German vessel was ultimately located off the North Coast of New Britain. At dusk one Saturday night the *Nusa* dropped anchor close to the unsuspecting foe, and in the morning the *Komet's* masts were seen through the trees 1,500 yards away. Silently and unobserved in the haze, the *Nusa* crept round the point, surprised the enemy and received her surrender. The surprise was complete; the *Komet's* captain, half dressed, was in the act of shaving when the British commander came upon him.

* * *

Mr. Rudyard Kipling has been writing for the *Daily Telegraph* a number of descriptions in his well-known picturesque style under the title of the "Fringes of the Fleet." As his title proclaims Mr. Kipling deals with the auxiliaries of the British Navy, and the following Kiplingesque description may perhaps prove interesting to Wireless readers, and induce them (if they have not already done so) to peruse the whole series of articles. They are well worth it.

"The child in the Pullman-car uniform "just going ashore is a *wireless operator*, aged "nineteen. He is attached to a flagship at "least 120 ft. long, under an Admiral aged "twenty-five, who was, till the other day, "third mate of a North Atlantic tramp, but "who now leads a squadron of six trawlers "to hunt submarines. The principle is "simple enough. Its application depends "on circumstances and surroundings. One "class of German submarines meant for "murder off the coasts may use a winding "and rabbit-like track between shoals where "the choice of water is limited. Their "career is rarely long, but, while it lasts, "moderately exciting. Others, told off for "deep sea assassinations, are attended to "quite quietly and without any excitement "at all. Others, again, work the inside of "the North Sea, making no distinction "between neutrals and Allied ships. These "carry guns, and since their work keeps "them a good deal on the surface, the "Trawler Fleet, as we know, engages them "there—the submarine firing, sinking, and "rising again in unexpected quarters; the "trawler firing, dodging and trying to ram. "The trawlers are strongly built, and can "stand a great deal of punishment. Yet "again, other German submarines hang "about the skirts of fishing-fleets and fire "into the brown of them. When the war "was young this gave splendidly 'frightful' "results, but for some reason or other the "game is not as popular as it used to be."

* * *

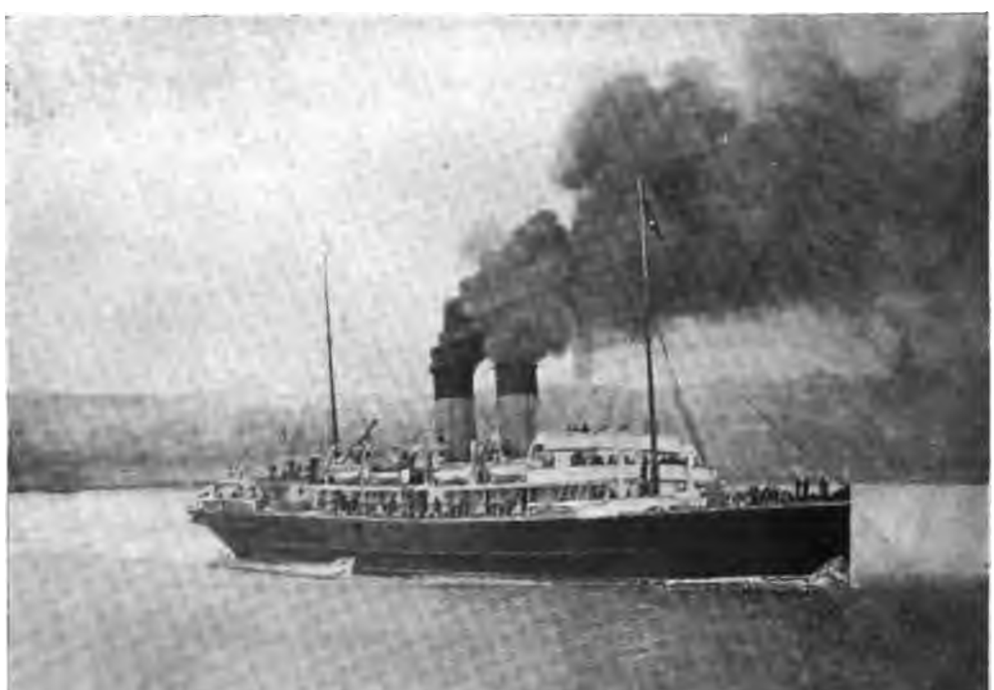
Young Kenneth Triest, recently imprisoned in London as a German spy, ran away from Princeton last January, and joined the ranks of the candidates for the Royal Navy's *Wireless Telegraphic Service*. If the lad had committed the offence of espionage against bloodthirsty Germany he would, as Mr. Theodore Roosevelt very aptly pointed out, have suffered the extreme penalty, promptly and mercilessly. The British Government, on the other hand, listened sympathetically to the father's plea and liberated the young scapegrace on his father undertaking to make himself personally responsible for his son's future behaviour and movements. Mr. Roosevelt, with characteristic bluntness, contrasted the black horror of the execution of Nurse Cavell with the almost parental leniency of the British Government. As the distinguished ex-President not unjustly remarked, "the British Government had a "thousandfold more justification for insisting "upon the execution of Triest than the "German Government had for putting to "death Miss Cavell." Comment is needless; neutrals will judge from this incident among many others of the difference in spirit between the Entente Powers and "Kultur."

* * *

The destruction of the British hospital

ship *Anglia* formed a recent and shocking example of the dangers involved in "mining "areas." "When about three miles from "the shore," said the Captain, "there was a "very loud explosion, doubtless under the "port side forward of the bridge. It blew "the bridge to smithereens, and I was blown "on to the lower deck. I ran up to the "wireless room to order the SOS. call to be "sent, and found the operator coming out "with blood on his face." News of the disaster was sent *by radiotelegraphy* without delay, and the war vessels in the neighbourhood rushed to the rescue. When they reached the *Anglia* she was badly down by the head and the propeller was elevated so high in the air that one of the rescuing vessels was able to pass under her stern. This steamer received 40 men who dropped upon her deck from their precarious position. Many of the passengers were wounded men lying in cots, without feet, without legs, or without arms. Such patients were, of course, perfectly helpless, and only a small proportion of the unhappy victims could be saved.

Our Yankee cousins have been deriving an immense deal of amusement from the project of the motor-car millionaire, Mr. Henry Ford. He secured a peace ship, the *Oscar II.*, and with a numerous party crossed the Atlantic, reaching Kirkwall December 15th. The "Ford's Ark," as the New Yorkers call it, was freighted with a party of peripatetic pacificists, who have proclaimed their intention of *peace-making by wireless*. His German-American secretary has let out the secret, and proclaims that Mr. Ford intends to send wireless messages from the peace ship to soldiers in the trenches "urging them to lay down their arms for Christmas Day and refuse to fight." The effusions sent out from the wireless stations of the German Government have been giving publicity to the "laudable objects" of this buffoon millionaire and his satellites. Innumerable cartoons in the Yankee Press ridicule the bombastic conceit of the motor-car manufacturer, whilst the United States Government has refused to issue passports for himself and his *umbrae*, and the party of



S.S. "Anglia."

The difficulties of Erection of Wireless Masts during Winter Campaigning.

cranks were denied permission to land in England.

* * *

Blackwood's Magazine recently published an interesting account of how H.M.S. *Cumberland* cleaned up the Cameroons. The wireless Arabian Nights stories sent out from Germany itself have convulsed the world to laughter many times by their vainglorious fiction. But they are as nothing compared with the news items perpetrated by the German wireless in the Cameroons. Here the hearts of Teutonic colonists had been continually warmed by information of colossal German victories ashore and afloat. The greater part of the Grand Fleet of England had been sunk several times with graphic details, and on one occasion a pathetic picture was drawn of the last words of Admiral Jellicoe.

The serious side of this part of the business is that the inhuman treatment of the natives by German brutes fostered a bloodthirsty spirit of revenge, with which the British victors have found it very difficult at times to cope. Over and over again our men have had to protect their prisoners from vengeance not unjustly earned by their own unspeakable actions.

* * *

"Great is the American nation!" Their newspaper men have in very reality the larger number of the qualities fictionally bestowed upon his analytical detective hero by Conan Doyle. Many revelations of German plots have already reached us from the "other side"; this is the latest which has come through. In order to get a firm hold of South Africa our Teutonic foes relied not alone on treachery amongst Dutch "Irreconcilables." They had matured an elaborate plan whereby 20,000 trained German soldiers should be transported and landed in South Africa to back them. In conjunction with the trained settlers already there, these would constitute a complete army amply supplied with rifles, cannon, machine guns and munitions. All the guns and stores for 45,000 men had been landed and secreted long before the declaration of war. As for the men, German and Austro-Hungarian reservists poured into New York by thousands from the interior cities. With a view to their transport, all the German ships on the Jersey side of the Hudson had been coaled up. Guards were posted about the decks of these vessels and most stringent precautions were taken to prevent outside observation and interference. Von Spee's Fleet was to round the Horn and rendezvous in the South Atlantic. The 13 liners laden with men were to burst out of New York Harbour, scatter up and down the coast, keeping within the three-mile limit, and—at a given signal—rush to sea at top speed. To the *Vaterland* was allotted the rôle of decoy duck; she was intended to draw the British cruisers in pursuit of herself, whilst the transports headed south, to get quickly under the guardianship of Von Spee's squadron.

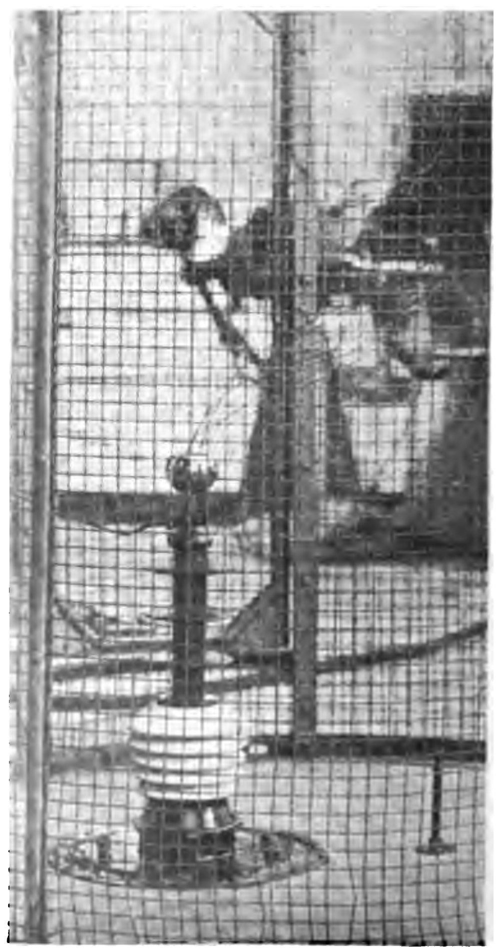
What spoilt the game? *Admiral Sturdee's wireless message!* He ordered the sending of a marconigram to the *Canopus* instructing her to proceed to the Falkland Islands, where, said the message, "new coast defence "guns would protect her." Von Spee recognised the bluff of the "coast defence," but could not resist the temptation of "bagging" the *Canopus* on his way north. The result we all know.

The "coast defence guns" did not exist; but Admiral Sturdee's squadron *did*, and the plans carefully matured by Germany vanished into thin air before the wireless message radiated from the British ships as they went into action, "God save the King." Mr. Balderston tells the whole story in the *Pittsburg Dispatch* and ends his lively account with this final spirited summation:

"Sad, indeed, has been the fate of the "German dreams dealt with in this article. "Von Spee's ships are at the bottom of the "ocean; the 20,000 reservists are back at "work; the thirteen liners are still tied to "their docks in the Hudson and at South "Brooklyn; all the great German colony, "whence the conquering army was to set "forth, is in the hands of the enemy!"

* * *

The Assistant United States Attorney-General recently conducted a successful prosecution of the Directors of the Hamburg-Amerika Line in New York, a trial which was historical in view of the fact that, had it not been for the sacrosanctity of diplomatists and representatives of a friendly Power, would have included in its scope in actuality, as it did morally, members of the German Embassy at Washington. This trial forms part of the Assistant Attorney-General's general investigation into the German conspiracy in the United States. For the prosecution of the inquiry this Federal lawyer has been studying the war book of the German General Staff, and includes in his inquiry the disposition of the nine million pounds sterling raised in the United States by the sale of German bonds. American-German bankers claim that this huge amount was *transmitted by wireless telegraphy* to Berlin. Few independent Americans give any credence to the statement, and little doubt appears to exist that this vast sum is being devoted to the purchase of "neutral" services of various kinds, including the purchase of ships flying other than belligerent flags, the acquisition of large stores and acids for high explosives, and the establishment of submarine *bases* for German boats in Mexican or West Indian waters.



The Wireless Cage which protects the Aerial "Lead-in" on a Warship.

NOTES OF THE MONTH

OUR contemporary, the *Daily Chronicle*, under the heading "British Opportunity for Trade in Canada and the West Indies," recently contained the following paragraph:

"Wireless telegraphy, also, will be an "important factor in the development of "trade relations between Britain and Canada "and in this connection it should be men- "tioned that the Dominion has between "40 and 50 coast stations for communication "by wireless with ships at sea."

* * *

The annual illustrated Christmas Course of Afternoon Juvenile Lectures at the Royal Institution will be delivered this year by Prof. H. H. Turner, D.Sc., D.C.L., F.R.S., his title being "Wireless Messages from the Stars." The subjects are as follows:—"How the Messages are Carried": "How the Messages are Received." First Message: "We are very far away." Second Message: "Some of us are giants and some are dwarfs." Third Message: "But we all behave much as you do." Fourth Message: "And in fact we are your blood relations."

* * *

A revised copy of the Berne International Telegraph Bureau's list of wireless telegraph stations throughout the world brought up to April 1st, 1915, shows that in the matter of coast stations premier position is occupied by the United States with 140 stations, and the second place by Great Britain with 61, whilst Canada ranks third with 47. The most important application of wireless telegraphy, however, is in connection with inter-communication between vessels at sea and the shore, and in the case of ship installations Great Britain leads the way with 1,568, whilst the United States is a poor second with 967, Germany following third with 537.

The training of boys and youths in all methods of signalling has always been a *forte* of the scout organisations throughout the world. We have before us a copy of the December number of *The Boy Scouts Association Headquarters Gazette*, in which it is advocated that "scout-masters should "take up signalling more thoroughly and on "wider lines than they have done in the "past."

The editor of that journal proceeds: "Signalling really falls under three heads:

"*Firstly*, learning to send and read by "means of flags, groups of letters—a test "of accuracy, memory, and disciplined "movement.

"*Secondly*, sending messages in proper "message form between properly con- "stituted sending and receiving stations— "here discipline, co-operation, and strict "attention to the matter in hand is re- "quired.

"*Thirdly*, the use of lamps, heliographs, "field telegraph, and wireless. Here a "great opportunity is opened for boys to "show mechanical ingenuity.

"Also it may be as well to add that "signalling requires accurate knowledge "of the use of maps and compasses.

"All scouts up to the age of fourteen "should understand semaphore sending and "reading; while older lads should be en- "couraged to take up Morse in some form, "preferably telegraphy and wireless, since "these forms of communication have been "more used than any other in the present "war. Buzzers are within the reach of "most troops, and once the boys have "acquired proficiency in their use it will "not be very difficult when the oppor- "tunity comes to acquire the necessary "technical knowledge of telegraphic and "wireless apparatus."

A Wireless Station and Observatory

By FRANK C. PERKINS

THE accompanying illustration shows the observatory and wireless antennæ, while in the second photograph may be seen the electrical equipment at the wireless station of the Illinois Watch Company at Springfield, Ill.

Fig. 1. Wireless Station, Illinois Watch Company at Springfield, Ill.

The engineer at the Illinois watch plant, recognising the fact that the great convenience and accuracy of wireless time signals ensure rapid development of this system of time distribution, lost no time in getting into the field to supplement the service of the Naval Observatory, whose wireless signals from the station at Arlington, Va., at once marked a distinct advance in this line of public service.

In the short period since the "Arlington" wireless time service was instituted hundreds of jewellers throughout the United States and Canada have equipped themselves to utilise these signals. The service is the last word for accuracy, seldom varying from true time more than two-tenths of a second and usually within less than five-hundredths. There are also thousands of amateur receiving stations that daily and nightly make use of the signals. In a short time there will be but few educational institutions down to the high grade school that will not be equipped with a wireless station.

While it may be thought that the Government service from the Arlington station would be sufficient for all needs, it is true that a duplication of the signals at different hours is a real convenience, and the hours of sending from the Illinois Observatory are

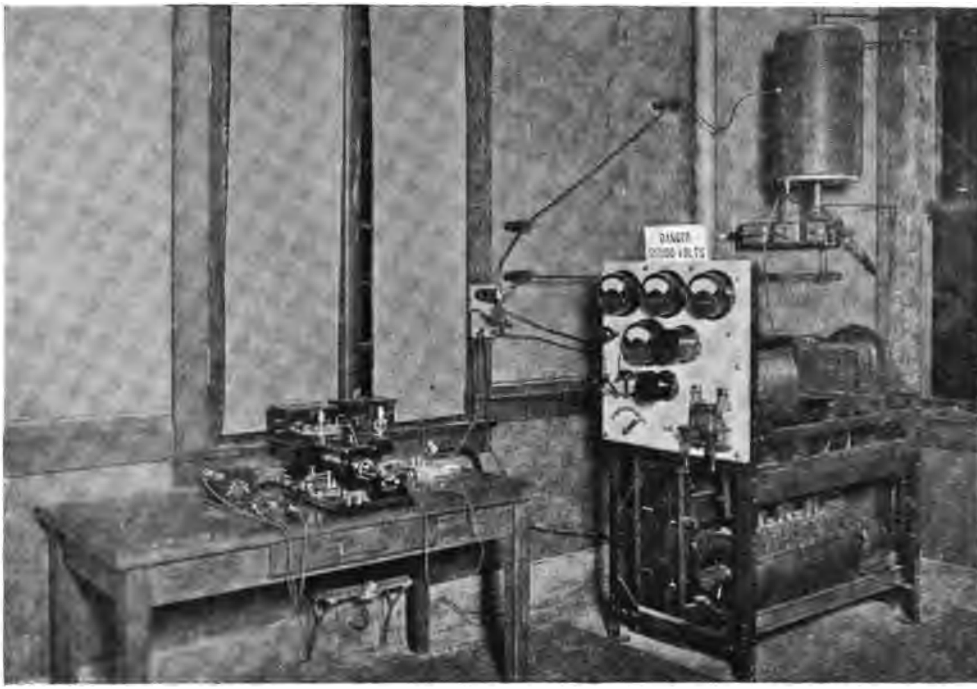


Fig. 2. Electrical Equipment of Illinois Watch Company.

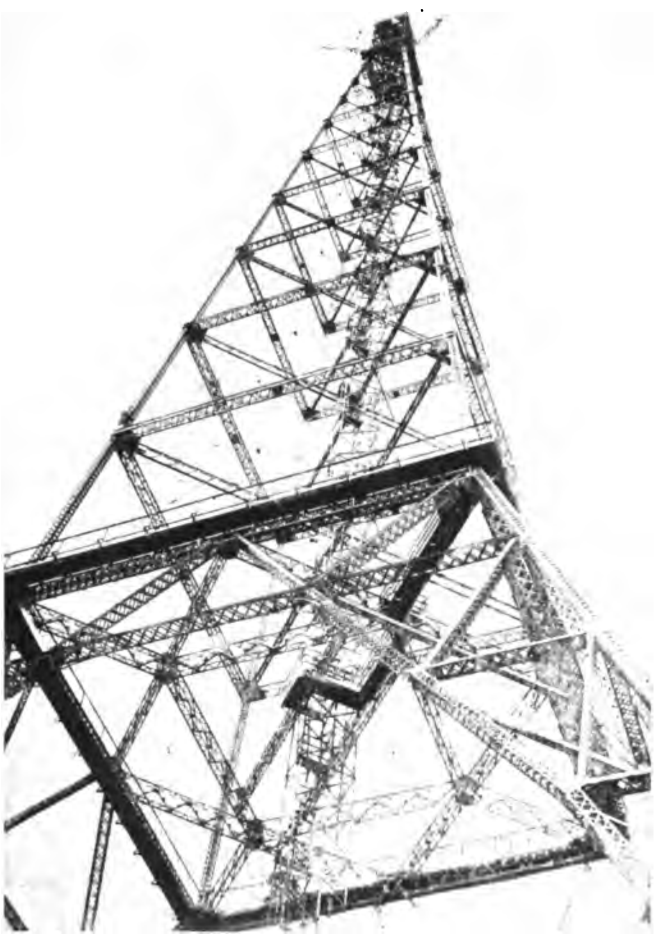
better adapted to the needs of the Central time zone than the 12 noon and 9 p.m. hours, Eastern time, adopted by the Naval Observatory. It also gives an opportunity to receive time four times in 24 hours instead of twice.

The signals from this wireless station and observatory are sent one hour later than the Arlington noon signal and one hour earlier than their evening signal; that is, they are sent at noon and at 8 p.m., Central time. To those unacquainted with the method of transmitting time it may be mentioned that the signals from either source are identical and consist of dashes of about a quarter second duration transmitted each second with certain regular breaks for purpose of identification. The series begins at 5 minutes to the hour, ticking regularly with the exception of a break at the 29th second and from the 55th to the 59th. This latter break is varied on the last minute of the hour by an interruption of 10 seconds before the final signal, which is a long one, beginning exactly on the hour and lasting a full second. With this series of breaks there are ten points of reference in the 5 minute series for the purpose of identification and comparison.

The transmitter used at this Springfield wireless station, while not as powerful as that of the naval station, is yet capable of a readable range of 1,000 miles. Its power, 10 kw., is probably greater than that of any inland station in the United States. The type is known as the rotary quenched spark. It is operated on 220 volt current from the city supply.

It will be seen from the photograph, Fig. 1, that there are no elaborate towers. The three wire aerial, nearly 600 feet long, is supported by masts 100 feet and 140 feet high. The Illinois Watch Company has a large correspondence both with jewellers and other amateurs, who either are reporting the reception of their signals or are seeking advice as to proposed stations.

Everything indicates a rapidly increasing vogue for wireless time service. The photograph shows the receiving and transmitting apparatus. The transmission of the time is automatic, the key being operated directly by the clock through a relay and break circuit wheel in the clock escapement. The



One of Arlington's Wireless Towers.

signals are sent on a wave length of 2,000 metres. This differs so much from the usual commercial lengths that interference is avoided.

TRANSMISSION OF WEATHER REPORTS BY NAVAL RADIO STATIONS.

THE following appeared in the 1915 edition of the list of "Radio Stations "of the United States":

"Through co-operation with local offices "of the United States Weather Bureau, "weather forecasts are sent broadcast to sea "through naval coast radio stations at "certain times, varying with the locality. "Coast stations are gene-"rally prepared to give "local forecasts to pass-"ing vessels without charge, "on request. Storm warn-"ings are sent whenever "received, and the daily "weather bulletins are dis-"tributed by the naval radio "stations at Arlington, "Va., and Key West, Fla., "a few minutes after the "10 p.m. time signal. These "bulletins consist of two "parts.

"The first part contains "code letters and figures "which express the actual "weather conditions at "8 p.m. seventy-fifth meri-"dian time, on the day of "distribution at certain "points along the eastern "coast of North America, "one point along the Gulf "of Mexico, and one at "Bermuda.

"The second part of the "bulletin contains a special "forecast of the probable "winds to be experienced a "hundred miles or so off "shore made by the United "States Weather Bureau "for distribution to ship-"masters. The second part "of the bulletin also con-"tains warnings of severe "storms along the coasts, as occasions for "such warnings may arise.

"Immediately following this bulletin a "weather bulletin for certain points along "the Great Lakes is sent broadcast by the "naval radio station at Arlington, Va., "consisting of two parts. The first part "contains code letters and figures which "express the actual weather conditions at "8 p.m., seventy-fifth meridian time, on "the day of distribution at certain points "along the lakes. The second part of the "bulletin contains a special forecast of the "probable winds to be experienced on the "lakes during the season of navigation—"about April 15th to December 10th."

Maritime Wireless Telegraphy

WAR NOTIFIED BY WIRELESS.

DURING a lecture, held in celebration of the tenth anniversary of the opening of the Darlington Baptist Tabernacle, it was stated that the lecturer was one of three gentlemen chosen to represent the Baptist Missionary Organization on a tour through China, but on the outward voyage to America they received news of the declaration of war by wireless. In consequence, the tour was abandoned and, after a short stay in the United States, the party returned to England.

* * *

BRITISH STEAMER IN DISTRESS.

A wireless message was received in Halifax to the effect that the British steamer *Oakfield*, from West Hartlepool, was in distress 600 miles south-east of Cape Race, Newfoundland. The wireless message was received from the steamer *San Giorgio* which was standing by, and it transpires that the *Oakfield* had lost all her propeller blades. A Lloyds message from Fayal, Azores, was subsequently received saying that the following wireless message was reported from the *San Giorgio*: "Towing steamer *Oakfield* to Fayal. Twice broken lines. Fresh north west wind; heavy sea. No further success possible." The *San Giorgio* gave the *Oakfield's* position, which vessel was eventually brought into Ponta Delgada, Azores, by the Cardiff steamer *Lady Ninian*. The *Oakfield* was bound from Rotterdam to Portland, Maine, and is a large screw steamer of 3,618 tons gross, registered at West Hartlepool.

* * *

WIRELESS TO RECALL A MAIL STEAMER.

For the first time in the history of the service the City of Dublin Steam Packet Company's mail steamer *Ulster*, which left Holyhead one day during the terrific storm which characterised the second week of November last, for Kingstown, with a large number of mails and passengers, received instructions from the Admiralty by wireless telegraphy that in consequence of the Irish harbour being crowded with craft she could not put into it. She was therefore ordered to return to Holyhead and to remain there pending the receipt of further orders. The *Ulster* accordingly put about and made the return voyage in the teeth of a most terrific storm of wind, sea, and rain, the sea at times rising mountains high.

* * *

AN UNTRACED MESSAGE.

During the great storm of early last November a steamer proceeding down channel picked up a wireless message saying, "On way to Scilly Islands. Lifeboats washed away. Big list. Amiral de Vorpont." About the time that this message was received on board a large French steamer was seen to sink off the Island of Guernsey. No further news has arrived and it is feared that all the crew have been lost. The ship issuing the distress signal did not apparently give her position, and the call was therefore rendered futile.

* * *

A HELPLESS LINER.

A wireless message has been received at San Diego, California, to the effect that the steamer *Minnesota*, of the Great Northern Steamship Company, in which an explosion recently occurred, and which it is thought is due to foul play, is lying practically helpless 25 miles south-west of Coronada Islands. The *Minnesota* was on her first voyage from Seattle to London. An earlier message stated that the vessel was returning to San Francisco. It has been reported that three men are suspected of having caused the explosion in the engine-room, and that one of them boasted that the ship would never reach her destination. The *Minnesota* is a vessel of 20,718 tons gross, and was built at New London (Conn.), in 1904.

* * *

A POWERFUL BATTLESHIP.

We are enabled to publish a photograph of the new type of battleship for the United States Navy. Plans for three have been established, and the first is the *California*. They are remarkable in two particulars. The first is that they will displace 32,000 tons, a figure which has not yet been attained by war vessels in any navy of the world, except the Russian, where the four cruisers of the *Borrodina* type possess a displacement of 32,500 tons. The second particular is that they are the first war vessels of large tonnage to be solely propelled by the medium of electricity. The four screws will each make 160 revolutions a minute, and the four electric motors necessary to drive them will possess a total horse-power of 32,000. For supplying the motors with electricity two turbines are provided, each making 3,000 revolutions, and each acting on a 3-phase alternating current electric generator. The use of one turbine only for the four propellers will drive the ship at a speed of 19 knots. It is almost needless to add that the ships are fitted with the latest type of wireless telegraphic apparatus.

* * *

CHILIAN SHIP LOST.

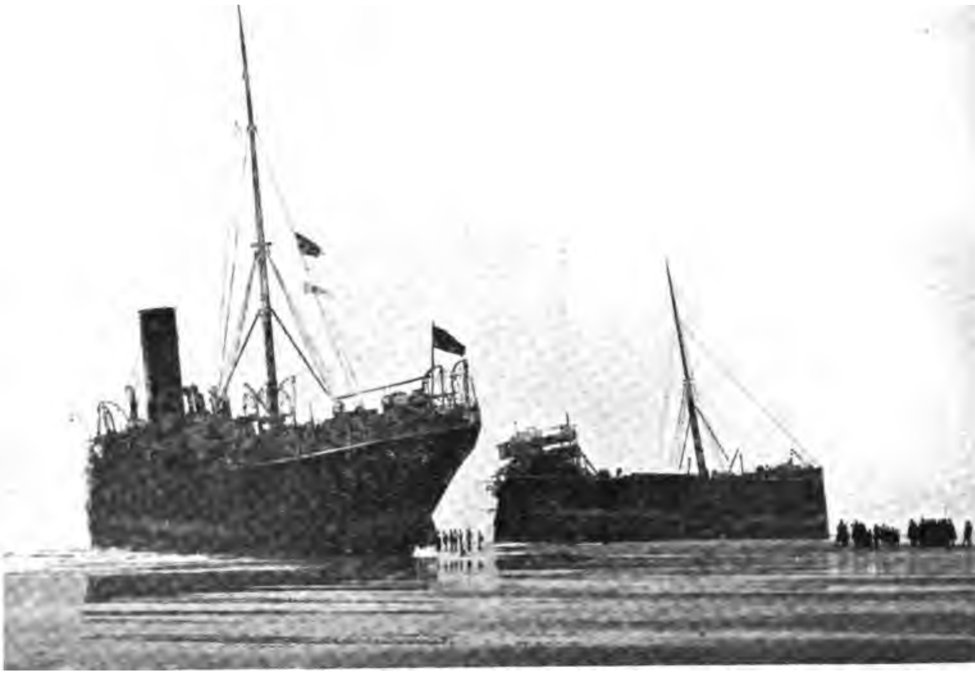
A message received from Lloyd's agent at Vancouver (B.C.) states that the steamer *Princess Maquinna* reports by wireless that a fully rigged ship lies a total wreck at Clayquot Sound, and that all hands were lost. She is thought to be the *Carelmapu*, of Valparaiso, but owing to the tremendous sea and south-west gale the *Princess Maquinna* was unable to render any assistance. The *Carelmapu* was an iron ship of 1,447 tons, built in 1877 at Liverpool.

* * *

BRITISH RESCUE FRENCH.

When recently the French liner *Euphrate* was wrecked on the eastern side of the island of Socotra she sent out wireless distress signals. The Ellerman-Hall steamer *City of Nagpur* heard them and called up the Dutch steamer *Tambora*, asking for assistance in the rescue of 670 people on board the ill-fated steamer which was ashore on a reef. The wireless operator of the *Collegian*, which was on a voyage from London to Calcutta, and had reached a position about twenty-two miles east of Socotra, intercepted the French ship's distress call and asked the *City of Nagpur* if she could be of any assistance, at the same time giving her own position. The reply from that vessel was that further help was sorely needed, and gave the position of the wrecked steamer. The captain of the

U.S.S. "California."



S.S. "Socotra."

Collegian at once turned his vessel's head to the indicated position and with all speed hastened to the work of rescue. The French steamer was found to belong to the Messageries Maritimes and was on a voyage from Saigon to Marseilles with a number of passengers and troops. Later in the day a wireless message was received from the *City of Nagpur* saying that everybody had been taken off the wreck.

* * *

THE WRECK OF THE "SOCOTRA."

Grave news has been received from the *Socotra,* which ran ashore at Boulogne during a voyage from Australia to London. The wind shifted to the west and, as is often the case, her position became consequently more dangerous. The captain sent a wireless message that his ship was breaking amidships and that the crew must be taken off. She was subsequently abandoned and became a total loss. She was built on the Tyne in 1897 and is of 6,009 tons.

* * *

FIRE AT SEA.

Another outbreak of fire at sea has to be reported. The British liner *Roscommon* was off the Australian coast when a conflagration broke out in one of her holds. She immediately sent a wireless message to Sydney advising the catastrophe, and shaped a course for Townsville. The fire, however, was extinguished within a couple of hours, but not before 3,000 bales of wool had been affected.

SHIPPING CONVENTION ACT.

A Further Postponement.

It has been announced by the Board of Trade that the Shipping Convention Act (1914) which was to have come into operation on January 1st, 1916, has been postponed. This forms the second time it has been put off, it being originally intended that the act should come into force on July 1st, 1915, but in May, 1915, it was postponed until January 1st, 1916. The act forms a confirmation of the International Convention for the safety of life at sea, and was signed by the delegates to the London Conference in January, 1914. One of its chief points is the introduction of improved reforms in regard to the use of wireless telegraphic and signalling apparatus on board ship.

CARTOON

Turks erecting Field Wireless in the Gallipoli Peninsula.

Selenium

By MARCUS J. MARTIN

Whilst the title of this article might not seem to indicate that it had any connection with "wireless," yet selenium is a substance which has many uses in radiotelegraphy, particularly in connection with "wireless control." Mr. Marcus J. Martin, whose excellent articles on "Radio-photography" in our previous issues have attracted considerable attention, writes as an authority on the subject, and we venture to think that the article below will prove of value to many.

SELENIUM, belonging to the sulphur and tellurium family, is a non-metallic element, and was first discovered by Berzelius in 1817 in a red deposit found at the bottom of sulphuric acid chambers when pyrites containing selenium was employed. This still continues the source of commercial supply, although it is found to a small extent in native sulphur and combined in native sulphides. It also occurs, combined with metals, as selenides, in a few rare minerals, as clansthalite. Symbol, Se; at. wt., 79·2.

Selenium, like sulphur, exists in several modifications, being obtained as a dark red amorphous powder (sp. gr. 4·26), as a brownish black, glassy mass (sp. gr. 4·28), as red monoclinic crystals (sp. gr. 4·47), or as a bluish grey, metal-like crystalline mass (sp. gr. 4·8).

Selenium is sold commercially in the form of small bars, and its value lies in the property which it possesses, discovered by May in 1869, that when in a prepared condition it is capable of varying its electrical resistance according to the amount of light to which it is exposed. It has not this property in its bar form, and to acquire it selenium requires to undergo the rather delicate process of "annealing." This process consists of heating the selenium to a temperature of 120° C. (the melting point), keeping it there for several hours, and allowing it to cool gradually, when it will be found to have assumed a crystalline condition and to have changed from bluish grey to a dull slate colour. In this condition it is very sensitive to light.

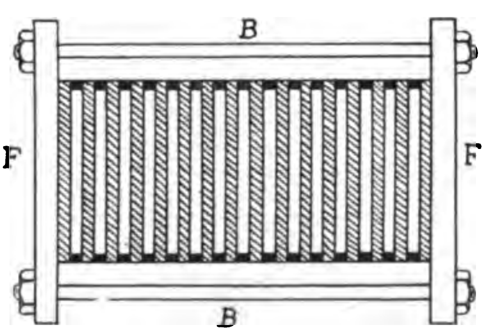


Fig. 1.

SELENIUM CELLS.

To make practical use of the peculiar property possessed by prepared selenium in connection with an electric circuit it is made up into what is technically termed a "cell." A selenium cell in its simplest form consists of merely some prepared selenium placed between two or more metal electrodes, the selenium acting as a high resistance conductor between them. The form given by Bell and Tainter to the cells used in their experiments is given in Figs. 1 and 2. They consisted of a number of rectangular or circular brass plates, P, P^1, separated by very thin sheets of mica, M; the mica sheets are slightly narrower than the brass plates, the whole being tightly clamped together in the frame, F, by the two bolts, B. By means of a sand bath the cell is raised to the desired temperature, and selenium is rubbed over the surface, which melts and fills the small spaces between the brass plates. The cell is kept at the right temperature for a definite time, and allowed to cool gradually, when the selenium will be found to have assumed the necessary crystalline condition. As will be seen from Fig. 2, the plates are connected in parallel, all those marked P being joined together

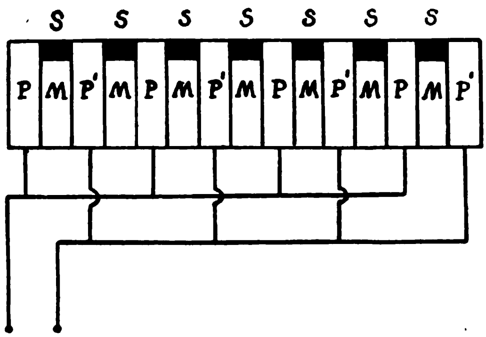


Fig. 2.

to form one terminal, and all those marked P[1] to form the other.

In its natural state selenium is practically a non-conductor of electricity, its resistance being forty thousand million times greater than copper (40×10^9), but Knox, in 1837, found that on being annealed it became a high resistance conductor. As the resistance of any cell depends to a great extent upon the transverse section of the selenium between the electrodes, it is evident that by varying the thickness of the mica strips, and so varying the transverse section of the selenium, cells of any required resistance can be constructed, while by using a number of elements, connected in parallel, a very large active surface can be obtained.

Mercadier adopted a slightly different method of construction. His cells consisted of two very thin brass bands 0·05 inch wide and 0·004 inch thickness, thoroughly insulated from each other by parchment strips, and coiled as shown in Fig. 3, where the dotted and full lines, A and B, represent the brass bands, and the white spaces between the parchment strips. The finishing end of the band, A, is connected to the brass plate, M, and the end of the band, B, to the brass plate, N; the plates, M, N, being provided with terminals, T, T[1]. The complete coil is placed in a wooden frame, F, and clamped tightly together by the bolts, E. One surface of the coiled block is then polished and heated to the required temperature in a sand bath, selenium being then rubbed over the polished surface until it is covered with a very thin layer.

The cell used for commercial purposes is usually constructed as follows. A small rectangular piece of slate, porcelain, mica, or other insulator, is wound with many turns of fine platinum wire. The wire is wound double, as shown in Fig. 4, the spaces between the turns being filled with prepared selenium. A thin glass or mica cover is sometimes placed over the cell to protect the surface from injury.

CHARACTERISTICS OF SELENIUM CELLS.

A strong light falling upon a cell lowers its resistance, and *vice versa*, the resistance being at its height when unexposed to light. Selenium cells vary very considerably as regards their quality as well as in their electrical resistance, it being possible to obtain cells of the same size for any resistance between 10 and 1,000,000 ohms, and also a cell may remain in good working condition for several months, while another will become useless in as many weeks.

The ability of a cell to respond to very rapid changes in the illumination to which it is exposed is determined largely upon its inertia, it being taken as a general rule that the higher the resistance of a cell the less the inertia, and the lower the resistance the greater the inertia; also the higher the resistance the greater the ratio of sensitiveness. Inertia plays an important part in the working of a cell slightly opposing the drop in resistance when illuminated, and opposing to a much greater degree the return to normal for no-illumination. The effects of inertia or "lag," as it is termed, can readily be seen by reference to Fig. 5. It will be noticed that the current value rapidly increases when the cell is first illuminated, but if, after a short time, *t* the light is cut off, the current value, instead of returning at once to normal for no-

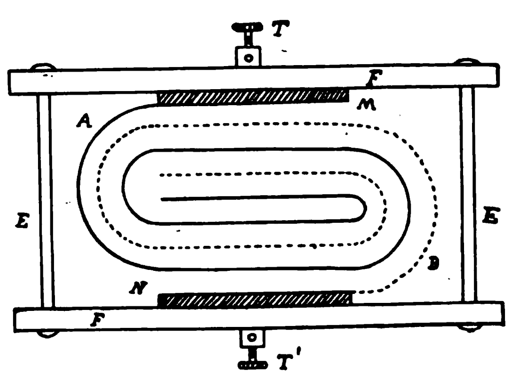


Fig. 3.

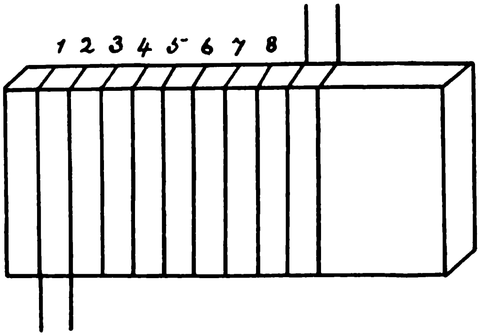


Fig. 4.

illumination, only partially rises owing to the interference of the inertia, and some time elapses before the cell returns to its normal condition; the time varying from a few seconds to several minutes, depending upon the characteristics of the cell and the amount of light to which it is exposed.*

The inertia or "lag" of a cell produces upon an intermittent current—caused by an intermittent varying beam of light being thrown upon a cell—an effect similar to that produced by capacity in a circuit, preventing the incoming signals from being recorded separately and distinctly, The comparative slowness of selenium in responding to any great changes in the illumination offers a serious drawback in many practical applications, but various means have been devised whereby the effects of the inertia can be counteracted. In any arrangement where the changes in the illumination are neither very rapid nor very great the inertia effects would be very slight, but where the source of illumination is constant, but intermittent, and the resistance of a cell is required to drop to a definite value and return to normal instantly, many times in succession, the inertia effects are very pronounced.

The most successful method of counteracting the inertia is that adopted by Prof. Korn, of always keeping the cell sufficiently illuminated to overcome it, so that any additional light acts very rapidly. Another method worked out and patented by Prof. Korn, and known as the "compensating cell" method, gives a practically dead beat action, the resistance returning to its normal condition as soon as the illumination ceases. The arrangement is given in the diagram, Fig. 6. A selenium cell, S^1, is placed on one arm of a Wheatstone bridge, a second cell, S^2, being placed on the opposite arm. The selenium cell, S^1, should have great sensitiveness and small inertia, the compensating cell, S^2, having small sensitiveness and large inertia. Two batteries, B^1 and B, of about 100 volts, are connected as shown, B being provided with a compensating variable resistance, W; W^1 is also a regulating resistance. When no light is falling upon the cell, S^1, light from L is prevented from reaching the second cell, S^2, by a small shutter which is fastened to the strings of the Einthoven galvanometer, H,* and the piece of apparatus, C—relay or galvanometer as the case may be—remains in a normal condition. When, however, light from the transmitting or receiving apparatus, as the case may be, falls upon the cell, S^1, the balance of the bridge is upset, and light from L falls a fraction of a second later upon the second cell, S^2, and the current flowing through C completes the circuit. Needless to say, it is necessary that the two cells be well matched, as it is very easy to have over compensation, in which case the current is brought below zero. It is also stated that by enclosing the cells in exhausted glass tubes their inertia can be greatly reduced and their life considerably prolonged.

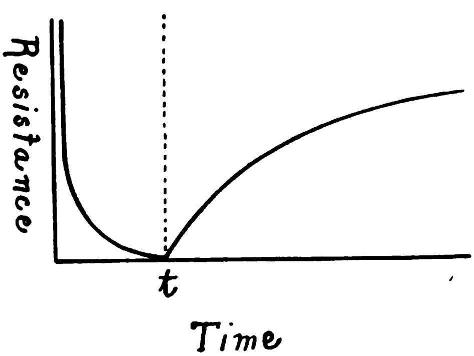


Fig. 5.

The sensitiveness of a cell is the ratio between its resistance in the dark and its

* An actual curve is given on page 295, WIRELESS WORLD, No. 29. 1915.

* A description of this was given on page 104, WIRELESS WORLD, No. 26. 1915.

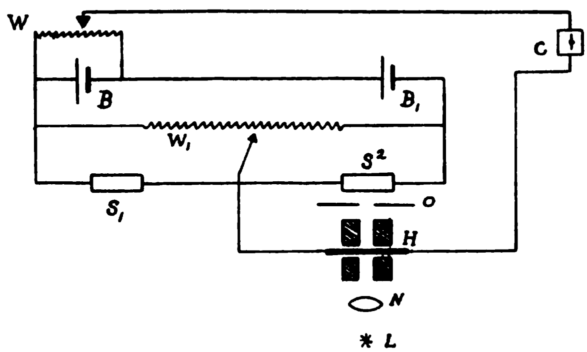


Fig 6.

resistance when illuminated. The majority of cells have a ratio between 2 : 1 and 3 : 1, but Prof. Korn has shown mathematically that by conforming to certain conditions regarding the construction the ratio of sensitiveness may be between 4 : 1 and 5 : 1. Thus a cell of R=250,000 ohms can be reduced to 60,000 ohms from the light of a 16 c.p. lamp placed only a short distance away, while another would only be reduced to perhaps 100,000 ohms. Some of the cells constructed by Bell had a resistance of 1,500 ohms in the dark, which was instantly reduced to 600 ohms when exposed to bright sunlight.

The resistance may be still further decreased by continuing the illumination, but this produces a permanent defect in the cells, termed "fatigue," the cells becoming very sluggish in their action, and their sensitiveness gradually becoming less, the ratio between their resistance in the dark and their resistance when illuminated being reduced in some cases by as much as 30 per cent. Excessive illumination will also produce similar results.

The inertia of a cell is practically unaffected by the wave-length of the light used, but the maximum sensitiveness of a cell is towards the yellow orange portion of the spectrum.

Common sulphur has been used to replace selenium in the cells, but the effects are much slighter than when selenium is employed.

In addition to light, heat has also been found to vary the electrical resistance of selenium in a very remarkable manner, At 80° C. selenium is a non-conductor, but up to 210° C. the conductivity gradually increases, after which it again diminishes.

PRACTICAL APPLICATIONS.

A sensitive galvanometer was employed by most workers to record the variations in the resistance of a selenium cell, but Bell, by substituting a telephone receiver for the galvanometer, was able to register much smaller variations, and this led to the invention of the "photophone," a piece of apparatus designed for the transmission of speech by means of a beam of light. The late Prof. Rhumer, who contributed many valuable papers on selenium and its properties, employed selenium cells in connection with his television apparatus, and also for obtaining records of eclipses during unfavourable weather conditions. He was also responsible for the invention of an automatic registering instrument which, by the aid of selenium cells, could register variations in the intensity of light, even up to several hundreds per second.

There have been many other applications, more or less useful, but the most remarkable and interesting is that devised by Prof. Korn for the telegraphic transmission of photographs and pictures over ordinary telegraph lines, some good results having been obtained over considerable distances. Selenium has also been employed as a wireless detector.

THEORIES REGARDING THE MICROPHONIC ACTION OF SELENIUM CELLS.

A selenium cell, owing to its somewhat similar behaviour, is sometimes referred to as a "light microphone," inasmuch as its action under the influence of light resembles the action of a microphone under the influence of sound. The peculiar property possessed by crystallised selenium of reducing its electrical resistance when under exposure to light has been the subject of the investigations of many eminent physicists, including Mose , Siemens, Adams, Bidwell, and Day. Dr. Moser formed his opinion that the microphonic action of the cells was caused by the alteration, due to heat, of the imperfect contact between the selenium and the metallic electrodes, but Mr. Bidwell, by simply heating the cells, has shown that the effect cannot be produced this way, a much higher temperature being required to reduce the resistance of the cells to a point to which they are instantly reduced by exposure to light.

The most generally accepted theory is that put forward by Profs. Adams and Day, in 1877, the results of their exhaustive investigations leading them to suppose that the "electrical conductivity of selenium is electrolytic." They gave the following reasons to support their theory: (1) that the resistance of selenium bars appeared to depend upon the E.M.F. of the battery employed, being generally diminished as the battery power was increased; (2) that the resistance of a bar, A B, was generally not the same for a current in the direction A B as for a current in the direction B A ; (3) that the passage of a battery current was always followed, when the battery had been disconnected, by a secondary or polarisation current in the opposite direction, it being clearly proved that this secondary current was not due to any thermo-electric action, either in the selenium itself or in any other part of the circuit.

The action of light in altering the electrical conductivity of crystalline selenium is supposed by those experimenters to arise from a modification of the crystalline condition when under the influence of light, and in their own words the explanation is as follows: "Light, as we know, in the case of some bodies tends to promote crystallisation, and when it falls upon a stick of selenium tends to promote crystallisation in the exterior layer, and therefore to produce a flow of energy from within outwards, which under certain circumstances appears in the case of selenium to produce an electric current. The crystallisation produced in selenium by light may also account for the diminution in the resistance of the selenium when a current from a battery is passing through it, for in changing to the crystalline state selenium becomes a better conductor of electricity."

HEAT CELLS.

Mercadier, experimenting with Bell's photophone, discovered that sound could be transmitted without using selenium cells and batteries, and that non-luminous heat-rays, under certain conditions, produce similar results. A thin plate of any material serves as a receiver in the "radiophone," by which name Mercadier termed his modification of the photophone, the sounds being conveyed to the ear by a tube running from the back of the plate. The thickness and size of the plates do not affect the intensity or timbre of the sounds to any great extent, but the slightest alteration of the surface makes a difference. Plates, the surfaces of which are scratched or oxidised, increase the intensity of the sounds, while paper and silvered glass give no sounds at all; the material of which the plates are constructed also affects the intensity of the sounds. Good results have been obtained by using plates coated with Indian ink, soot, or other non-radiant matter. Paper or mica plates coated with soot make very sensitive receivers. Plates which absorb the rays strongly, but do not reflect them, generally prove the most effective.

The great sensitiveness of surfaces coated with soot led Tainter to substitute soot for the selenium in a selenium cell, and one form of soot or carbon cell is given in Fig. 7. A film of silver is precipitated upon a glass plate, B, and the silver is divided into two portions by means of a zigzag line, A A, running across the plate, which is filled up with soot. Each portion of the silver coating is provided with a terminal, T, for connecting to the battery and telephone receiver.

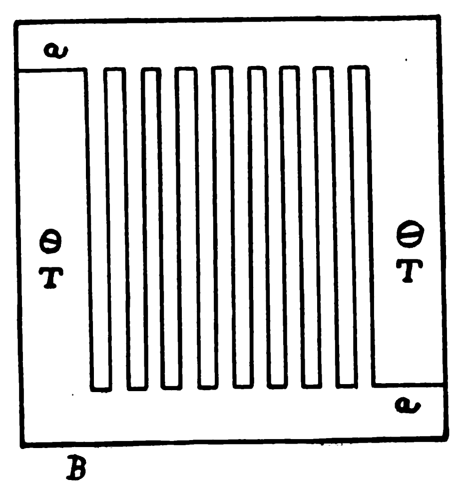


Fig. 7.

Doings of Operators

Operator W. F. Steward.

THE ss. *Californian*, which was recently sunk in the Mediterranean, carried two wireless operators, W. F. Steward and G. F. Ness. Mr. William Fairlie Steward hails from Rutherglen, and is twenty-two years of age. Prior to joining the Marconi Company he was for some years in the employ of a Glasgow cotton firm, and on leaving them came to the Marconi Company's London School in June, 1914. Mr. Steward has served on the ss. *Californian* for some time, and before this was on the ss. *Cambrian*.

Operator G. F. Ness.

* * *

Mr. George Findlay Ness, the second operator of the *Californian*, is also a Scotsman, his home being in Fifeshire. He is nineteen years old and had held a clerical position before taking up wireless. His appointment to the Marconi Company's staff dates from June last, and his whole time had been spent on the *Californian*. Both men were rescued uninjured and are now in England.

* * *

The ss. *Mercian*, also sunk recently, carried as operators Messrs. L. Hughes and T. E. Walmsley. Mr. Llewelyn Hughes' home is at Aberystwyth. Born in 1890, he was educated in that town, and for some time was in business at Liverpool. He joined the Marconi Company in June, 1915, and served on the ss. *City of Benares* until he went to the ss. *Mercian*. Mr. Hughes was injured in the head, but is making good progress, and we sincerely trust that he will soon fully recover from his wound.

Operator L. Hughes.

* * *

Mr. T. E. Walmsley, the second operatorr is twenty-two years of age, and is a

Operator T. E. Walmsley.

Lancastrian. Previously engaged in the textile trade, he is quite a new recruit to the wireless service, and did not wait long for adventure, being torpedoed on his second day at sea. At the time of writing we believe him to be uninjured, as his name does not appear in the list of casualties, and we hope that he is feeling none the worse for his exciting adventure.

* * *

Whilst most attention is naturally given to cases where the ship has been the victim of an enemy submarine, we must not forget that there are many other risks to be faced. The ss. *Socotra*, which recently ran ashore near Boulogne (see page 679 of this issue), carried a Marconi installation in charge of Operator A. R. Coomber. Mr. Arthur

Operator A. R. Coomber.

Robert Coomber, whose home is at Rochester, Kent, has served as a wireless operator for fifteen months, joining the Marconi Company soon after the outbreak of war. He is twenty-one years of age, and took to wireless after serving as assistant chemist in a cement works near his home. Mr. Coomber had sailed on the ss. *Comrie Castle*, *Corinthian* and the *Simla* before joining the *Socotra*. At the time of writing we believe Mr. Coomber to be saved from the wreck, and we hope he has not sustained any injury.

* * *

Among the latest casualties is the ss.

Operator G. B. James.

Umeta, of the British India Line. Operator G. B. James, who was in charge, is twenty-two years old, and when ashore lives at Brixton. During his eighteen months in the service of the Marconi Company he has sailed on the ss. *Narragansett*, *Westmeath*, and *Umeta*. Mr. James was, fortunately, saved from the wreck, and is uninjured.

* * *

Peter Rasmussen Rechnagel, the wireless operator who so faithfully carried out his duties on the burning *Athinai* (see p. 522 of November issue), is a member of the operating staff of the Belgian Marconi Company, and was born at Egvad in Denmark on February 3rd, 1890. He was appointed telegraphist in the Marconi service in July, 1914.

Wireless in the Courts

ON November 23rd last, Horace Neate, of Great Quebec Street, Marylebone, was charged with forging and uttering a certificate of identity and character, whereby he obtained a situation as a wireless operator.

It was stated that the prisoner, after undergoing instruction at the school of the Marconi International Marine Communication Company, passed the necessary test on September 20th, and a fortnight later was asked to obtain two letters of identity and character from persons who were not related to him. He furnished two such letters, and on October 14th left the school as a qualified telegraphist for the purpose of joining a hospital ship.

Chief Detective-Inspector Gough, of Scotland Yard, said that the prisoner was arrested on board the hospital ship when she arrived at Southampton. When he was told that the letters of character he had produced were forgeries, he said that the persons whose names appeared on them were personal friends. The inspector added that the prisoner had been a dairyman at Cross Keys, Monmouthshire, for five or six years, and nothing was known against his character.

The prisoner told the magistrate that he wrote the letters himself, as he forgot to get them from his friends until it was too late, and thinking that his negligence might lose him a job, he wrote them himself. He intended to write to his friends telling them what he had done, but was ordered to the Dardanelles before he could do so.

The magistrate inflicted a fine of £20.

* * *

Although William Nettle was working on the wireless telegraph station at Shepherd's Shore, Devizes, he was unpatriotic enough to " use in public certain expressions calcu-" lated to cause sedition or disaffection " among the civilian population, or to cause " disaffection to his Majesty, or to prejudice " the recruiting, training, discipline, or " administration of his Majesty's Forces." The magistrate, in pointing out the seriousness of the case in this time of war, fined the defendant £2 and 15s. 6d. witnesses' expenses, or in default imprisonment for fourteen days. On his own application, the prisoner was allowed seven days for payment.

* * *

A somewhat interesting case was dealt with last month in the Courts concerning the prohibition by Admiralty Regulations of the use of wireless telegraphy by merchant ships in harbours and territorial waters of the United Kingdom and the Channel Islands. The Dutch steamer *Roepat*, on a voyage from Dutch East Indies with general cargo to London, had called at Deal, and was rounding the North Foreland up the mouth of the Thames when she was heard by a naval officer stationed at Ramsgate calling up the Dutch wireless station at Scheveningen. The actual message was in appearance innocent enough, reading in translation, " Arrived safely at Deal; expect reach London to-night, hearty greetings, Kees." In view, however, of the fact that dangerous communications are often wrapped up in seemingly innocent messages, and seeing that the calls were strong and interfered with Admiralty wireless communications, the captain, Jacob Veenhoven, was charged on warrant at East Ham Police Court. The Dutch captain was able to clear himself of guilty intentions; but as a warning to others, and to emphasise the importance attached to strict obedience of Admiralty Regulations, the Court imposed the substantial fine of £10 and costs.

ADMIRALTY WIRELESS BADGE.

One of the smartest armlets imaginable is the Admiralty wireless badge. Dark red, with two wings and a zig-zag shaft of electricity worked upon it, it is both neat and effective. It is also very rare. " Only " thirty-three have been issued since the " war," said the wearer of one.

Stranger than Fiction

By E. BLAKE.

I.

IN spite of what metaphysicians may argue to the contrary, there are two distinct kinds of truth. One is the kind which proclaims that twice two are four, and that King John lost his gewgaws in the Wash and died through eating an excess of lampreys—and such-like facts which, owing to their sweet reasonableness, excite no suspicion; the other is that sort of truth which is practically monopolised by the wonders of science and the long arm of coincidence.

Regarding the wonders of science I have nothing to say, and the scientific men must make peace with their consciences as best they may; this story deals with a case of the long arm. Call it fiction if you will, and I answer that truth includes, utterly swallows up the most imaginative fiction, and then still has a word to say. There is nothing in fiction so incredible that its counterpart cannot exist in some concourse of atoms or events in the plastic fabric of Nature or the intricately-woven web of human affairs.

In April, 190—, I was wireless operator on the *Kapitan* in the South American trade. At that time she was the only vessel engaged on that run which carried wireless gear, and as coast stations were scarce I had a fairly easy time. Partly from a sense of duty and partly because I was making some private observations of "atmospherics," I used to wear the telephones for several hours daily, even when the nearest station was over fifteen hundred miles away. In wireless work as in most other human activities it is the unexpected which happens, and a good motto for an operator is, "When in doubt, listen in." You never know when some unheard-of craft, fitted with wireless the day after you left port, may come sneaking within range and bleat for help.

One afternoon I was lying in my bunk, pretending to be on watch, but really reading "The Purple Prince," a novel borrowed from our romantic third mate, when I was suddenly interested by hearing sounds in the telephone which I at first thought to be x's of unusual strength and tone. As I listened I decided that they were not "atmospherics"—at least, not like any I had ever heard. The sounds seemed to come with something like regularity, giving rise to a dim reminiscence of the Paris time-signals. After a time the signals broke up into dots and dashes which seemed systematic enough—not the result of a mere defect of spark, but as though the circuit was being made and broken according to a pre-arranged plan. It was not Morse; not even the Morse as conceived by continental operators of a nationality which shall be nameless. We were at this time about two days' steaming past the Horn, bound for Valparaiso, and reference to the chart showed that the nearest land was about forty miles distant and consisted of an archipelago, a mere scattering of large rocks off the coast of Chile.

I called "CQ" ("all stations") until my apparatus became overheated, but the steady flow of dashes continued, alternating with curious groups of dots and dashes, hour after hour without cessation. The signals, which sounded like those radiated by a "plain aerial," grew weaker as the *Kapitan* proceeded northward, and were inaudible about seven hours after I first heard them. I made a full report of the matter in my log and promised myself that I would investigate it further on the return voyage.

II.

Some weeks later, when the ship again approached the region where I had heard the strange signals, I found myself absurdly excited at the thought of once more getting at grips with mystery. I was possessed by an eerie feeling that somewhere something was wrong; that those regular, insistent ether impulses had a deeper significance than I could fathom. At times I vaguely wondered whether I had chanced upon signals from another planet, explaining their localisation by the supposition that a directional radiator was being employed. I favoured this view when I pondered on the facts that the signals were not those of any known code, and that they revealed none of the small imperfections characteristic of work performed by the hands of men. Then commonsense asserted itself and whispered, "Automatic transmission." But why did it continue for so long? And who, in that desolate region, would be playing with a development of wireless which was still in its infancy in the scientific nurseries of Europe?

At last I realised that my receiver was once more within range of the mysterious waves. My trained ear distinguished them as attenuated wisps of sound which impressed my alert imagination with their seeming other-worldliness, and I experienced a disquieting recrudescence of the sense of the uncanny. I felt that behind the physical manifestation worked a mind, which, by means of those rhythmical sense-impressions sought *to convey intelligence*; that it was appealing, under the dire stress of limited means, to a similar mind as though to say, "Given such a phenomenon, in such a place and under such circumstances, what do you deduce therefrom?" I tried to deduce, but in vain; the data were hopelessly inadequate. And yet, although I was present on a rescue ship at the burning of the *Gloria* off Achin Head, and at the loss of the *Arbaces*, I had never heard so poignant a cry for aid as those persistent dots and dashes. Just as one sometimes feels another's presence in the room, so was I sub-consciously aware that I was hearing a deliberate attempt to attract attention to the mind which had conceived that particular arrangement of longs and shorts.

"It was a mass of barnacles shaped roughly like a bottle. 'Hullo!' I said, 'there's something inside it.'"

I got the ship's surgeon and three deck officers to listen to and describe the signals, with the following result: short dashes for a period of five minutes; an interval of twenty seconds; then fifty groups each consisting of —— · · —— · —— ·   —— ——; finally, a dot every second for one minute. Then the cycle recommenced.

From the moment when I picked up the signals to when they became inaudible, a matter of seven hours and fifty-three minutes, this continued without variation. The signals at their loudest were never of more than medium strength. We signed my log as five independent observers, and the affair furnished us with ample food for speculation until the ship was docked in London and we went our ways.

I laid my log before those in authority at my office, who, for the space of five minutes, pretended to be interested, and then went on to speak of an undercharge of five cents. . . .

III.

I had been down to the ship in order to fit some new insulators, and noticing that the *Almirante* was lying close by I went aboard for a chat with my friend Croome, her chief engineer. He received me with

"Floated bang up to the boat, and a Lascar hooked it out."

open arms and his best Burmah cheeroots, and we spoke of coal bills and the damnableness of adverse currents plus head winds. Presently I noticed on his locker a curio which I had not seen before, and strolled across the cabin to look at it.

"Ah! funny thing that," he said. 'Found it during lifeboat drill somewhere near the Falklands. Floated bang up to the boat, and a Lascar hooked it out."

It was a mass of barnacles shaped roughly like a bottle. "Hullo!" I said, "there's something inside it." I could easily distinguish the dull clicks as some small object slid about when I turned the relic in my hands. "Shall we break it open?"

"Go ahead," assented Croome, flinging me a hammer. "I expect it's a bit of rock or a shell."

A few blows laid the thing in fragments, and from the midst of the litter of barnacles, weed, and broken glass, I caught a glimpse of paper. Croome started up with an exclamation and began to sweep aside the débris, whilst I stood there tingling with excitement—and something else; I believe I knew even then a great deal about the contents of that bottle.

"Great guns, look here!" Croome held up some folded pieces of yellow paper and a tarnished gold ring. "This was what tinkled," he added, handing me the ring. "And this—it's a blessed long screed. Come on, let's see what Don Rougemont de Crusoe has to say."

We examined the papers, shoulder to shoulder. Sea water had rendered some portions of the writing illegible—it was written in pencil—but the gist of it, except an important detail which I was able to supply myself, was quite readable. We read:

"*January*, 1864.

"... of Tierra del Fuego, where ... "November gales and foundered. Myself "and a spade-bearded ship's carpenter, "Maconochie, were cast upon this rock, "and I fear that every other soul aboard "perished. ["Not the packet *James Hands*, "I suppose?" interjected Croome.] Four "months ago I lived in Palmerston "Square, London, and now I am exiled "amongst these shrieking sea-birds, doomed, "maybe, to watch the face of the Pacific "and the inscrutable heavens till my course "is run. I have little hope of rescue, for

"I believe we deviated much from the cus- "tomary track of the shipping. And I "have no fire, no implement of any sort ". . . cold, and we were forced to hew "with our hands two holes, graves by their "shape, in the immense accretion of guano, "in which to huddle our shivering bodies. "My food is the seaweed and shellfish, my "drink rain-water from the pools. The "length of time for which human life can "be sustained by this fare in an environ- "ment so utterly desolate as mine cannot, I "suppose, be very great; loneliness and "bodily misery will probably suffice to kill "me. Yet I am strangely reluctant to "contemplate death, even though my present "condition is a death without the mercy "of oblivion. Was ever a man in so "cursed a situation? Young, rich, sensitive, "educated, I am chained to a rock and live "like a beast. And in London a woman "waits for me, as she must wait, oh, heaven! "until she dies. The agony of this thought "alone seems enough to destroy me, yet I "am become strangely calm, though not "resigned. The frenzies, in which I raved "and blasphemed, shaking impotent hands "at these wheeling, screaming birds, have "passed, and I am like a child who has "wept himself to a drought of tears from "weariness and lack of results.

"When I have used all my paper I shall "contrive to seal it up in a bottle together "with my ring, and deliver my last message "to my fellow creatures into the keeping of "the sea. Maconochie picked up a bottle, I "believe. I beg the finder to send my ring "and message to my brother, Mr. Adrian "Warner, of Burton-on-Trent, England. "My will is with Gunn the attorney, "who . . .

". . . alone. Maconochie died after "three days, and lies in his bed and grave, "covered with such sand and stones as I "could collect. He made a strange end. "Perhaps he suffered a blow on the head "when the waves dashed him ashore. Just "before he passed he raised himself in my "arms and said, ''Tis a mysteerious warld. "I spoke wi' my mother a minute sence.' "Then, sinking back almost gone, he "whispered, 'Till the day break, laddie—an' "'the shadows—flee—awa'.'

"Ay, the shadows! There are shadows "between me and my kind; the shades of "ignorance. Did I but know as much as "Maconochie I could have a ship here in a "few weeks. He spoke to his mother. But "I am dumb before the space which "separates me and mine. I, a living, pal- "pitating net of nerves, a man of the same "stuff as those who discovered the secrets "of the stars in their courses, who weighed "the sun, raised the Pyramids, and who "constructed the telescope and magnetic "compass—I am impotent, lost, damned "in my ignorance. A point or centre of "psychic force, and I am cut off from all "other such points. Can this be so? Can "it be that this unit, myself, is utterly "isolated? Is a gulf fixed between soul "and soul or mind and mind? I now see "my problem clearly. *To project intelli- "gence across space.* The electric telegraph "cannot help me now. I have meditated "much on Maconochie, *for he spoke with his "mother.* Telepathy? Is it the fruit of "disordered minds or of minds attuned to "others? I have come across other in- "stances of this, and it is true that in every "case the communicating persons were "bound in sympathy, friend to friend, wife "to husband. 'Two hearts which beat as "one'; better still, 'two minds with but "a single thought'—can there be a scien- "tific principle underlying this fancy of "the rhymester? Perhaps harmony is the "secret; the approximation of pulse to "pulse, the striking of a chord which echoes "in another; like vibrating only to like. "We know so little, so little." ["This is getting uncanny," muttered Croome, chewing his cold cheroot. "It's like watching a blind man grope. The plucky beggar!" "He's getting on the track, too," I replied. My thoughts flew back to that place near the Chilian coast, and I heard again those appealing signals. I licked my dry lips.]

"I have it! *There must be a medium.* "Just as the electric fluid needs the wires "to conduct it, so the subtler thought-cur- "rents must travel on some finer threads. "But the medium, the medium? Some "intangible, imponderable, all-pervading . . .

". . . instrument, not a telegraph, to "disturb it, vibrate it, to create commotion "broadcast, in some invariable and sys- "tematic manner from which men may "reason from the disturbance, to me, the "disturber. The light-ray necessitates an eye,

"... . doomed, maybe, to watch the face of the Pacific and the inscrutable heavens till my course is run."

"and the sound-wave an ear, thus how will "men perceive the disturbance of the "universal link without some receptor "designed to that end ? Professor Huxley "says he does not believe in thought-"transference because he can trace no "organ of reception in man's body; "I look to my fellow men to produce "that which is sensitive to this action at a "distance. It will come. I have hope, nay, "faith. Perhaps even at this moment "some influence from me may be inspiring "my friend, Mr. Maxwell the mathema-"tician, to turn his mind to the . . ."
["Or conversely," whispered Croome. "Wasn't his theory just out then ? "]*

*In 1864, J. Clark Maxwell published his "Electromagnetic Theory of Light." In the light of present knowledge it is conceivable that telepathic communication may have occurred between him and the castaway.

" . . . faith in man's perpetual endea-"vour. My work lies before me, and it "may be my destiny, here in this utter "solitude, save the birds, to evolve out of "my sore need some astounding thing for "the use and benefit of posterity . . . if I "can keep body and soul together, though "I fear the effect of the increasing cold . . . "religious only in the broadest sense, but I "am strong in the belief that each one is "endowed with . . . to use or neglect . . . "and that man is immortal till his work is "done. I see in the history of our race a "passion for and a striving towards articu-"lateness, expression; or, as I said, the "power to convey thought. I see it in our "slow, evolutionary march upwards from "the lower, mute forms to the chattering ape "and early man with his primitive lan "guage; I see it in the first rude sketches "of the cave dwellers, the signal fires, the "hieroglyphics on the enduring monuments "of the East, the sounding war-drums whose "throbbings rolled over forest and creek, "the waxen tablets and frail papyri; in the "marble marvels of Greece, in the printed "book, in music and poesy, and, later, in our "own modern telegraph. Yes, it will come "as surely as to-morrow's dawn, that "conquest of space, when the shadows "shall flee away and it shall be known that "the visible universe is but as a pattern on "a garment, which is of one stuff from infinity "to infinity. In that day 'there shall be "no more sea,' and man shall speak with "man from one continent to another. I see "it, I see it. . . . . vouchsafed a sign, for I "have just noticed that the after portion of "the vessel lies within reach at low tide, "though it is rapidly breaking up. I can, "however, obtain fire, light, tools, and "comforts against stress of weather. I "shall take everything which time and my "strength permit, but particularly the "electrical machinery, which is new . . . any "medical solenoids and such-like appliances.

"I entreat my brother to search these "parts in the hope of finding me alive, but "in the event of failure I trust that . . . "comfort and sustain for my sake the lady "whom I . . . her and my many friends, "that in my thoughts . . . and cherish the "hope that at . . . memory . . . great "Hereafter.

"(Signed) EDWARD WARNER."

Croome expired a mighty breath and stared at the pieces of paper as though he were uncertain of their reality. "A prophet, a prophet, by gum!" he said in an undertone. As for myself, the strange signals were buzzing in my ears again. Both telepathically and with his "disturbances"—not to mention the message from his bottle—that great man had worked his will.

I started up, seized my hat and hastened to the nearest telegraph office, telling Croome as I ran out that I would see him and explain things on the following day.

. . . . . .

Adrian Warner, guided by the story I was able to tell him, is on his way to Chile in a fast British cruiser, to look for his unfortunate brother. Will he find a madman, crouching by a wonderful machine which produces electro-magnetic waves, a machine conceived by the genius of desperation and fashioned out of the unpromising materials salved from the wreck, or will he find the second grave sheltering a corpse, and an undreamed-of marvel of human ingenuity, a mysterious, never-failing source of energy, perpetually flinging its creator's appeal out upon the infinite expanse of ether?

AMONG THE SOCIETIES.

Croydon Wireless Society.—The second annual meeting was held at Croydon Polytechnic recently, when Mr. C. Harrison presided. Dr. T. C. Baillie and Dr. J. Erskin Murray continue as presidents, and the officers were elected as follows:—Chairman, Mr. F. G. Creed; Hon. Treasurer, Mr. W. Ryley; Hon. Secretary, Mr. H. T. P. Gee; and other members of the Council: Dr. H. A. Eccles, Dr. F. Knott and Messrs. R. E. H. Carpenter, C. Harrison, C. W. Raffety, and F. F. Roberts. Mr. E. A. Salt gave a short paper on "Primary Batteries, Past and Present," and showed and explained a small double fluid bichromate battery of his own design.

FROM A CORRESPONDENT IN HOLLAND.

"Your publication makes the greatest Providence we could find, wireless amateurs, specially your questions and answers and your clear and precise instructional articles."

THE IMPORTANCE OF MATHEMATICAL TRAINING.

A MATTER under discussion at the moment is the actual value to the student of a mathematical training, and whether it is necessary to go deeply into the subject in order to become a competent electrical engineer. Many have complained that the ordinary methods of imparting mathematical knowledge are far from interesting, and the famous Canadian humourist, Mr. Stephen Leacock, in his new book *Moonbeams from a Larger Lunacy*, particularly emphasises this point of view. He writes as follows:

"Here, for example, you have Euclid "writing in a perfectly prosaic way all in "small type such an item as the following:

"'A perpendicular is let fall on a line BC "'so as to bisect it at the point C, etc., etc.'

". . . just as if it were the most ordinary "occurrence in the world. Every news-"paper man will see at once that it ought "to be set up thus:

"AWFUL CATASTROPHE.

"PERPENDICULAR FALLS HEADLONG ON A "GIVEN POINT.

"The Line at C said to be Completely "Bisected.

"President of the Line makes Statement.

"etc., etc., etc."

SHARE MARKET REPORT.

London, December 21st, 1915.

There has been very little business doing in the share market during the past month. The Dividend announcement of 5 per cent. Interim on the Ordinary shares, though favourably received, has not had any material effect on prices, which remain about the same. English (Marconi), Ordinary, £1 17s. 6d.; Preference, £1 13s. 9d.; American 15s. 3d.; Canadian, 5s. 6d.; International Marine, £1 5s.; Spanish and General Wireless Trust, 4s.

QUESTIONS AND ANSWERS

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor,* THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

We have to acknowledge receipt of numerous letters from correspondents in all parts of the world relating to the "Little Problem" published in our November issue. In nearly every case the answer sent has been the correct one (5/6ths of an ohm). We would refer our correspondents to the announcement on another page regarding the prize competition for the best problem.

H. L. (Rugby).—Many thanks for your exceedingly well-worked-out letter on the problems. We much regret that space will not permit us to publish it, owing to its length.

Cte. de la B. (Paris).—We are afraid that we cannot answer your question without further particulars concerning the aerial. There is one point, however, which may help you. With the condenser placed as at first, no *direct* current could flow from the wire to the earth. With the condenser in the second position there is a path for the direct current through the crystal and telephones to earth. It is possible that the singing of which you complain may be caused by a small direct current flowing from the telephone wire to the earth via the crystal and 'phones. If this is not the cause, please let us have a few more particulars of the aerial (length, form, whether it is parallel to other similar wires, etc.), and we will endeavour to help you.

W. S. H. (Leicester).—Your answer to the problem was correct. With reference to your question asking what is a rough-and-ready test for the efficiency of a relay, we do not know of any really rough-and-ready method. In the days of the coherer receiver each of the Marconi Co.'s relays for use with the coherer had to pass a test of working with one volt through 350,000 ohms, the resistance of the relay itself being 10,000 ohms. These, however, were not telephone relays. With regard to yours, so much depends on what you call efficiency. If you will let us know what you regard as efficiency we will endeavour to help you further.

We should be glad if "F. G. B." (Yarmouth), who was answered in the Christmas number, would communicate with us again.

J. L. (Blackheath).—The answer to your question is Yes, in the case of the wave-lengths given, provided that the coupling be suitably adjusted. Your detector circuit diagram is not a good one for the purpose, as it would not enable very sharp tuning to be obtained. A condenser should be shunted across the inductance. Sorry we cannot go into constructional details in war-time.

"DUBLIN" asks: (1) "From which direction do the signals come the loudest in a sloping aerial, say the free end pole is 40 feet and the receiving end 20 feet? Do they come loudest from the free end towards the receiver or is there much difference in strength when coming from any other direction?" (2) "In an induction coil connected to an oscillating or closed circuit with a condenser and spark-gap, does the secondary of the coil charge the condenser sufficiently to cause a spark to take place across the gap for every make and break of contact?" (3) "Is it known the duration of the oscillations during a single spark, or in other words, the duration of the spark? I presume it is regulated by the coupling, or is it possible to design an alternating machine of such high frequency so as to catch up on them?"

Answers.—(1) With an aerial of the form referred to by our correspondent signals would be received in greatest strength from the direction opposite to the free end. The longer the distance between the two poles (the heights remaining the same) the more pronounced would be the directional effect. (2) There is one spark every "break." The "make" is comparatively slow, owing to the self-induction of the primary, and only a low e.m.f. is created in the secondary, but the "break" is very rapid and the resulting sudden change of field in the secondary creates a high e.m.f., which enables the condenser to be charged to the full voltage, whereupon it discharges across the spark-gap. (3) From the way this question is worded it is evident that our correspondent is not very clear on the subject. The spark continues as long as the oscillations continue in the closed circuit. How long these continue depends on the frequency of the circuit and the damping. For example, in a closed circuit tuned to a 600 metre wave-length each oscillation will occupy one five-hundred thousandth of a second. If there are fifty oscillations before the spark is extinguished, the duration will be one ten-thousandth of a second. The number of oscillations will depend on the damping of the circuit. As tight coupling withdraws energy more rapidly from the closed circuit into the aerial than does loose coupling, in certain circumstances tightening the coupling may be said to reduce the duration of the spark. The last part of question (3) is not at all clear. A number of alternators have been designed which work with a frequency sufficiently high to be used directly for wireless telegraphy, but of course when such machines are used there is no need for a spark. The purpose of the spark is to release the charge in the condenser suddenly and create oscillations; if you have an alternator which in itself gives currents of an oscillatory frequency, it can be used directly on the aerial, the condenser circuit and spark gap being dispensed with.

J. de N. (The Hague).—Thanks for your letter and answer to problem. With regard to the query in the second half of your letter, we should be glad if you would write more fully stating clearly what you wish to know, and if possible giving references to the books from which the equations are taken, as so far we have been able to trace only one of these. We are pleased to hear that you like our magazine, and trust that in the future you will find it even more helpful.

Instructional Article

NEW SERIES (No. 5)

The following series, of which the article below forms the fifth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

The Circle.

(a) *Circumference.*

27. Take some circular body, say an ordinary glass tumbler, and a piece of string. Wind the string tightly round the top of the tumbler, and mark off in some way the length of string which just makes one turn. This length, say 9 in., will be approximately equal to the circumference of the top of the tumbler.

Next measure the diameter across the top and you will find that it is about $2\frac{3}{4}$ in., and so the ratio $\frac{\text{circumference}}{\text{diameter}}$ is $\frac{9}{2\frac{3}{4}}=3{\cdot}3$ (nearly).

Now, if you repeat this simple experiment with any circular body, you will always find that the ratio $\frac{\text{circumference}}{\text{diameter}}$ is rather greater than 3, and if the measurements are made with absolutely no error then the ration will always be 3·1417 .... This value is given a Greek symbol π (pi), and so the circumference of a circle equals $(\pi\times d)$, where d is the diameter. As $d=2r$, where r is the radius, we can put

$$\text{circumference}=\pi d$$
$$=\pi\times 2r=2\pi r.$$

EXAMPLE.

What length of wire is required to wind a coil of 100 turns on a former 3 in. in diameter ?

One turn of the coil would need (πd) inches of wire, or $(\pi\times 3)=3{\cdot}1417\times 3=9{\cdot}4251$ in.

Therefore 100 turns would require

$$100\times 9{\cdot}4251=942{\cdot}51 \text{ in.}$$

$$\text{This length}=\frac{942{\cdot}51}{12}=78{\cdot}54 \text{ ft.}$$

Thus 80 ft. of wire would be sufficient, this leaving about 9 in. to spare at each end of the winding.

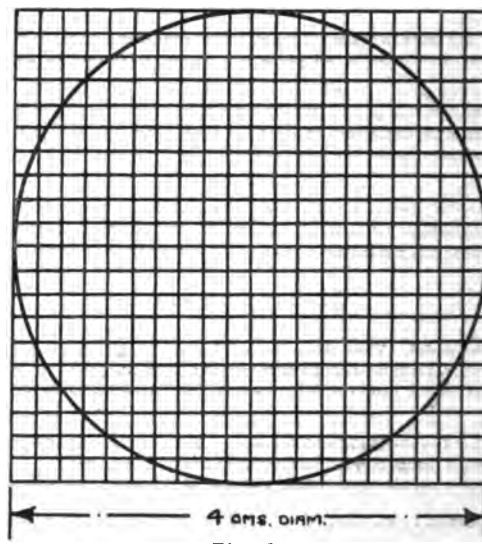


Fig. 6.

(b) *Area.*

28. A circle with a radius of 2 cms. is drawn upon squared paper (Fig. 6). The squares are each of 2 mm. sides, and so the area of each is $(0{\cdot}2\times 0{\cdot}2)=0{\cdot}04$ sq. *cms.*

On counting up all the squares and parts of squares enclosed by the circle, you will find that the total is about 308 squares, and so the area of the circle (being the number of squares multiplied by the area of each square) is $(308\times 0{\cdot}04)=12{\cdot}32$ sq. cms.

Now $(\text{radius})^2=r^2=(2)^2=4$, and so the ratio $\frac{\text{area}}{r^2}=\frac{12{\cdot}32}{4}=3{\cdot}08$.

If we had found the area with sufficient accuracy we should have got

$$\frac{\text{area}}{r^2}=3{\cdot}1417\ldots=\pi.$$

Now this is true for *any* circle, and so the area of a circle is equal to πr^2, or putting $\left(\frac{d}{2}\right)$ for r, area $=\pi \times \left(\frac{d}{2}\right)^2$

$$=\frac{\pi d^2}{4}=0{\cdot}7854d^2.$$

EXAMPLE.

A condenser is made up of two brass plates each 10 cms. in diameter, and placed 0·5 mm. apart in air. Find the capacity.

The capacity of two parallel plates of equal area, separated by air, equals

$$\frac{A}{4\pi t\times 9\times 10^5}\text{ mfds.,}$$

where A = area of each plate (sq. cms.) and t = distance apart (cms.).

$$\text{Now area}=\frac{\pi d^2}{4}=0{\cdot}7854(10)^2$$

$$=0{\cdot}7854\times 100=78{\cdot}54 \text{ sq. cms.}$$

$$t=0{\cdot}5\text{ mm.}=0{\cdot}05\text{ sq. cms.}$$

$$\text{Therefore capacity}=\left(\frac{78{\cdot}54}{4\pi\times 0{\cdot}05\times 9\times 10^5}\right)$$

$$=0{\cdot}00014\text{ mfds.}$$

29. Before leaving the subject of circles it will be as well to note the following formulæ:

(1) The area of the *curved* surface of a cylinder with radius r or diameter d is equal to the *circumference* of the base multiplied by the length of the cylinder, or $(\pi d\times l)=(2\pi rl)$.

(2) The volume of the above cylinder equals the *area* of the base multiplied by the length of the cylinder, or

$$(\pi r^2 l)=\left(\frac{\pi d^2 l}{4}\right).$$

(3) Volume of a sphere of radius r

$$\text{is }\frac{4}{3}\pi r^3=\frac{4}{3}\pi\left(\frac{d}{2}\right)^3=\frac{4}{3}\pi\frac{d^3}{8}=\frac{\pi d^3}{6}.$$

(4) Surface of the above sphere

$$=4\pi r^2=4\pi\left(\frac{d}{2}\right)^2=4\pi\frac{d^2}{4}=\pi d^2.$$

EXAMPLE.

If 1 cu. ft. of cast-iron weighs 450 lb., what must be the diameter of a ball to weigh 10 lb.?

1 cu. ft. = 1728 cu. in.

Thus, as 1728 cu. in. weigh 450 lb., a weight of 10 lb. would require a volume of

$$\left(\frac{10}{450}\times 1728\right)=\frac{1728}{45}\text{ cu. in.}$$

Let d inches be the diameter of the required ball.

Then volume of the ball (see above)

$$=\frac{\pi d^3}{6}=\frac{1728}{45}.$$

$$\text{Therefore }\pi d^3\times 45=6\times 1728$$

$$\text{or }d^3=\frac{6\times 1728}{45\times\pi}=\frac{2\times 576}{5\pi}=\frac{1152}{5\pi}.$$

Now log 5	$=0{\cdot}6990$
Log 3·1417	$=0{\cdot}4972$
Adding	$=\overline{1{\cdot}1962}=\log(5\pi)$
Log 1152	$=3{\cdot}0615$
Subtracting $\log(5\pi)$	$=1{\cdot}1962$
	$1{\cdot}8653=\log d^3$
Dividing by 3	$=0{\cdot}6218=\log d$
Therefore d	$=\text{antilog }0{\cdot}6218$
	$=4{\cdot}186$ in., say 4·2 in.

Measurement of Irregular Areas.

30. In later articles the subject of curve plotting will be dealt with, and we shall there see that an area such as ABCD (Fig. 7), contained by a curve AB, and the two perpendiculars AD and BC, taken to a base line, CD, will have a definite meaning. For instance, if AB was a curve showing the relation between force and distance moved, then the area ABCD would equal work done.

Now to find this area we can proceed as follows.

Divide DC into any suitable number of equal parts, say ten, and erect perpendiculars at each division point, thus dividing the whole area into ten strips of equal width.

Then, if we consider any one of these strips $pqrs$, we see that the area of the strip is equal to the base rs multiplied by

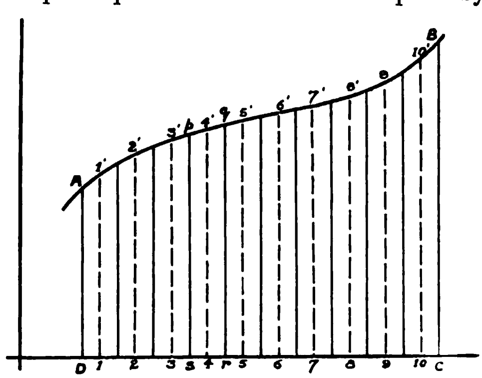


Fig. 7.

E

the *average*, or *mean height*. Now this mean height is obviously greater than ps and less than qr, and so *if we have made our strips so narrow that the pieces of curve across the tops are practically straight lines*, we can take the mean height as being the mean of ps and qr, or $\frac{ps+qr}{2}$.

The usual method of arriving at the mean height, however, is to draw a third vertical midway between r and s, and to take the length of this as the mean height of the strip. Thus the area of the strip $pqrs$ is equal to the base rs multiplied by the length of this central vertical, called the mean *ordinate*.

It is obvious that the total area ABCD equals the sum of the areas of all the separate strips, and so equals each particular base multiplied by each particular mean ordinate.

We can write this as:
(base 1×ordinate 1)+(base 2×ordinate 2)+(base 3×ordinate 3)+ . . . . +(base 10×ordinate 10).

As, however, base 1=base 2=base 3= . . . . . =base 10, the above expression simplifies down to:
(common base or width)×(ordinate 1+ordinate 2+ . . . . +ordinate 10) or area=(width of strips×total sum of all the mean ordinates).

In our particular example (Fig. 7) the common width=0·5 cms., and

ordinate	1.1′ = 2·55	cms.
,,	2.2′ = 2·82	,,
,,	3.3′ = 3·04	,,
,,	4.4′ = 3·19	,,
,,	5.5′ = 3·30	,,
,,	6.6′ = 3·41	,,
,,	7.7′ = 3·50	,,
,,	8.8′ = 3·64	,,
,,	9.9′ = 3·82	,,
,,	10.10′= 4·15	,,
	Total=33·42	,,

Thus, the total area is (0·5×33·42)=16·71 sq. cms.

31. This method can be adapted to measuring the area of a figure such as ABCF (Fig. 8).

By dividing the figure into strips as before, and using any convenient line, ED, as a base line, we can find firstly the area, ABCDE, and, secondly, the area, AFCDE.

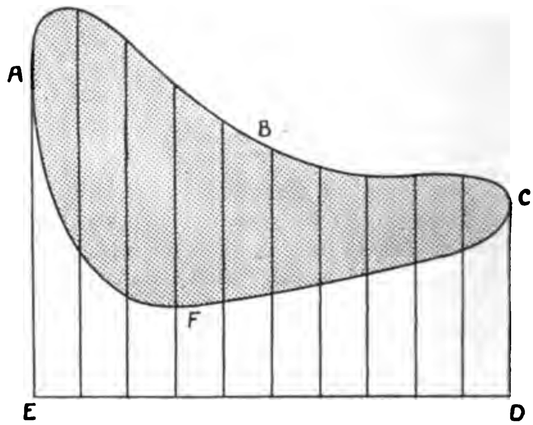


Fig. 8.

By subtracting the latter from the former we have left the area of the figure ABCF.

It must be remembered that the accuracy of this and the following method is dependent on the figures being divided up into a sufficiently great number of strips for the pieces of curve across the tops of the strips to be very approximately straight lines. The greater the number of the strips, the more accurate will be the final result.

Simpson's Rule.

32. Taking a similar area to that in the last case, we first of all draw two *parallel tangents* AB and CD at the extremities of the figure (Fig. 9). A tangent is a line which just touches a curve without cutting it. In this case the tangent AB runs along the left-hand end of the figure between the points a_1 and b_1, and so a_1b_1 is the *first ordinate.* Similarly the *last ordinate* is $a_{11}b_{11}$.

The mid points of a_1b_1 and $a_{11}b_{11}$ are next joined by a straight line XY, and XY is then divided up into any suitable *even* number of parts—in this case ten. Ordinates a_2b_2, a_3b_3, etc., are drawn through the points of division along XY.

By Simpson's Rule the area of the figure is obtained as follows:

Add together the first ordinate, the last ordinate, twice the sum of all the other odd ordinates, and four times the sum of all the even ordinates; multiply this sum by one-third of the common (perpendicular) distance between the adjacent ordinates.

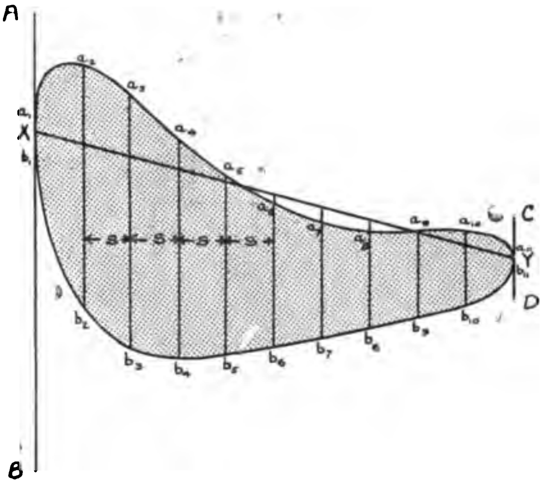


Fig. 9.

Thus, in our case, the area is

$$\{a_1b_1+a_{11}b_{11}+2(a_3b_3+a_5b_5+a_7b_7+a_9b_9)+4(a_2b_2+a_4b_4+a_6b_6+a_8b_8+a_{10}b_{10})\}\frac{S}{3}$$

Now $a_1b_1=0{\cdot}16$ in.	$a_7b_7=0{\cdot}48$ in.
$a_2b_2=1{\cdot}02$,,	$a_8b_8=0{\cdot}41$,,
$a_3b_3=1{\cdot}06$,,	$a_9b_9=0{\cdot}36$,,
$a_4b_4=0{\cdot}91$,,	$a_{10}b_{10}=0{\cdot}33$,,
$a_5b_5=0{\cdot}75$,,	$a_{11}b_{11}=0{\cdot}03$,,
$a_6b_6=0{\cdot}60$,,	$S=0{\cdot}20$,,

From this, area

$$=\{0{\cdot}16+0{\cdot}03+2(1{\cdot}06+0{\cdot}75+0{\cdot}48+0{\cdot}36)+4(1{\cdot}02+0{\cdot}91+0{\cdot}60+0{\cdot}41+0{\cdot}33)\}\frac{0{\cdot}20}{3}$$

$$=\{0{\cdot}19+2(2{\cdot}65)+4(3{\cdot}27)\}\frac{0{\cdot}20}{3}$$

$$=(0{\cdot}19+5{\cdot}30+13{\cdot}08)\frac{0{\cdot}20}{3}$$

$$=\frac{18{\cdot}57\times0{\cdot}20}{3}=6{\cdot}19\times0{\cdot}20=\underline{1{\cdot}238 \text{ sq. in.}}$$

33. To divide a straight line into any number of equal parts we can use the following simple construction.

Let us divide the line AB (Fig. 10) into seven equal parts.

First, draw any convenient line AC from the point A, and along it, starting from A, mark off seven equal parts of any suitable length. This can be done either with a pair of compasses or with a ruler. Let A*a*, *ab*, *bc*, *cd*, *de*, *ef*, *f*C be these seven parts.

Join CB, and through *a*, *b*, *c*, *d*, *e*, and *f*, draw aa^1, bb^1, cc^1, dd^1, ee^1, ff^1, parallel to CB, and cutting AB at a^1, b^1, c^1, d^1, e^1, and f^1.

Then the line AB will be divided into seven equal parts Aa^1, a^1b^1, b^1c^1, c^1d^1, d^1e^1, e^1f^1, and f^1B.

Right-Angled Triangles.

34. A right-angled triangle is a triangle one angle of which is a right angle. ABC (Fig. 11) is a right-angled triangle, in which the angle ABC is the right angle.

Let us construct squares on each of the three sides AB, BC, and CA. Now AB=0·55 in., BC=1 in., CA=1·14 in.

Area of square on $AB=(AB)^2=(0{\cdot}55)^2=0{\cdot}3025$ sq. in.

Area of square on $BC=(BC)^2=(1)^2=1{\cdot}0000$ sq. in.

Area of square on $CA=(CA)^2=(1{\cdot}14)^2=1{\cdot}2996$ sq. in.

You will see that the square on AB *plus* the square on BC (0·3025+1·0=1·3025 sq. in.) very nearly equals the square on CA (1·2996 sq. in.). Indeed, if our measurements had been sufficiently exact the two values would have been exactly equal. Thus $AB^2+BC^2=CA^2$.

If this is tried with *any* right angled triangle it will *always* be found that the sum of the squares of the two sides which *include* the right angle is equal to the square of the side *opposite* the right angle.

It will be easily understood that if two sides of *any* right-angled triangle be known, the third side can always be calculated.

Example.

What length of wire would be needed to stretch from a window 6 ft. above the ground level to the top of a 40-ft. pole, which is 30 ft. away from the house ?

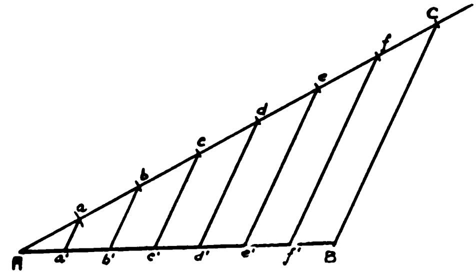


Fig. 10.

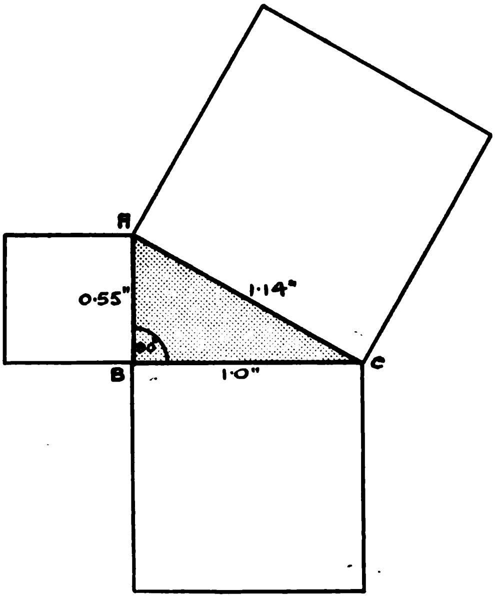


Fig. 11.

In the diagram (Fig. 12) draw, at the 6-ft. window level, a horizontal line, CB, to a point, B, on the pole. Then if A is the pulley at the top of the pole

$$AB=(40-6)=34 \text{ ft.}$$

Also BC=30 ft., and angle ABC is a right angle.

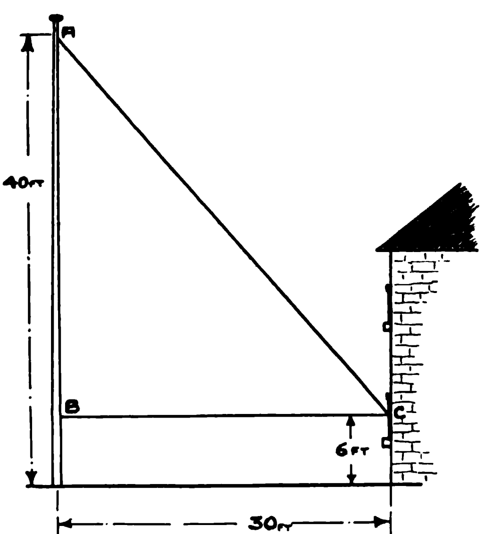


Fig. 12.

$$\text{Thus } AC^2 = (AB)^2+(BC)^2$$
$$= (34)^2+(30)^2$$
$$= 1156+900$$
$$= 2056.$$

Therefore $AC=\sqrt{2056}=45{\cdot}34$ ft., say $45\frac{1}{3}$ ft. or 45 ft. 4 in.

PRO BONO PUBLICO.

Some Further Notes.

Sergeant Wissaerts.

In the Christmas number we gave some short accounts of the heroic efforts of certain members of the Belgian Marconi Company. We are now enabled to give particulars of two more brave men belonging to the same company—Sergeant G. T. Wissaerts and Sergeant F. Befahy. Both these gentlemen were telegraphists in the Belgian Company's service when war broke out. When their country was dragged into the war they were called up for active service and have been doing their share continuously ever since. We offer them our best wishes for their continued safety.

Sergeant Befahy.

The LIBRARY TABLE

"WIRELESS TIME SIGNALS." London: E. & F. N. Spon, Ltd. 3s. 6d. net.

Appearing as it does at a time when all time-signal wireless work and experimentation is in a state of suspended animation, this little volume—the authorised translation of the French official handbook, *Réception des Signaux Radiotélégraphiques par la Tour Eiffel*—will not have the ready sale which would have been its lot had it appeared in the smiling days of peace, but nevertheless we are sure many will purchase and study it in preparation for the happier days which are to come.

Chapter I. is devoted to a description of receiving apparatus and how it can be simply constructed for the reception of signals from the Eiffel Tower. The circuits described are of simple design and free from complications likely to confuse the new student. One or two points in the text call for comment, such as the translation of the word "commutateur" on page 19 as "commutator" instead of "switch." A bad error, too, is made in translating "L'absence d'organe de réglage de la différence de potentiel" as "The absence of an *induction coil* for regulating the potential difference" (page 16). These points will doubtless be corrected in a future edition.

The remainder of the book is devoted to particulars of the signals themselves, and calculations arising therefrom. The translators have added some useful appendices to the original work, that including a vocabulary being very helpful to the amateur unacquainted with the French language. When peace is proclaimed and aerials again rear their masts into the air, we are sure many listeners will find this volume of great assistance in their work. Meanwhile, we think that the publishers might have added a little note to the effect that none of the constructional work described may be undertaken during the war, as it is conceivable that some purchasers, unacquainted with all the provisions of the Defence of the Realm Act, might commence to erect the simple apparatus referred to. The note might take the form of a small gummed slip.

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"ALL ABOUT FLYING." By Gertrude Bacon. London, 1915: Methuen & Co., Ltd. 1s. net.

The science of aeronautics in peace time forms as interesting a study or hobby as it is possible to conceive. More particularly is this statement true at the present time, when half the civilized world is engaged in deadly combat. The little book under review forms one of Messrs. Methuen's "sport" series, and the information given in so small a compass is just what those superficially interested in flying want to know. Its title would seem at first glance to be a little presumptuous, but from the non-technical standpoint there is very little more that could be said. Miss Bacon has evidently devoted a considerable amount of time and energy in producing it. She does, however, devote one chapter to the power unit, in which she explains briefly the engine and other apparatus necessary for the propulsion of the machine. Her last chapter is devoted to a comparison of flying in peace and war, and it is in this latter that the mention of the application of wireless telegraphy to aircraft occurs.

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"A TREATISE ON THE THEORY OF ALTERNATING CURRENTS." (Second Edition.) By Alexander Russell, M.A., D.Sc., M.I.E.E. Cambridge: The University Press. 15s. net.

Whilst the practical side of alternating current work is receiving increasing attention from technical writers, the theoretical aspect is not being neglected, as is evidenced by the appearance of this volume. Of a purely theoretical nature, it assumes that the student is already acquainted with the elementary theory of electricity and magnetism, and has a working knowledge of trigonometry and the elements of the calculus. Electricians and students interested in the application of high frequency currents to wireless telegraphy will find Chapter VII. of interest, for in it the author has discussed high frequency currents at length. A brief *résumé* of the theory of two coupled oscillation circuits is also given in Chapter IX. The five hundred or more pages of the book are well filled with important and useful matter, and will doubtless afford much pleasure and instruction to those who have proceeded somewhat further in electrical studies than the students of elementary classes.

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"THE MYSTERY OF THE GREEN RAY." (Second Edition.) By William Le Queux. London, 1915: Hodder & Stoughton. 2s. net.

The name of the author of this book forms a recommendation to his works in itself, and the fact that the book is already in its second edition aptly bears out the justice of this statement. The basic facts of the story, as might be judged from a knowledge of the author, are concerned with espionage and refer to the present war. The principal figure and his friends are introduced to the reader during a holiday boating trip on the Thames at the time of the outbreak of war. This news causes his friends to abandon their trip and return to London bent upon enlisting. The hero before enlistment proceeds to Scotland to bid good-bye to his fiancée, and whilst on the Scotch express comes into contact with a man purporting to be an American who owns a large house within a mile or two of the residence of the fiancée's father. This girl with her friend roves over the mountains one day and at a particular bend in the stream is suddenly struck blind. Investigations point to the fact that the American owner of the house close by is responsible for this, and it is assumed that by some wireless agency he is able to produce a bright green flash which blinds those who see it. Another remarkable fact ascribed to these wireless waves is the withdrawal of its life-giving properties from the air, and in this connection the hero very nearly loses his life. It subsequently transpires that the American and various accomplices were German spies sent to establish a submarine base in one of the lochs of the Western Scottish coast. To those interested in wireless the book should make a thrilling appeal, and we commend it to all who revel in exciting adventure.

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"RELATIVITY AND THE ELECTRON THEORY." By E. Cunningham, M.A. London: Longmans, Green & Co. 4s. net.

This book is one of the excellent series of Monographs on Physics which Messrs. Longmans are publishing, and forms a companion volume to *The Spectroscopy of the Extreme Ultra-Violet*, recently reviewed in these columns. As its title suggests, it is a volume dealing with advanced physics, and as such will, we are afraid, make little appeal to many of our readers, but to those who have already mastered the elementary stages of the science we do not doubt it will afford much interesting reading. In Chapter I. the author in a very clear manner introduces his subject, and in subsequent chapters treats of the Origin of the Principle of Relativity, The Relativity of Space and Time, Mechanics and the Principle of Relativity, Relativity and the Objective Aether, and other matters. The book contains much of interest to the advanced wireless student, as it deals with the Aether and the difficulties which have arisen in endeavouring to arrive at a proper conception of its properties.

* * *

"BRAZIL AND THE BRAZILIANS." By G. J. Bruce. London, 1914: Methuen & Co., Ltd. 7s. 6d. net.

Of all the countries of the South American Continent Brazil probably possesses the largest resources and the biggest commercial possibilities. The exploration and definition of the interior proceeds apace, and every year witnesses the formation of new towns and settlements according to the importance of the neighbourhood. The author glances briefly into the history of the country, gives a description of the Indian Aborigines and the civilized Brazilians, touches upon politics and laws, makes short reviews of the States, and deals generally but more fully with the natural resources of the land from a commercial standpoint. He describes the inhabitants as "a people reaching out." Many of them have already reached out, and wireless telegraphy has been brought into use in order to keep them in touch with the more populous districts. Radiotelegraphic stations are springing up all over the South American Continent in increasingly large numbers, and their utility is proved by the eagerness with which the prospectors of unknown lands desire outfits. In a vast territory like Brazil the commercial use of wireless is not overlooked. And this is due to the impracticability of laying cables through the dense tropical forests and the wide marshy expanses of land. To those interested in the commercial application of radiotelegraphy the book should prove of unending interest and we can heartily recommend it.

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"SPECIFICATION AND DESIGN OF DYNAMO-ELECTRIC MACHINERY." By Miles Walker, M.A., M.I.E.E. London: Longmans, Green & Co. 32s. net.

The purpose of this volume is well explained in the Preface, where the author points out that there appeared to be no book of precedents of electrical specifications analagous to the famous "Conveyancing Precedents," compiled by Prideaux, which are so widely used by lawyers; and it occurred to him that such a book would be of some use to those engineers who have from time to time to draw up specifications for the purchase of electrical machinery. Professor Miles Walker is to be congratulated on his achievement in producing this book, for it is a volume of more than six hundred large pages filled with information, diagrams, and illustrations of the greatest value to all who have to do with the specification of such machines. The book is divided into two parts, the first dealing with short rules for use in the design of dynamo-electric machinery, and the second with the specification and the design to meet the specification. At the conclusion the author introduces an index of the clauses in the specification together with a carefully compiled general index.

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"A TEXT-BOOK ON PRACTICAL MATHEMATICS FOR ADVANCED TECHNICAL STUDENTS." By H. Leslie Mann, B.Sc., A.R.C.Sc. London: Longmans, Green & Co. 7s. 6d. net.

As lecturer in advanced practical mathematics at the Woolwich Polytechnic, the author of this book is in a good position to appreciate the difficulties which confront the average student of mathematics, and to know the chief points upon which to lay emphasis when teaching the subject. Based upon some of the work done by the senior students at the institute above referred to, the volume before us assumes in the reader a knowledge of the fundamental principles of Algebra, Trigonometry, Mensuration, and the use of Logarithms and squared paper. It is the intention of the author that the book should cover a two- or three-years' course and he has divided it into three sections, the first being devoted to Algebra and Trigonometry, the second to the Differential and Integral Calculus, and the third to the application of the subject-matter of the two previous sections to concrete examples. Numerous examples, carefully chosen in accordance with the text, are provided wherever the need for them has shown itself, and should prove of great assistance to the student. The book is well printed and will doubtless be welcomed by many teachers and students.

Foreign and Colonial Notes

Guatemala.

It was announced recently in the United States Navy Department that congratulatory messages had been exchanged between the President of the United States and the President of Guatemala in celebration of the opening of the new high-power radio station at Guatemala City, and referred to in our Christmas Double Number.

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Japan.

A new regulation came into force in Japan on November 1st last by means of which radio telegraphic apparatus may, subject to a licence being first obtained, be installed by private persons outside the State Telegraph and Telephone area in vessels and on aircraft. Up to the present no one, other than officials, has been permitted to set up or work any wireless apparatus in that country. It may be noted also that licences may be obtained by persons who take experiments in wireless telegraphy.

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Oceania.

A high-power wireless station has been erected on Ocean Island in the Pacific Ocean, which is a spot of some considerable importance. It lies almost on the equator and about 2,400 miles due north of New Zealand. It possesses a wonderfully rich deposit of phosphate, a native population of about 450, in addition to some hundreds of native labourers engaged in recovering the phosphate, and 50 white men who act as overseers and engineers.

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Paraguay.

A wireless station has been erected at Asuncion, the capital of Paraguay, constituting the second military zone. It was opened to public service at the beginning of October.

Portuguese East Africa.

A wireless station has been opened at Lourenço Marques, and it is interesting to learn that the cost of its erection was borne by the Union of South Africa as a return for certain services rendered by Portugal. It is able to receive messages up to a distance of nine hundred miles, whilst its transmitting range is nearly one hundred miles.

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Straits Settlements.

It is learnt that a wireless telegraph station has just been erected for public service at Singapore.

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Sweden.

Our contemporary, the *Morning Post*, in its issue of November 19th, prints a message from Stockholm regarding a wireless telephonic invention, by means of which messages may be transmitted from trains and automobiles travelling at the highest speed. The simply constructed apparatus forms the invention of two Swedish army officers, and in one instance, it is alleged, messages were intelligibly received from a distance of over 700 miles.

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United States.

The well-known inventor, Mr. Thomas A. Edison, recently made a trip out to sea on board the *Mayflower*. Whilst undertaking this voyage Mr. Edison desired to communicate with the new high-power station at Arlington. He sent the following message to Captain Bullard, the chief of the United States Naval Radio Service :—" Congratulations on your big Arlington plant. I have heard the small and large sets, seated in the wireless room of the *Mayflower*, and they are great." After a short delay the following reply was flashed back :—" My compliments to Mr. Edison and the Naval Advisory Board, by this message, transmitted on the 100 k.w. spark set."

The contractors have begun work on the installation of wireless telegraph apparatus at the Navy Department building. This will place the station at Arlington, and all other naval wireless stations, in direct communication with the bureau of operations through which all the movements of the fleet are directed. Five sets will be placed on the roof of the building, and that number of operators will be able to receive all the messages which come into Arlington from the vessels of the fleet, and also from numerous wireless stations. Also five separate short distance sending sets will allow the Navy Department to communicate without interrupting the work of the Arlington station.

* * *

The value of wireless telegraphy has been recognised very considerably. We understand that if the private telephone line, built by the Empire Gas and Electric Company, U.S.A., and connecting its six plants, is put out of commission by storms or other causes, two, and eventually all, of the stations will be able to communicate by radio telegraphy. Several employees of the company have become proficient in the use of wireless apparatus in an amateur way and others, it appears, will be instructed.

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At the "Electrical Prosperity Week" celebrations which took place in the United States from November 29th to December 4th last an interesting spectacular feature was the showing by wireless on a miniature scale of the manœuvres of a battleship, a facsimile of a submarine, an aerial battle, and various high-frequency electrical discharge features of a nature to interest the public. The whole thing was the climax of a gigantic and unprecedented advertising campaign.

* * *

It is interesting to record that the wireless operator at the Great Lakes, Illinois, wireless station recently distinctly heard one of the new stations in Japan, which was about 5,000 miles distant, talking to Kokoa Head station in the Hawaiian Islands. To eliminate any doubt upon the efficiency of the new wireless station at Great Lakes, the Japanese message was transcribed word for word.

Uruguay.

The *South American Journal*, in its issue of November 13th, states that the Uruguayan Government have under consideration a proposal for the erection of a high-power wireless station similar to that projected in Argentina.

COMPANY NOTES.

MARCONI'S WIRELESS TELEGRAPH COMPANY, LTD.

THE Directors of Marconi's Wireless Telegraph Co., Ltd., have issued the following circular:

"DEAR SIR (OR MADAM),—The Directors "regret that they have not yet been able to "obtain from Government Departments a "basis of settlement in respect of either "remuneration or compensation for services "rendered, for the use of their stations since "the commencement of the war, nor in "respect of other matters in which the "Government is indebted to the Company.

"However, without taking into account "the considerable sums which are estimated "to be due to the Company in respect of "these matters, the business which has been "actually completed for the current year "has been satisfactory, and the Directors, "without departing from the policy, which "was approved at the last General Meeting, "of husbanding their resources, feel justi- "fied in declaring the 7 per cent. Prefer- "ential Dividend upon the Cumulative "Participating Preference Shares, and an "Interim Dividend of 5 per cent. on the "Ordinary Shares.

"Warrants for the Dividends upon the "registered shares will be forwarded by "post on the evening of January 31st next.

"Notice will be given in due course, by "advertisement in newspapers in London, "Italy, Montreal, Buenos Aires, and the "United States, regarding the deposit of "coupons for the payment of Dividends on "Bearer Shares."

THE MARCONI INTERNATIONAL MARINE COMMUNICATION CO., LTD.

The Directors have declared an interim dividend of 5 per cent., equal to one shilling per share, less income tax, on account of the current year, payable on February 1st next to shareholders registered at December 24th.

PERSONAL PARAGRAPHS.

Hearty felicitations to Warrant Telegraphist Eric Sharp on his marriage. Mr. Sharp has for some time been engaged on Admiralty duty, and has been in the thick of the Gallipoli fighting as well as in other places. Prior to joining the Forces, Mr. Sharp had considerable experience as an operator on board ship, having joined the Marconi Company some five years ago. We trust the happy couple will have a long and prosperous life.

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Mr. W. G. Martin, who at the outbreak of war was Chief Instructor in the Marconi Company's London School, has received the following letter from Sapper Holmes, of the Wireless Signalling Section of the Royal Engineers, British Mediterranean Expeditionary Force. Sapper Holmes was for some time a student in the London School, and had only just passed his Postmaster-General's Examination, gaining a First-Class Certificate, when the war broke out and he was called up for service in the Territorials, to which he already belonged. The numerous members of the Marconi Company's Operating Staff who studied in the school with Sapper Holmes will, no doubt, be interested to hear of his adventures, and so we reproduce the letter practically in full.

"I must apologise for not communicating with "any members of the Marconi School staff since I "left in August, 1914. Whilst I was in England I "did not think it was necessary, but as I am now on "the Gallipoli Peninsula, and have been here for "the last eight weeks, I take the liberty of writing "you as being the most likely person to remember "me. If you remember, I had to leave the school "on mobilisation, as I was in the Territorial Royal "Engineers. I came and saw you about last "January, and had then joined the above Signal "Company in order that I might not get out of "touch with wireless, etc. We left England on "22nd May, and, after a brief stay in Egypt, were "sent to General Headquarters. I was a member "of a pack set, and our instruments are the standard Marconi field sets of ½ kw. They are used "with pack horses, and have proved very reliable "indeed, even when used as permanent stations. "My section was engaged in the landing on August 6th, 1915, and we had to erect and work "under fire from the very beginning. I was "slightly wounded about a quarter of an hour after "landing which was done, by the way, at 4 a.m. in "the semi-daylight. The bullet cut a mark about "2 in. long on my back, and, after being bandaged "up, I was able to take my turn at operating without any inconvenience.

"We are acting as a flanking station, and keep up "communication with the ships and the shore "during bombardment, etc. This is the eighth "week we have been here, and are safely established in a dug-out quite out of harm's way "although shells come over pretty well every day. "I am the only original operator left out of our "pack, and we have been reinforced with five "operators at various times, and each one in turn "has gone sick after a few days with us.

"We work ship's watches with three operators— "a sailor, a new man from England and myself. "The flies are simply terrible, due, no doubt, to "the close proximity of dead bodies, the firing line "being roughly two miles away.

"Trusting that you are in excellent health, and "with my kind regards,

"I am, Sir,

"Yours, etc.,

"(Sgd.) C. F. HOLMES."