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THE INTERNATIONAL RADIOTELEGRAPH CONVENTION OF WASHINGTON, 1927

An Account of the Proceedings at the International Radiotelegraphic Conference, by

COMMANDER J. A. SLEE, C.B.E., R.N. (Retd.)

The Institution of Electrical Engineers has as Chairman of its Wireless Section this year, Commander J. A. Slee, C.B.E., R.N. (Retired), Assistant General Manager of the Marconi International Marine Communication Co., Limited.

Commander Slee's opening address to the Wireless Section delivered on the 7th November last dealt with the proceedings at the International Radiotelegraphic Conference held at Washington in the autumn of last year, at which he was one of the representatives of the Marconi International Marine Communication Co., Limited.

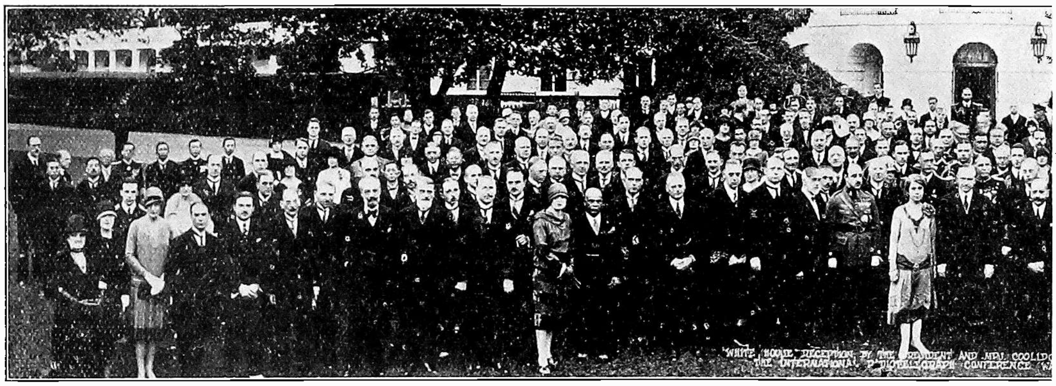
As the result of intensive committee work and the spirit of earnest goodwill which animated all the delegates, international agreement was reached on very many important questions affecting the art of wireless communication, and the decisions arrived at were incorporated in the document now known as the Radiotelegraph Convention of Washington, 1927, the signatures of all the official delegates being appended thereto.

As the Convention comes into effect on the 1st January, 1929, Commander Slee's address, which explains its import, is very opportune, and by the courtesy of the Institution of Electrical Engineers is therefore given in full below.

I FEEL that perhaps it may be of interest to all those concerned with wireless if I say a few words on the recent International Radiotelegraphic Conference of Washington. I should like to divide my remarks into three sections, discussing in turn, what a Radiotelegraphic Conference is, how its work was carried out, and what effect the proposals of the Conference will have when they come into effect as the Radiotelegraph Convention of Washington, 1927.

Conferences prior to 1912.

In the infancy of wireless there were, practically speaking, no national rules, and no international agreements whatever. The Government did not assume control of wireless until 1904. Moreover, in those days, which now seem so dim



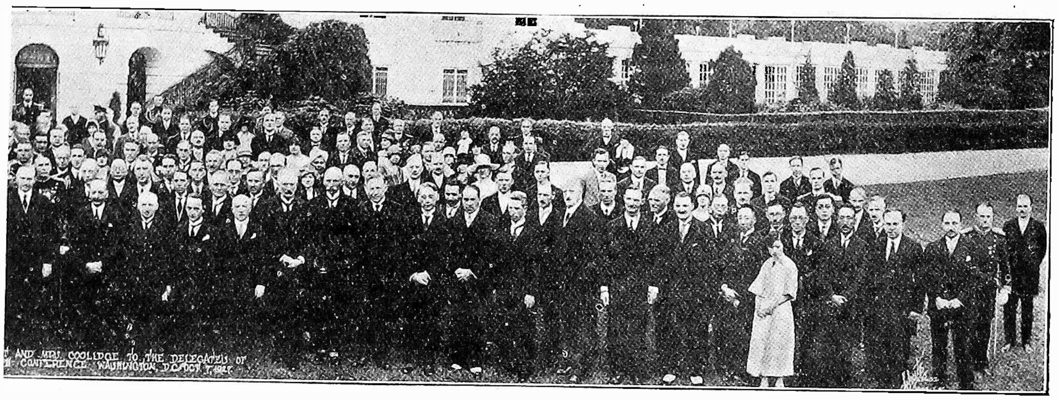
and distant, practically the whole application of wireless consisted of ship to ship and ship to shore communication. Long distance working and working between fixed points were almost unknown. As the communications between ships increased in quantity and importance, and especially as the great value of wireless as an instrument for increasing the safety of life at sea became more fully recognised, the necessity was felt for some international agreement, especially with regard to safety of life at sea questions. As a result of this feeling a meeting was summoned in Berlin in 1903. As some nations were not then in a position to issue regulations, the main work of this meeting was to prepare proposals for a subsequent assembly, which was the International Radiotelegraphic Conference of Berlin, and was held in 1906. There are some gentlemen still intimately connected with wireless who took part in these original discussions.

Perhaps the most striking decision reached at Berlin resulted in the abolition of the "no-intercommunication" principles which had grown up. This was the birth of the principle that wireless is a universal, as opposed to a private, means of communication between the inhabitants of the world.

London Conference, 1912.

The Convention of 1906 was followed by the Conference of 1912 in London, at which was produced the document known as the Radiotelegraphic Convention of London, 1912. This carried on the work of the 1906 Convention, keeping to much the same general ideas, for with the exception of Clifton and Glace Bay Trans-Atlantic Service very little progress had actually been made in long distance communication and in point to point working.

This Convention was almost exclusively concerned with ship work, and with "spark" as a means of signalling. The Poulsen Arc had appeared and was in very limited use, and experiments had been carried out with wireless telephony. The standard detector was a crystal—carborundum was only just coming into use, and the magnetic detector was in common use in most ships. There were very few valves, no air services, and no broadcasting. The wireless interests were strictly professional; amateur experimenters were very few, and the general public took only the faintest interest in the matter.



In such conditions the Convention of 1912 was worked out, and the arrangements then made have formed the basis on which all ship work is still carried out. Accustomed as we are to think of the technical side of the subject, we must not forget that the original object of installing wireless in ships was to earn a revenue, and the methods of conducting the truly international accounts—for ships and coast stations of all nations take part in this service—which were settled in 1912 remain almost without alteration to this day.

In passing, it may be interesting to note that the word "Radiotelegraphy" was adopted for international use at the 1912 meeting.

In 1912 it was decided that Radiotelegraphic Conferences should be held at five-year intervals, and that the next meeting should be at Washington in 1917.

But in 1917 the world was plunged in the war, and wireless arrangements could only exist between allies.

Effect of the War on Wireless Communication.

During the war the advance in the technical side of wireless was remarkable; the wholesale introduction of the three-electrode valve revolutionising both transmission and reception.

The development of valves, especially for reception, was extraordinarily rapid, and the use of amplifiers, then for the first time available, put a fresh complexion on the whole use of wireless from a warlike point of view, for, in addition to the enormous increase in the distance at which signals could be received, the use of amplifiers made direction finding a practicable proposition. The introduction of transmitting valves threw open the door to wireless telephony, first of extended use for aircraft, and now in daily and world-wide employment for broadcasting.

The effect of these enormous strides was felt in the warlike organisation of the time, and elaborate inter-allied agreements were worked out and made use of during the war, but these were in essence the very reverse of "International" in spirit.

After the end of hostilities it was clearly necessary to bring all nations together again to recommence the series of international conferences, but in addition to the difficulties of rearranging the old Convention so as to bring it into line with the vast technical improvements made in the interval, there remained the diplomatic problem of getting the nations so recently and so bitterly at war to meet in friendly discussion on so thorny a subject. The technical improvements of the war and the time immediately after it had given stations a world-wide range and world-wide powers of interference, so that there was every prospect of acute differences arising between rival claimants for the wavelengths necessary to carry on the wireless communications of the world.

In many countries, certainly in this country, expert committees were kept in almost constant session, trying to solve these most difficult points. Schemes were prepared, which displayed the most remarkable ingenuity, for the division of the globe into sections in which various wavelengths could be used with appropriate powers, the shorter waves, which were to be used by the lower power stations, being repeated at suitable distances.

Washington Conference, 1923.

In 1923 an inter-allied committee was got together in Washington for the purpose of working out some document which could be circulated to the world as a basis of truly international discussion. This meeting used the old war-time inter-allied arrangement as a foundation from which to start, and in due course the result of their labours was circulated, and with it an invitation to all nations to attend at an International Radiotelegraphic Conference as soon as it could be arranged. Again every nation set up committees to consider this draft, which was generally called the "green book," and finally government rejoinders were forwarded to Washington, where the original "green book" with all the remarks and counter proposals, and explanations of all the 74 states likely to be represented, were printed together and circulated for further discussion under the name of the "brown book."

Thus, some kind of agreement was worked out, so to speak, by correspondence, but during the whole period the difficulty and complexity of the subject was added to by the rapid growth of the Broadcasting Service, and the enormous weight of public opinion which it carried, especially in the United States, and to a slightly less extent in this country. In a word, the old professional wireless services—Naval, Military, Air Force, Post Office and Commercial—found themselves being elbowed out of the ether by the demands of this vigorous new claimant for a share in the available wavelengths.

Then, as a final complication, just as the ponderous documents which I have sketched out were beginning to produce some kind of probable concord, came the reintroduction of short waves, topped up by the appearance of the beam system which only proved itself to be a truly practical proposition a few months before the Conference assembled.

Washington Conference, 1927.

We now can appreciate the conditions under which the Conference of 1927 assembled at Washington. There were delegates from 74 governments, speaking 52 languages. The subject to be discussed had changed out of all recognition since the last fully international meeting, and the elaborate and laborious preparations had undergone a great change in perspective—due to the recent triumph in short wave work. On top of this lay the fact that the administrative side of the proposals opened up a wide cleavage of view, due to the fundamental differences between the constitutional powers of the U.S. Government with regard to the regulations which it could enforce on its subjects, and the powers of most of the European States. The Government of Canada is in nearly the same position in this respect as that of the United States. To these must be added the claims and desires of commercial companies and the Broadcasting Union, and a certain soreness between some of the nations—not necessarily on subjects connected with wireless. There is no wonder then that some at least of the 400 delegates and representatives thought that yet another postponement was more probable than an agreement.

Sub-Committees of the Conference.

The Conference, consisting only of official delegates from the various countries, met and drew up rules of working, dividing the work into sections under eleven committees. It was also decided that the representatives of the Wireless Companies and other wireless interests, who had been invited to be present, might attend the main and committee meetings, and address the meetings by permission of the Chairman, but that they had no voting powers.

The great changes which had taken place in the subject made the distribution of work among the committees difficult, but by goodwill and give and take the matter was straightened out, either by handing over parts of the work from one committee to another, or by joint meetings of two or more committees.

These formal committees split up into somewhat less formal sub-committees and in many cases these were further divided, there being no other hope of carrying the work through in any reasonable time.

This fine distribution of work made it necessary for each of the maritime countries to be represented simultaneously in several rooms, and the daily working hours of all members of the delegations became very long.

Even this sub-division was not adequate to the task of finding a path through the intricacies of proposal and counter proposal, especially those concerning the allocation of waves to the various services, and the regulations for the conduct of ship communications. It is worth while recalling the fact that the first of these had always presented the most grave difficulties, which had just been redoubled by the sudden appearance of short waves, and that the latter had formed the bulk of all previous Conventions.

Language difficulty.

In order to get on, the sub-committees were still further split up, small coteries meeting after dinner, as there was no other time available to discuss detail and prepare papers which the more formal bodies higher up in the scale might study and discuss. These small meetings ranged from about ten members down to two, and in many cases the language difficulty was solved by producing papers in parallel columns in French and English. There was one small detail which caused a lot of bother for the first week or so—the difficulty of drawing a clear distinction between the advisory and mandatory sense when using the French conditional sense. The most intricate of the subjects dealt with, that of the distribution of wavelengths below 100 metres, was worked out by a small party which remained in being for some weeks and finally became known as the " Kilocycle Club."

The language question was settled as follows. Volunteers from among the delegates, and the representatives of private companies, were appointed as "Rapporteurs" to the various committees and sub-committees which had any formal existence. It was the duty of these gentlemen to act as secretary and as interpreter. The official language was French, as is usual at these meetings, and any delegate who so wished might ask for a translation into English, and any speech made in English was translated into French as a matter of routine. The drafts of all minutes embodying the proposals of the various gatherings were agreed at the next meeting and handed by the "Rapporteur" to the Drafting Committee, which was responsible for cleaning them up into correct French and into the literary style of the rest of the work.

The way in which these gentlemen performed their work was truly admirable. Technical discussions, involving long and complicated arguments, entirely impromptu, were translated instantly and tersely from one language to the other, and I do not think that any speaker ever had cause to complain of inaccuracy, or lack of appreciation, of the points of his arguments.

In the smaller and less formal meetings the Chairman himself usually did any necessary interpreting, and we were indeed fortunate in finding enough gentlemen with an expert knowledge of the appropriate branch of the subject, and sometimes as many as three European languages, to conduct these intimate and vital discussions.

Final draft of Regulations.

Work was carried out in this way for about six weeks, a steady progress being maintained in sub-committee with but little to show for it on the surface, and then began the period of sub-committees reporting to committees and committees reporting to plenary sessions. The apparent progress during this period was very rapid, and a stranger attending one of the later plenary sessions might have thought that important regulations were being rushed through with indecent haste, but the discussions had all taken place outside, and a real agreement had been reached. The only detail requiring careful scrutiny at this stage was the exact drafting of those paragraphs which embodied the work of two or more committees.

Particular care was necessary in the exact wording of the administrative regulations, in order that the largest possible number should be acceptable as they stood to the United States and other countries whose constitutional position differed materially from that of the bulk of the European States. This object was achieved in a most satisfactory manner, none of the Convention proper, and only a very small proportion of the regulations being left in an appendix which only a small number of governments were unable to sign. It should not be thought that those countries which found themselves compelled to abstain from signing the whole document did so on account of any disagreement with the letter or spirit of the article in question. Abstention was only due to the legal inability of these states to undertake to enforce regulations which were outside their constitutional powers.

Throughout all the long preliminary discussions, and during the Conference itself, the government officials had at their disposal, and made free use of, the services of the representatives of the Commercial Wireless Companies. The most cordial relationship existed, and the closest co-operation took place. At many of the smaller sub-committees—that is to say, during the most complicated negotiations of detail—there were almost as many unofficial members, consisting of representatives of commercial companies, as there were national delegates. Indeed, in some few instances it was difficult to say in which capacity individuals were sitting, as some nations had to delegate temporarily the national voice to the representative of a commercial company, in order that enough people might be available to attend the large number of simultaneous sub-committees.

This, I think, will give an outline of the work which goes to the making of an International Radiotelegraphic Convention, and to the methods by which an International Conference can arrive at an agreement, even on such a complicated subject.

International Convention, 1927.

Turning now to the provisions of the Convention itself, we find that it consists of a short formal Convention, properly so called, consisting of 24 articles, couched in the broadest possible terms, in which the governments concerned bind themselves to work together and to enforce the regulations attached to the Convention, and to repress illicit work. It also sets up the principle of arbitration in case of disagreement, and restates the former principles of priority for distress messages from ships and of general inter-communication between ships.

Then follow the Regulations which are enforced under the Convention—34 in all as now printed. In order that the discussions might be kept to some kind of framework, the numbering of old articles was adhered to, with new articles interposed. As a consequence, the arrangement of articles, and the distribution of the matter which they contain, are perhaps capable of improvement, but all who were present at the discussions know that it would have been quite impracticable to carry the re-arrangement of the articles any further than has now been done.

The technical side of the regulations is based on the idea that, there are certain wireless services carried out by stations distinguished by the corresponding name, and that types of emission shall be classified and their uses controlled according to this classification. The " Wireless Services " are " Fixed," " Mobile," " Broadcasting " and " Special," the names being self-explanatory, except with regard to Special Services, which include Time Signals, Direction Finding, Standardised Waves, etc., and might perhaps have been better called " Miscellaneous Services." A generous allocation of the shorter waves is also made to amateurs for experimental purposes.

Subdivision of Wavelengths.

Waves are divided, in fact, into four clasess, viz., A1, A2, A3 and B, and for all practical purposes these may be interpreted into ordinary colloquial language as Continuous Waves, Interrrupted Continuous Waves, Telephony, and Spark. Technically speaking Article 5 is the core of the matter, as it lays down the wavelengths to be used for the various services, and goes as far as is possible in the direction of discouraging the use of spark. Almost any person could produce a corresponding Article which would please some interest better than Article 5 ; indeed, I suppose it may be said that every country and interest represented at Washington was prepared with a detailed proposal on this subject, but the point to be remembered is that all of these different interests gladly accepted this article as a workable basis on which the wireless work of the world could be carried out.

In this, as in several other closely detailed regulations, it was necessary to use wording which would prevent lawless and unneighbourly practices, but which would not close the door to future progress along lines as yet unforeseen, and, where possible, to provide for a certain amount of flexibility so that future contingencies might be met without the necessity for summoning a special Conference to rectify the wording chosen by that held at Washington.

Designation of Wavelengths in terms of Frequency.

The Convention agreed to the introduction of the practice of designating waves by their frequencies, expressed in kilocycles per second, but no very great progress has yet been made in this direction.

Distribution of Wavelengths.

The distribution of waves among the different services is a remarkable piece of work. In a word, every service clamoured for about half the available waves, and so far as short waves were concerned, there was not much firmly established data to go upon. The tact and patience displayed by all concerned is beyond praise, and by the time the proposals reached the Technical Committee there was not a single dissentient voice.

Very nearly the whole of the remainder of the regulations deal with the Mobile Services. The position with regard to the Fixed Services is comparatively simple. The regulations admit, as a general principle, of one wave being allocated to one station. To that wave the station must keep within very narrow limits, and so long as it keeps within those limits there are no restrictions. The Administrations—that is, the Government Departments concerned—are responsible that suitable waves are allotted, and once a station is granted a licence to work on a certain wave the station is left free to make the best use that it can of the privilege.

Ship and Aircraft Stations.

With mobile stations the reverse is the case. There are a huge number of ship stations—about 12,000—all moving about. They must all be able to get into touch with one another or with the land. They represent many nationalities and use as many languages and as many coinages. Although fixed stations have the power to produce world wide interference, unless properly regulated by international agreement, yet the mobile stations must be capable of world wide and truly international inter-communication. Hence the volume of detail regulations.

The men who work the stations must be up to a high standard of competence, otherwise one incompetent man may obstruct the communication of several ships, perhaps for hours. Apparatus must be kept up to a definite state of efficiency. Hours of watch must be arranged. There must be an international code of signalling and of procedure. Accounts which are to be rendered in many languages and using many currencies must be standardised in form.

Above and through all this ride the regulations made in the interests of Safety of Life at Sea, for wireless has proved itself time and again to be a most potent agent in improving the chances after a casualty, as well as in the prevention of casualties. The ship service must thus be regulated so as to provide for the best touch between ship and ship and between ships and the shore, for in this way, both the safety of life at sea and the convenience of the average ship are best served, and, in addition, there is the numerically small but important class of great liners which keep up a heavy stream of traffic of the private affairs of their passengers. Other lines of communication have to be opened for the benefit of such craft, and all the regulations governing all these complex matters must be truly international in character, clear, binding, and yet flexible enough to permit of unforeseen contingencies being encountered and satisfactorily dealt with.

Detailed as these regulations are, there are yet finer distinctions required, and these are kept in being by statements as to individual practice now in use, which are published in the International List of Radiotelegraph Stations, commonly called the " Berne List."

The regulations applicable to aircraft are similar in principle to those for the control of ship working. So far, there is no regular exploitation of commercial communications to and from aircraft, but no doubt such a series will come into being when long distance flights become frequent. There is no opportunity for a commercial telegraph service while flights last for only a few hours.

The detail regulations as to the procedure to be followed in the case of ships in distress, and for the handling of other urgent navigational messages, represent the result of the accumulated experience of years.

After the regulations proper appear numerous appendices, which support the regulations in a more detailed fashion. They include a remarkable table of authorised abbreviations which are known all over the seven seas, and are used so much by the senior telegraphists in everyday life that some of them have developed into a kind of slang.

Finally, the book is completed by the additional regulations (7 in number) nearly all dealing with the details of accountancy, which certain states were unable to sign, for the reasons previously mentioned.

Summary.

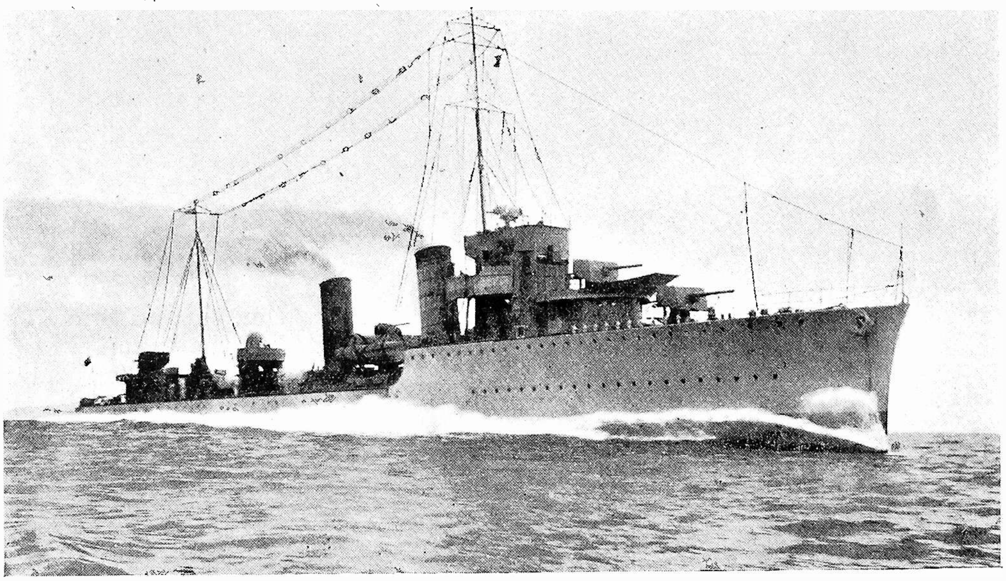
Taking a broad view of the whole of the Convention and its regulations, and trying to look into the future for a few years, we may say that the Convention will have the effect of regularising existing practices without fixing them so firmly that progress will be impeded. So far as is possible, without inflicting an intolerable hardship on the shipping world, progress will be accelerated in the direction of the reduction of the interference caused to other services by the Mobile Service. There will be a general reduction in interference, brought about by a more scientific use of the means of communication now available, and above all the foundations have now been firmly laid for a series of similar international meetings, at which there will be less to be done at one blow, and fewer conflicting requirements to be satisfied, and from which real improvements in the international wireless arrangements can be looked forward to with confidence.

This, I think will give a fair idea of the Radiotelegraphic Convention of Washington, 1927. As far as is consistent with brevity I have tried to explain its origin, its production and its aims. I feel that it is in every way a remarkable and important document, most of all from the point of view of international peace and goodwill. The evolution of a perfectly agreed document, by no means vague or lacking in detail, from such a mass of proposals and counter proposals, often directly opposed in principle as well as in detail, after so long a period of intensive progress and so soon after active hostilities, seems to me to be a veritable triumph for diplomacy and the happiest augury for future international understanding.

THE CHILIAN DESTROYERS "SERRANO" AND "ORELLA"

The destroyers ordered by the Chilian Government, and now being constructed by Messrs. J. I. Thornycroft & Co., Ltd., at Southampton, are fitted with wireless equipment supplied by the Marconi Company. The apparatus is comprehensive and of the latest design, and the whole installation represents a very efficient and modern equipment.

THE Chilian destroyers "Serrano" and "Orella," which have recently successfully completed their wireless equipment acceptance trials, are fitted with Marconi apparatus of the latest type.



These trials mentioned above were carried out under severe working conditions in harbour and at sea. Good communication was maintained with Lisbon and Chelmsford throughout the tests.

The photograph shows the destroyer "Orella" at sea, her aerial equipment being clearly indicated.

AN EJECTOR UNIT FOR DUPLEX WORKING WITH THE R.G.18 AND 19 RECEIVERS

When simultaneous reception and transmission have to be practised in the same locality, some form of circuit is necessary for use with the receiver to eliminate the powerful field set up by the neighbouring transmitter.

In the November issue of the "Marconi Review" an account was given of the R.G.18 and 19 receivers, which are coming into general use for Naval Service. The instrument here described is an ejector unit specially designed to be used with these receivers, for use on board ship where receiver and transmitter are in close proximity. The efficiency of the instrument is such that a frequency separation of 20 per cent. is quite sufficient to enable signals to be received while the main transmitter is in use.

THIS ejector unit has been designed to enable duplex working to be carried out with certain types of ship installation, especially where an R.G.19 Receiver is used in conjunction with a type T.N.1 Transmitter.

The apparatus renders possible reception on the receiver when the main transmitter is in use.

Two examples may serve to demonstrate the capabilities of the instrument under severe practical conditions.

With 10 amperes in the transmitting aerial (which was tuned to 300 metres), under which conditions 150 milliamperes were found to be induced in the receiving aerial, 2LO on 361 metres could be received on a loud speaker with no interference from the local transmitter.

Again, with the receiver tuned to 600 metres, and the transmitter being keyed on a wavelength of 700 metres (15 per cent. wavelength separation), with 18 amperes in the transmitting aerial, the coast stations FFB (Boulogne) and OST (Ostend) were always perfectly readable at Chelmsford.

The arrangement of aerials under which this test was carried out is shown in Fig. 1, and it will be appreciated that these conditions represent the most severe that are likely to be met with in practice.

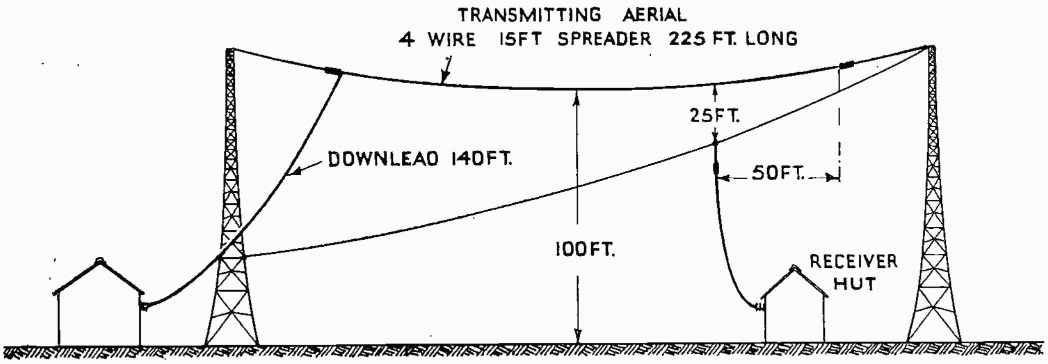


FIG. 1.

A simplified diagram of the connections of the ejector is shown below (Fig. 2), from which it will be seen that the instrument consists of two units inserted between the receiving aerial and the receiver.

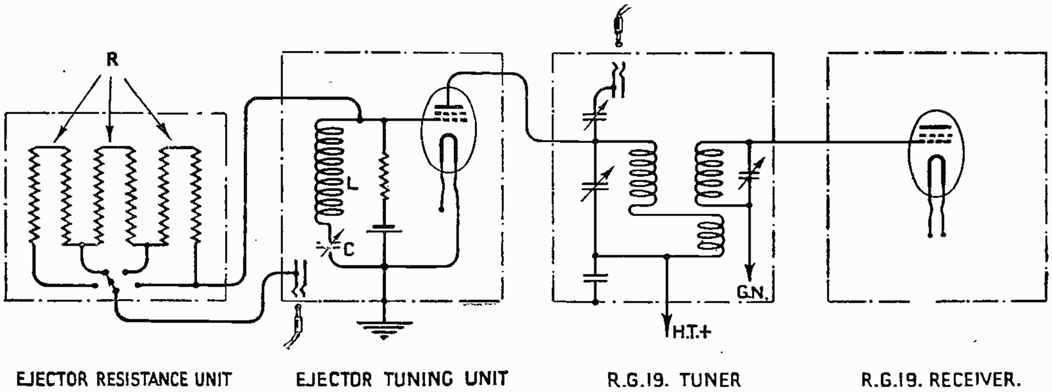


FIG. 2.

The ejector tuning unit will be seen to utilise an S.625 Valve. For duplex working the aerial is connected to the grid circuit (LC) of the tuning unit via the resistance unit R. The tuning range of this grid circuit is 300-4,000 metres, which covers the waveranges of all the types of transmitters with which it is intended for use. The anode circuit of the ejector valve is what corresponds to the aerial circuit of the R.G.19 in simplex working. It is therefore tunable over the receiver waverange.

Now if the circuit LC be tuned to the transmitter wavelength, it will possess a very low impedance to this wavelength. Hence the voltage set up by the transmitter signal will be very small. To all other wavelengths, however, the circuit LC will offer a high impedance, and a high voltage will be impressed on the grid of the ejector valve. The receiver, being tuned to the frequency of the desired signal, will amplify these voltages in the normal manner.

The ejector resistance unit is necessary for various reasons, one of which is to limit in certain cases the currents induced by the local transmitter.

The change from simplex to duplex working is effected by the simple process of removing the insulated aerial plug from the receiving tuning unit and inserting it into the ejector tuning unit.

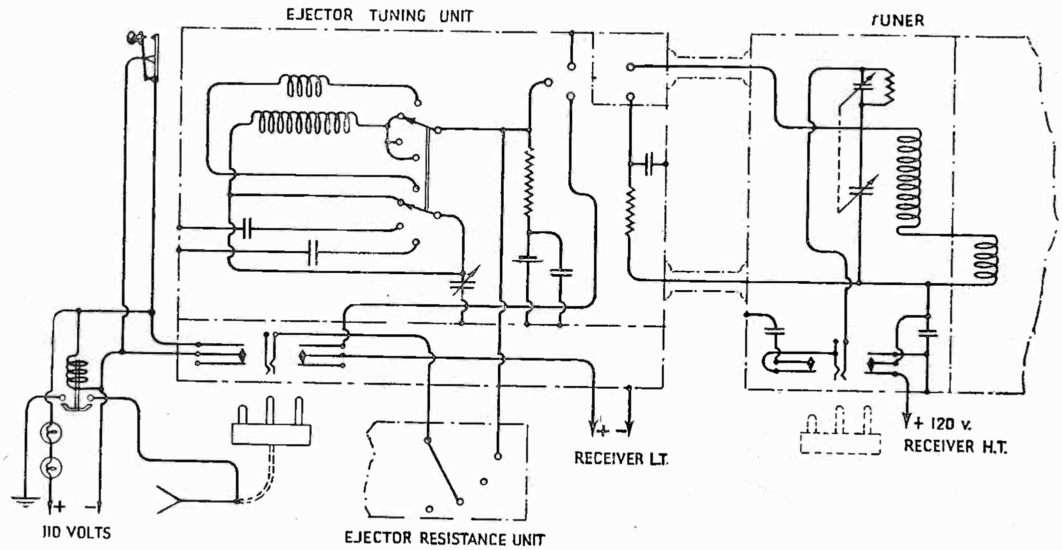


FIG. 3.

In Fig 3 is shown the complete diagram of connections, and it will be seen that the above operation effects the following changes :—

(1) The aerial is disconnected from the first circuit of the R.G.19 tuner, and this circuit is blocked off from earth.

(2) High Tension is switched through to this circuit.

(3) The capacity of the aerial is replaced by a condenser so that the calibration is unaltered.

(4) The ejector valve filament lights.

(5) The aerial is connected to the ejector circuit.

(6) The listening through relay, which earths the aerial when the main transmitter is keyed under simplex, is rendered inoperative.

In considering the effect of the ejector resistance unit, we see that the impedance offered by the circuit LC to the incoming local transmitter signal is r, the ohmic resistance of the coil, for the total impedance.

$$Z = \sqrt{r^2 + \left(Lw - \frac{1}{Cw}\right)^2}$$

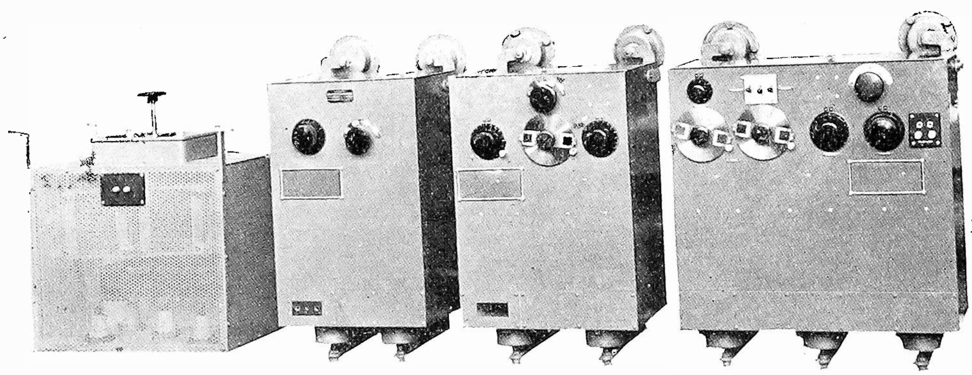
Hence if $w^2 = \frac{1}{LC}$

$$Z = r$$

Now, if the transmitter is inducing a current I into the receiver aerial, the voltage set up across the ejector valve grid will be

$$V = rI$$

There will be a limiting value for this voltage, beyond which the signal cannot be cut out. The value of r is fixed and so it may be necessary to reduce I, which can be done by increasing the value of R in the ejector resistance unit.



It will be found necessary for any given conditions to increase the ejector resistance R with the wavelength of the local transmitter.

In the illustration given above the resistance unit is shown on the left and is made of robust construction owing to the fact that it has to dissipate a large amount of energy picked up by the receiver aerial from the transmitter. The second unit comprises the ejector tuner circuit and the third and fourth units are the tuner and amplifier of the R.G.19.

MARCONI NAVAL TRANSMITTERS

Type T.N.1.

The exacting requirements demanded from all wireless apparatus on board warships have resulted in the design of a complete series of Naval Transmitters for use on all types of naval vessels.

The power of these sets varies from 50 watts to the aerial to 4 kilowatts, and they are arranged for transmission on either C.W. or I.C.W.

The most important features of the transmitters are—

(1) *Robust construction.*

(2) *Simplicity of operation.*

(3) *Large Wave Range.*

(4) *Flexibility of power.*

(5) *Constancy of wavelength.*

(6) *Safety in operation.*

A detailed account of the T.N.1 transmitter which possesses many points of interest in its design is given below.

THE type T.N.1 Transmitter has been designed as a moderate power compact unit with a particularly easy control, and a considerable waverange transmission can be effected on C.W. or I.C.W. over the whole of the wavelength range of 300 to 3,000 metres with a power of 3 kilowatts to the magnifier anode. The various combinations of condensers and inductances, I.C.W., note control, etc., are operated from the front panel of the transmitter, together with suitable interlocks to prevent accidental damage when under power. Here also are the instruments necessary to read the various filament voltages, feed currents, and high tension voltage. There are two separate A.C. single phase supplies to the set ; one for lighting the valve filaments, and the other for power.

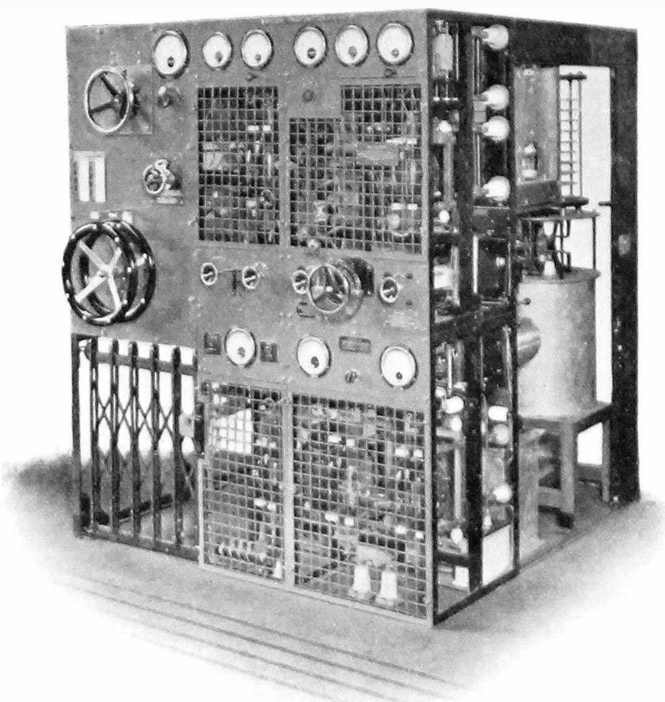
Power to the transmitter under keying conditions is very constant, since the absorber method of keying is employed. The grid positive potential for the absorber, and the grid negative bias for the magnifier valve, are obtained from another but smaller machine.

The valves, of which there are five in number, are all visible and replaceable from the front of the panel, being protected by metal screens. The removal of any one of these screens immediately shuts off the power. Sliding gates enable access to be obtained for inspection purposes, the power being similarly removed when the gates are opened.

In order to study the transmitter in detail, its various circuits may be classified under four heads, as follows :—

(1) The rectifying system.
(2) The drive or master oscillator.
(3) The magnifier and aerial high frequency gear.
(4) The absorber.

Taking these in the order mentioned above :—



1.—The Rectifying System.

A single phase 500-cycle 350-volt supply from the main alternator is connected through a power relay to the primary of the power transformer—housed in the transmitter—and is then transformed up to approximately 20 kilowatts. Thus there is a potential difference of 10 kilowatts between the centre point of the secondary which is earthed, and the ends of the secondary which are connected respectively to the anodes of the two rectifying valves (M.R.7.A.'s), each of which becomes alternatively conductive for each half cycle. This maintains the smoothing system to which the valve filaments are connected at a potential of 10 kilowatts. The smoothing system consists of an oil-cooled low frequency choke shunted to earth on either side by a large capacity condenser. High tension D.C. is thus available, capable of easily maintaining a normal output of 450 milliamperes. The smoothing condensers are automatically discharged when the power is cut off, through a megohm leak, which serves also as a voltmeter resistance. In addition, a hand-operated shorting device is fitted.

2.—The Drive.

The drive or master oscillator controls the wavelength and energy transferred to the magnifier circuit. It is so designed that a simple four-position switch mounted on the front of the set, makes all the adjustments to the high frequency circuits to cover the whole range from 300 to 3,000 metres the adjustment of the fine graduations of wavelengths being effected by means of a calibrated control, also on the front of the set, which operates a variable condenser. The switch is so connected that a change of position not only adjusts the coil tappings, but enables a variable oil or air condenser to be used alternatively with a long or short wave inductance. It also has a mechanical lock which only allows the circuit to be broken by the switch at a given point where an electrical contact opens the power relay, thus rendering the circuits "dead." All the inductance coils are arranged astatically to prevent extraneous coupling due to stray field. The high tension supply to the drive oscillator valve—an M.T.6—is reduced to a suitable value by a series resistance. This resistance also serves as the absorber resistance in the anode of the absorber valve.

3.—Magnifier Valve and Aerial High Frequency Circuit.

This valve serves to amplify the oscillations set up on its grid by virtue of the drive coupling. Since, however, the anode of this valve is supplied with high tension D.C., it would—but for the neutrodyne condenser—oscillate due to its own self-capacity on some part of the wave-band. The function of this neutrodyne condenser is to set up an equal and opposite balancing voltage—the "bridge" circuit thus formed being shown in the diagram below.

A pure grid swing provided by the drive oscillator is therefore obtained and is then superimposed on a steady applied negative potential. The neutrodyne condenser adjustment, once found, needs no alteration for change in wavelength. The aerial system is a direct load on the magnifier valve, and, as it is tuned to the drive, will oscillate at the same wavelength. This is a great advantage where there are likely to be fluctuations in the aerial constants due to aerial swinging, as no change in the radiated wavelength can take place. The anode feed current of the magnifier

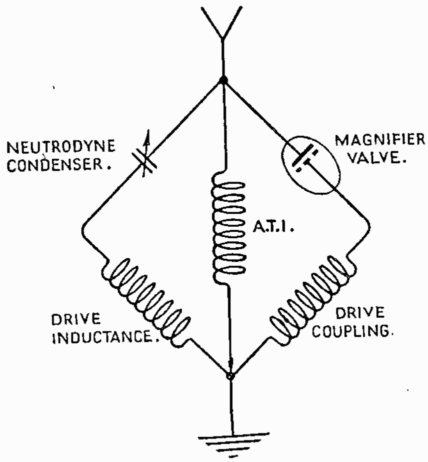


FIG. 1.

valve for normal position of anode tap should be approximately 300 milliamperes at 10,000 volts. At this power the valve anode will be heated to a bright "red," the normal temperature for this type of valve. A three-position selector switch enables any desired adjustment of tap to be obtained. A combination of fine and coarse inductance taps controlled by two rotary switches, which also insert aerial series condensers, with a drum type variometer, makes it possible to tune to any desired wavelength. The rotary switches automatically cut out the unused sections of aerial inductance, preventing undue high frequency losses and voltage strain. An aerial current indicator is situated adjacent to these aerial adjustment controls on the front of the panel. A mechanical device registers the number of variometer turns in use, and special spring-buffers prevent the drum being rotated beyond its limit. To obtain I.C.W. a motor driven interrupter makes and breaks the grid leak and applied negative potential circuit of the magnifier valve at a speed depending upon the note required. The valve ceases to oscillate during the "break" period, but is restored to a normal oscillating condition when the circuit is again completed. A tapped motor field resistance allows variation of motor and interrupter speed. Normally three note frequencies are available—600, 900 and 1,200.

4.—The Absorber.

The absorber valve plays the part of a switch, instantly transferring the load to the absorber system when not required in the high frequency circuits and vice versa. This is accomplished by means of a relay operated by the manipulating key, which reverses the potential on the grid of the valve. Thus, when the key is closed, the grid is made highly negative, the valve becomes non-conductive, and the load passes to the transmitting circuits. When the key is opened the grid becomes positive, the valve highly conductive, and the load is absorbed by the absorber resistance, which is adjusted so that the load is approximately equal to the transmitting load. Actually this resistance serves the dual purpose of absorber and drive valve anode resistances, thus ensuring a very clean cut off of aerial energy when the key is opened. The grid potentials required for the absorber and magnifier valves are obtained from a potentiometer having an earthed centre-point, and excited by a small generator. An aerial calibration chart is supplied which gives the actual adjustments for every 100 metres. These adjustments vary with the aerial in use, and the figures are therefore logged when the set is installed. An overload relay is provided, and is adjustable from the front of the set. Filament transformers, with variable resistances for adjusting individual filament voltages, are mounted on the panel. The entire set, with the exception of the machines and switchboard, is 5 ft. wide, 5 ft. deep, and 7 ft. high overall.

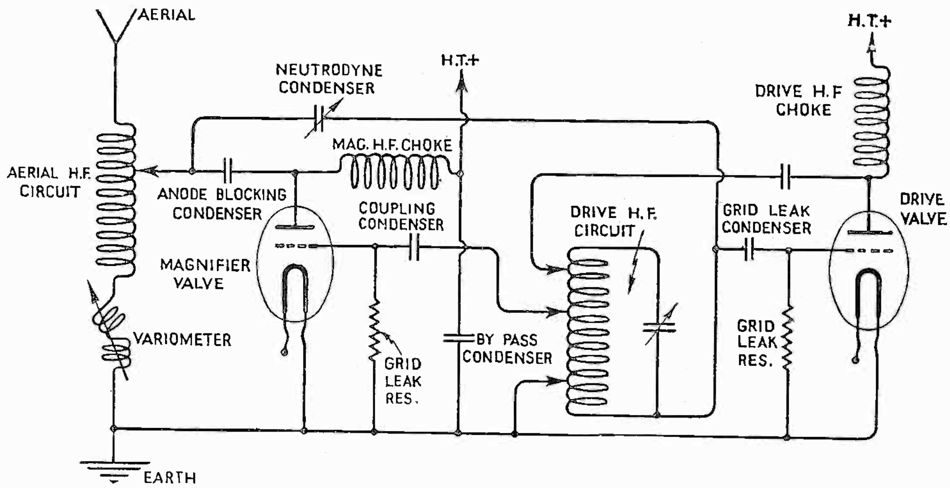


FIG. 2.

All machines are started by push button controls, the motors being usually designed to run on the standard ship's mains, with a total input of 9 to 10 kilowatts. With the regulator provided for the power alternator it is possible to obtain very fine regulation, from maximum power down to about 1/60th full power, the regulator being of the potentiometer type.

A suitable switchboard carries the necessary switches, meters and fuses for power, lighting, grid potentials and relay circuits. The machine regulators are also mounted here, the whole occupying only a small space.

A much simplified diagram of the high frequency circuits is shown above (FIG. 2).

SHORT DISTANCE COMMUNICATION—II.

The Development and Performance of the S.A.1. Set.

In the October issue of the " Marconi Review " a technical description was given of a 7-8 metre combined transmitter and receiver—the S.A.1 set.

As both the receiver and transmitter are of unusual design, it was thought that an account of the development of the circuits employed would be of interest.

With a view to establishing authentic transmission range records, many range trials have been carried out with the S.A.1 set, and a detailed account of some of these are given in the following article, from which it will be seen that the apparatus is of a very dependable nature, and gives excellent results, and its guaranteed range is easily obtainable.

It has been stated, in the case of the S.A.1 set, that as a general performance, using a half wave aerial, distances of 8 miles for Telegraphy and 6 miles for Telephony could be covered, whilst for the quarter wavelength aerial the figures were respectively 4 and 3 miles.

The difficulty of developing a set using frequencies of the order of 40,000 kilocycles to give a *guaranteed* performance such as is given above, can only be really appreciated by those who have undertaken a similar task. When it is considered that, in addition, this equipment has been developed for use by non-skilled personnel, and that the main essential before the designers has been the production of a set with the minimum of " knobs," the performance obtained becomes remarkable.

Without doubt, the S.A.1 set has no parallel in ease of working and adjustment, and the amazing facility with which the guaranteed ranges can be obtained by personnel with absolutely no prior knowledge of the apparatus places the set in the forefront of Military Equipments.

It is safe to state that the evolution of the set has demanded a series of building up tests which have far exceeded in time and number those of any kindred type of equipment.

The Development of the Circuits.

The possibility of the use of ultra-short wavelengths for military purposes was first conceived at the beginning of 1925. At that time the Marconi Company had developed the 6 metres revolving Beam as an aid to marine navigation, and it was principally from the success attending the use of this Beam system that the idea emanated of using similar circuits for military communications.

Throughout 1925 development work was carried out at Croydon, and by November of that year the first experimental model had been completed; the circuits finally adopted embodied all the technical characteristics of the Beam transmitter and receiver, suitably modified for military purposes, and with the addition of Telephony.

Before, however, the equipment was placed on the market a complete series of range trials were carried out to determine exactly what performance could be expected under varying conditions of locality, screening, &c.

In general, the scheme adopted for these range trials was to place the transmitter at some predetermined position, and then to explore the surrounding terrain in all directions, carefully noting the effects of various distances and localities on quality, strength of signals, etc.

During these range trials a large number of demonstrations were given to various authorities, and in each and every case the results obtained were consistently good, and confirmed that in the S.A.1 set the Marconi Company had evolved an equipment which could be guaranteed to give 100 per cent. communication over the specified ranges at all times of the day and night, and in any locality.

Range Trials carried out near Croydon.

The locality in the neighbourhood of Croydon was especially suitable for carrying out tests of this nature, since, in certain directions, there are heavily wooded parts, in others, high ridges, and in others, localities completely covered with all forms of buildings.

A very great number of trials was carried out from time to time here, but the results may be summed up as follows:—

In whatever locality around Croydon the sets were tested on every occasion—whatever the screening, either due to trees, land or buildings—a range of 5 miles for telephony and 7 miles for telegraphy was obtained with ease, using half wave aerials at each end. As an example, it may be mentioned that on one occasion, when the car containing the " out " station was being repaired *inside* a galvanised iron garage, excellent communication was maintained over a range of 4 miles. In this instance the aerial was completely screened by a metal sheet within a few feet.

Ultimate ranges could not be worked in the direction of London, due to the difficulty of working in crowded city streets, but Fig. 1 shows the ground covered during the final trials.

The first position was in a small roadside clearing completely covered by trees, and with a high wire fence on one side. There was no overhead room to rig the aerial upright, but even with the aerial lying on the ground, signals, both on telegraphy and telephony were perfectly readable.

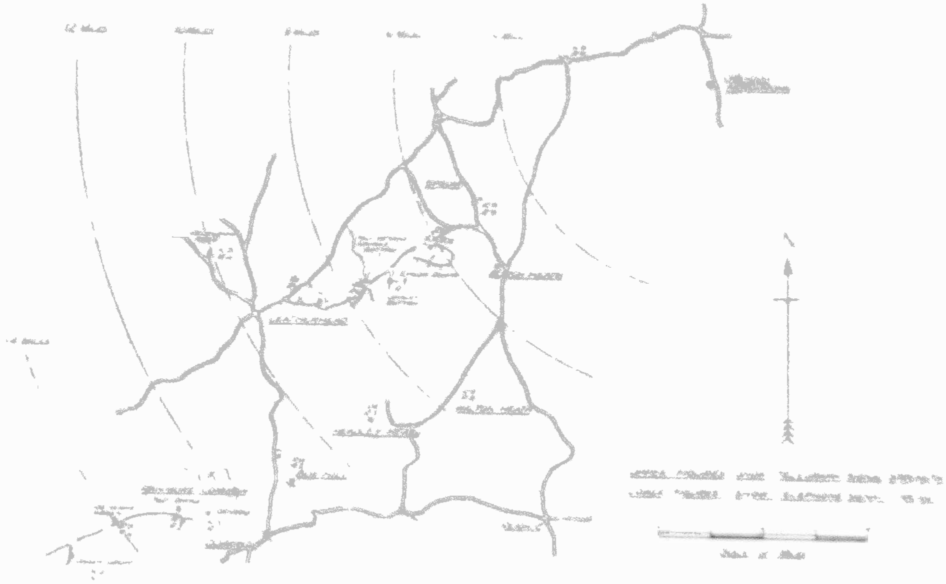


FIG. 1. S.A.1. *Range Trials around Croydon Aerodrome.*

In the next position, in a small wood just before commencing the climb to Epsom Downs, signals were R9. On Epsom Downs, which is high ground and 6½ miles from the transmitter, signals were very strong. The next position explored was the heavily wooded valley at Langley Bolton (7½ miles), and here speech was unintelligible and Morse R3. On mounting the hill beyond the valley (8 miles) signals were again loud and clear, both speech and telegraphy.

It is interesting to note that on one occasion at this spot a loud speaker was used direct with the receiver, and Morse signals could be clearly read at 44 yards from the receiver, and telephony 25 yards.

Approaching Leatherhead a deep valley is reached. Here signals were only just audible, but about half a mile further L. W. signals were R5 and easily readable, speech being R4.

The next point was the top of Box Hill (11 miles). Telegraph signals were readable at strength R4, speech being only 50 per cent. intelligible. At a later date a further trial was made at practically the same position but near trees, and no signals could be obtained. Two hundred yards away, in a clearing among the trees, signals were obtained R3.

At Ranmore Common (13 miles) telegraph signals were R3, whilst at the Post Office, half a mile further, signals had increased to R5, speech being R3-4.

At Dog Kennel Green (14 miles) signals were about the same strength, and dropping down into the valley here, tests were made in the middle of a thick wood (15 miles) and to the general surprise, Morse signals were received R3.

At the next place, 16 miles, signals were inaudible. On other days tests were made at Headley Heath, Walton Heath and Burgh Heath, and various neighbourhoods around Warlingham and Sanderstead. In all cases signals were easily readable, and the effect of hills and valleys up to distances of 7 to 8 miles seemed to make little difference to signal strength.

Range Trials carried out over Sea and Land.

In order to determine the useful range of the S.A.1 set over water, arrangements were made with the kind permission of Trinity House Authorities to instal one set at the North Foreland Lighthouse and another on the T.S.Y. "Alert."

Preliminary tests were made in the neighbourhood of Blackwall Docks, and it was found that, despite the fact that in various cases there were very large masses of metal between the two sets, in the shape of steamers, dock buildings, etc., communication was *always* possible over distances of several miles.

At the North Foreland Lighthouse the half wavelength aerial was originally rigged on the seaward side of the light, whilst on the ship a half wave aerial was lashed to the stanchions of the deck above the Wireless Cabin, and some 20 feet from the funnel.

Various tests were carried out, which may be summarised as follows :—

Speech was always readable, whatever the position of the ship, up to distances of 16 miles, and was readable on occasions at 20 miles.

With the aerial on the lighthouse inside the building (the lighthouse is of stone and steel construction), and inclined at an angle of 70°, due to overhead steel beams, signals were received on the ship at 10 miles with perfect clarity. Morse signals were easily readable at 20 miles, and were heard at 22 miles with 6 miles of land intervening.

With the quarter wave aerial, speech was comfortably readable at 17 miles.

Experiments in turning the ship through a complete circle at 17 miles showed that for about five seconds, when the funnel was directly in a line between the two aerials, signals dropped to inaudibility, but placing the aerial on the opposite side of the lighthouse to the ship seemed to make very little difference to signal strength.

Fig. 2 shows the approximate course of the ship and strength of signals received at various distances.

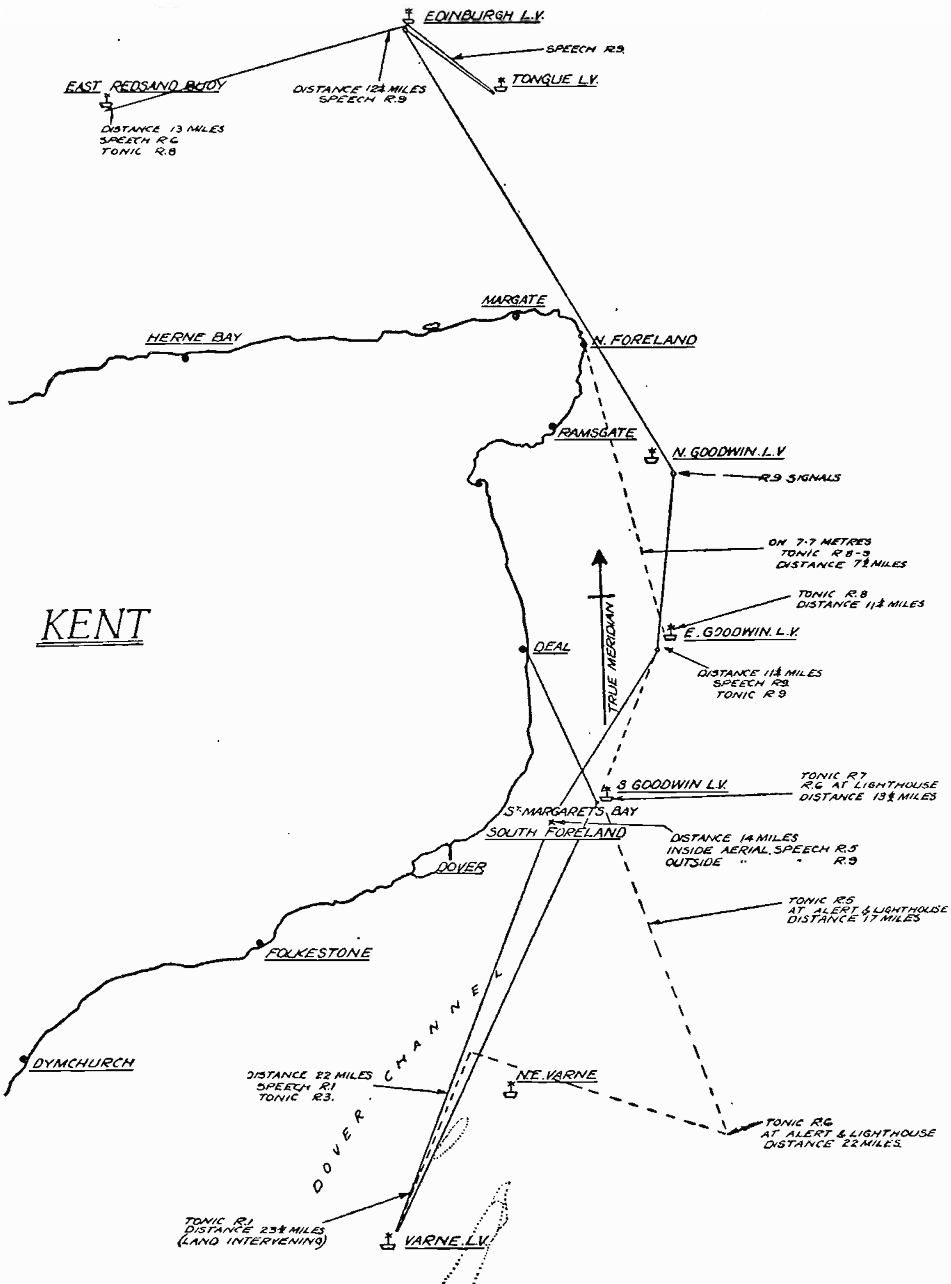


FIG. 2. *Chart of Trinity Steamer "Alert" during S.A.1 Range Trials.*

Tests Abroad.

Since the S.A.1 set has been on the market a large number have been sold abroad, and reports received from time to time have confirmed the excellence of the results obtainable in even the most unskilled hands.

One interesting fact which has been commented on from several sources, is the extreme mobility of the set.

The following message, received from one of the users abroad, speaks for itself :—

> "It is worth mentioning that, taking the correct time at which the
> "station ceased working in any of the positions, it was observed that it
> "only required five minutes to pack, lift the set into the motor car, drive
> "two kilometres, erect the set and start a fresh communication. In some
> "instances only four minutes were required."

During trials in Spain, good signals have been received, all overland, at 26 kilometres.

The performance of the S.A.1 set under practical conditions as detailed above, combined with its stability, ease of handling, immunity from atmospherics and jamming, make it eminently suitable for the purpose for which it was designed—a hard wearing, extremely mobile and compact, foolproof set for military communications.

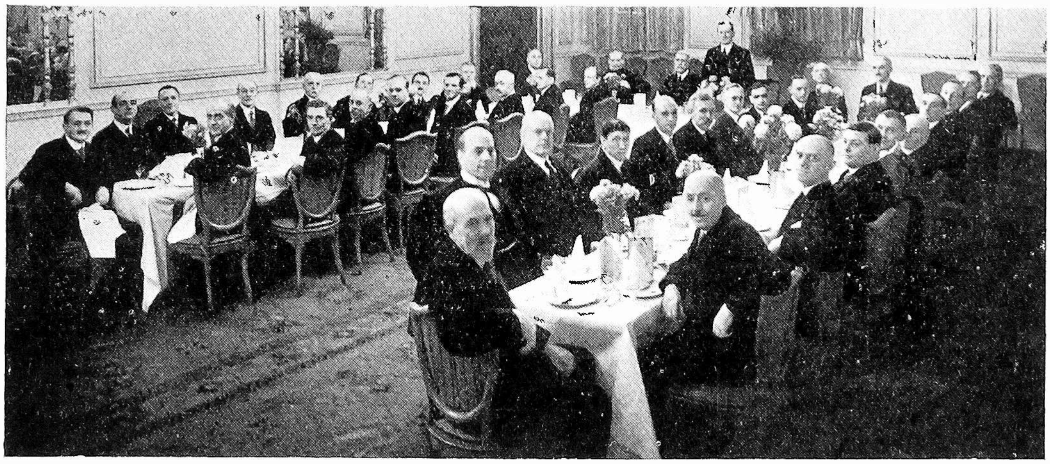
H. C. Van de Velde.

MARCONI NEWS AND NOTES

A MARCONI RE-UNION

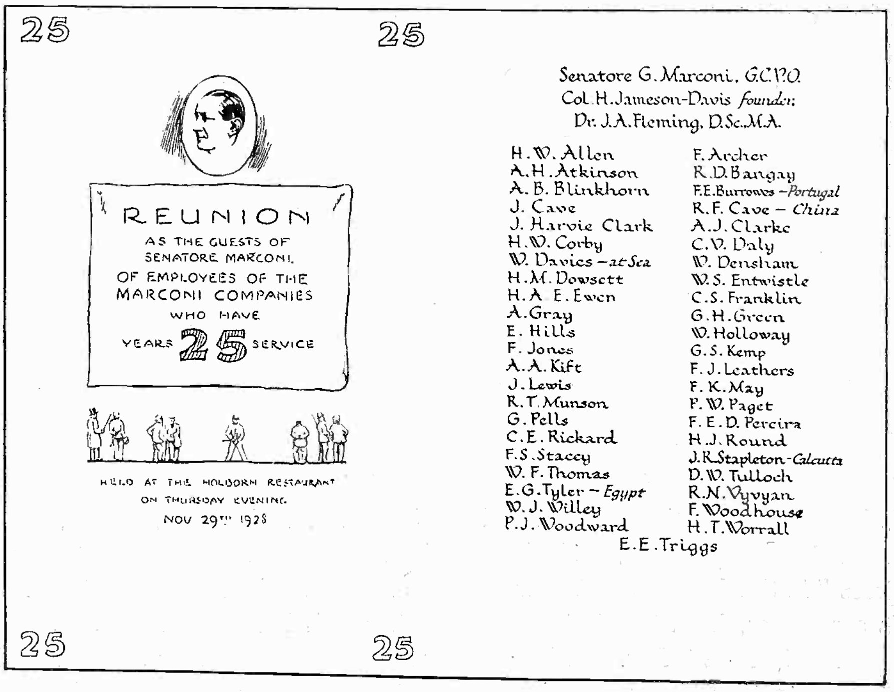
A RE-UNION of old employees of the Marconi Companies as the guests of Senatore Marconi was held at the Holborn Restaurant on November 29th.

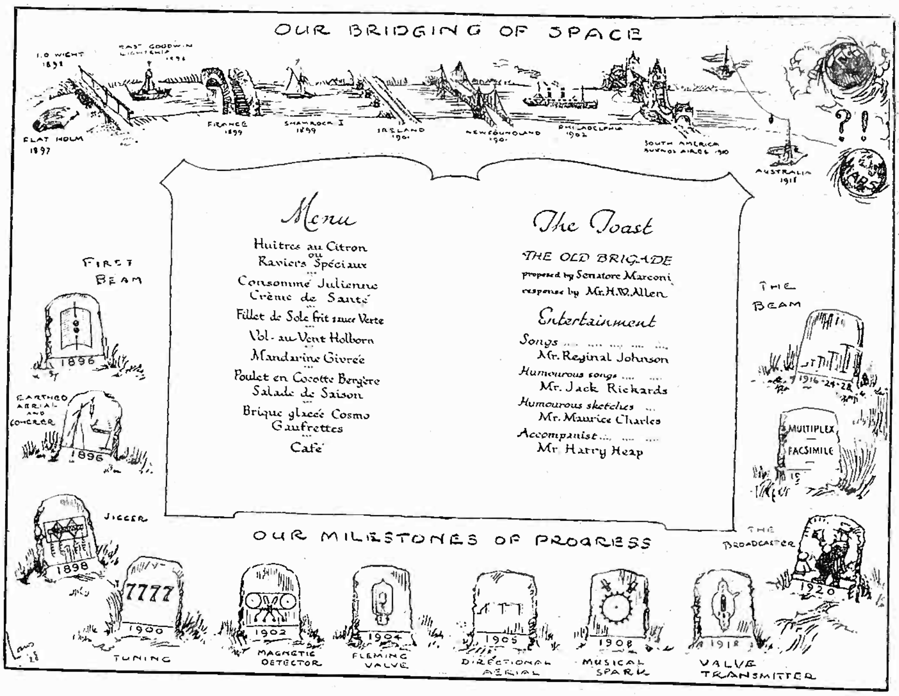
Every guest had been with one or other of the Marconi Companies for 25 years or more, and 40 of the 47 persons having this qualification were able to be present.



Among the guests were Colonel H. Jameson-Davis, the Founder in 1897 of the original Company, then known as the Wireless Telegraph and Signal Company, and Dr. J. A. Fleming, F.R.S., who has been associated with the Company almost from its inception. Additional interest attached to the presence of Dr. Fleming who was also celebrating his 79th birthday.

After the toast of " The King," Senatore Marconi proposed " The Old Brigade." He referred to several of the very early tests ; the watch-keeping on the East Goodwin Light Vessel ; the tests across the Atlantic when the first signals were received, and mentioned the names of a number of men who took part in them, several of whom were present that evening ; he spoke of the many Operators who did their work so nobly during the War, members of a body who at all times are liable to be called upon as a consequence of their special duties to live up to a great tradition of service. He congratulated his guests on having stayed the course so long.





The Menu Card.

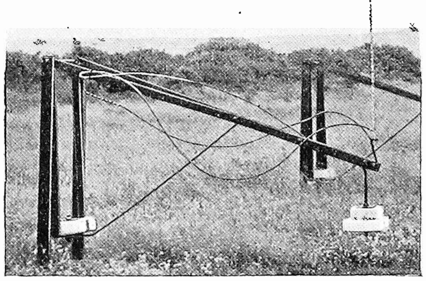
Mr. H. W. Allen, the first Secretary of the parent Company, responded. Short speeches were also made by Colonel Jameson-Davis, Dr. Fleming, Captain Daly and Mr. G. S. Kemp, who reminded his audience that the 29th November was also the anniversary of the erection of the mast at the Needles, Isle of Wight, which was the first Wireless Station to be installed in Great Britain.

Mr. Andrew Gray proposed that the present gathering should inaugurate an annual function at which Senatore Marconi, instead of being the host, would be an honoured guest. This was unanimously agreed to with acclamation, and after a vote of thanks to the Honorary Secretary, Mr. C. E. Rickard, who on behalf of Senatore Marconi was responsible for all the arrangements, the proceedings terminated.

The Menu Card, which is here illustrated, was in the nature of a surprise for the guests, to whom it will be an interesting souvenir.

Under the inspiration of Mr. Rickard, Mr. W. J. Laws, artist, and Mr. L. H. Blouet, photographer, had illustrated on the card some twelve "milestones of progress" in the development of wireless technique achieved by Senatore Marconi and his associates, from the first reflector tests carried out in 1896 to the Beam Stations of the present day. This feature was supplemented by another series of drawings illustrating the progressive conquest of space by a parallel development in bridge-building, from the simple foot-bridge spanning a stream, to a rope-way with a carrier where the distance was too great to be spanned by any other means. This series ends with a problem—Can we communicate between the Earth and Mars?

Beam Aerials withstand Worst Gale for 30 Years.



Balance weight and check wire.

The Marconi Beam aerial system has been specially designed to withstand the severest weather conditions, and during November all the English Beam stations were put to the most severe test during a hurricane which swept over the country and which was described as the worst gale for 30 years.

At times the wind, in certain places, reached a velocity of 120 miles per hour and, in addition to extensive damage to property, hundreds of trees and telegraph and telephone poles and wires were hurled to the ground, thus throwing landline communication into disorder.

Notwithstanding the severity of the gale, however, the safeguarding apparatus of the Beam aerials fulfilled its function and the Beam stations escaped without damage.

In order to keep the aerial and reflector wires of the Beam stations taut under varying wind pressure, they are suspended from triatics slung between the masts on a double catenary system, so that there is hardly any movement at the top of the wires. The lower ends of the aerial and reflector wires are attached, by means of insulators and short lengths of chain, to safety hooks fixed to the arms of the balance weights. When the windage on the wires increases the weights gradually rise to keep the load approximately constant. If the wind increases further, at a certain value the arm of the balance weight rises to a position in which the hook is automatically opened, thus releasing the aerial wire. The balance weight then comes to rest on the ground, and the wires are prevented from flying away by a check wire attached to the chain and to the balance weight. In this way any excessive load on the triatics and masts is released, and when the strength of the wind is reduced all that has to be done is to restore the wires to their respective hooks.

In the recent storm, the most serious that has yet been experienced since the Beam stations have been in operation, this safety device worked perfectly. In every case of which we have record the landlines serving the wireless stations were interrupted before the aerial wires were released. It was expected that when the wires were released communication would be interrupted, but experience has proved that the aerials, though loose, retain their general formation and communication can be maintained.

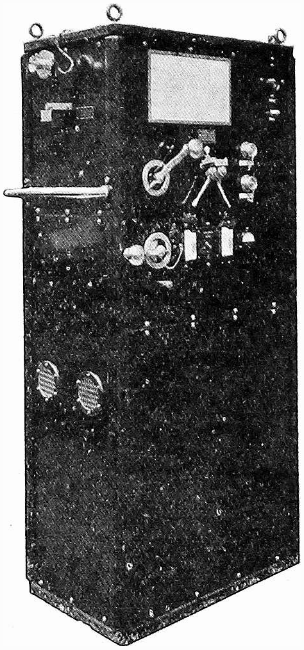
Air Telephony Records.

A message recently received at Croydon Aerodrome from the R.A.F. wireless station at Cairo states that telephone conversations sent out by an air liner which was carrying out tests with a Marconi short-wave experimental telephone transmitter while flying over England were distinctly heard in Cairo.

This is a world's record in long distance telephone transmission from an aeroplane in flight, the distance from Croydon to Cairo being some 2,000 miles. The feat is the more remarkable because the power used by the aeroplane was only in the neighbourhood of 50 watts.

A previous Marconi record was achieved as long ago as June, 1923, when the late Captain Hinchcliffe, the famous British air pilot, using a standard Marconi A.D.6 transmitter of 150 watts power, spoke to Croydon by wireless telephone while flying near Bremen, Germany. The distance covered on that occasion was 400 miles.

Wireless Apparatus for Whalers and Trawlers.



Type XMC1.

During the last two or three seasons, Marconi apparatus has played an important part in the whale-catching industry in the Antarctic. The fleet of the Southern Whaling and Sealing Company has been equipped with specially designed Marconi telephone apparatus to enable the whale catchers and the factory ships to keep in constant touch with each other and with their base at Prince Olaf Harbour, South Georgia, where a Marconi land station has been erected.

The telephone sets on board the whalers have been designed for operation by totally unskilled persons, and to withstand the hardest usage. They are in fact usually worked by the gunners, and in view of this arrangement are made for loud speaker reception so that the gunner need not remove his heavy head-dress in order to carry on a conversation with other members of the fleet. The whalers have found that astounding results and record seasons have followed the use of the wireless telephone, which enables the closest co-operation to be maintained between the various units of a fleet.

Previously, several vessels of one fleet might search for days without sighting a whale while another found more than it could cope with alone. It is now a simple matter for all the vessels to work together and in consequence a wider ground is covered and greatly increased catches have been obtained.

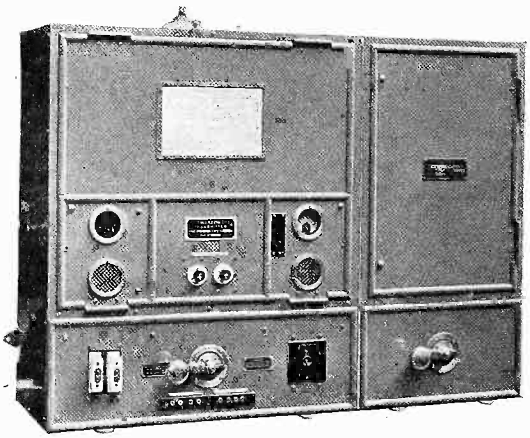
Similarly, deep sea fishing fleets are being equipped with Marconi telephone apparatus to enable whole fleets to take advantage of the best fishing grounds and to keep in touch with their owners so that landing arrangements can be made to take the greatest advantage of prevailing market conditions.

Apart from the commercial value of wireless communication to whalers and fishing vessels, it is of proved utility to the safety of life and property at sea. As an instance of this may be cited the case of a whaler which broke down with four whales made fast alongside when far out at sea, through engine trouble. The wireless telephone set installed on board the whaler enabled the gunner to communicate with another whaler which immediately proceeded to his assistance and towed the vessel and whales to land, thereby averting great hardship to the crew and the loss of many thousands of pounds by the whaling company.

In another case a steam trawler, returning home from Greenland, crashed into an iceberg during dense fog. Within a few minutes the damaged vessel was in telephone communication with a sister ship which came up and stood by as a precaution. Fortunately, although badly damaged, the injured vessel was able to proceed under her own steam, but she was accompanied by her sister ship across the Atlantic.

The Marconi telephone sets specially designed for use by unskilled persons under such conditions as those prevailing on whalers and fishing vessels are the type XMC1 of 500 watts power, the type XMD1 of 250 watts power, and the type XMB1 of 100 watts power. The transmitting and receiving units are totally enclosed in sheet steel cabinets. The wavelength for the required service is fixed beforehand, and there are none of the usual adjustments to be made. All that the operator has to do in order to carry on a conversation is to switch over a send-receive lever.

For Island Communication.



Type XMD1.

Quite apart from their value for service at sea, as shown above, this type of Marconi apparatus is of great value for land stations. It is being used by the British General Post Office in connection with a scheme which has been receiving the careful consideration of the authorities for some time past for the purpose of linking up outlying islands with the British mainland owing to the expense, in these circumstances, of maintaining cables which are frequently broken by the tide.

Two XMD1 stations, which can be used for communication either by telegraphy or telephony, have been erected at Loch Boisdale and Tobermory in the Hebrides to ensure communication with the mainland in the event of cable breakdown.

It is confidently expected that, owing to the successful operation of these stations, other stations included in the scheme will be fitted with this type of apparatus in due course.

At Alderney and Guernsey, in the Channel Islands, XMB1 sets have been installed, their purpose being to augment the service of the cable between the islands and, in time perhaps, to displace it altogether.

Marconi Wireless Telephone Equipments.

Marconi wireless telephone installations are proving of the greatest value for communication between scattered posts, in oil fields, ranches, and other similar undertakings in all parts of the world.

The following is an extract from a letter accompanying an order on Marconi's Wireless Telegraph Co., Ltd., for five wireless telephone stations, types XMC1 and XMD1, together with the Marconi Automatic "Call."

> " We thank you for the prompt and helpful advice which you have given " us in connection with this matter, as has been the case in our past dealings " with you.
>
> " It was, as you will understand, with some misgivings that we entered " upon the experiment of using wireless telephony on our oilfields, but the " experiment has more than justified itself, and this has been in no small " measure due to the satisfactory service which the apparatus supplied by " your Company has given."

The Company has previously supplied this customer with ten stations of various types, and these have now been in constant use for a considerable time.