THE MARCONI REVIEW

No. 40. *Jan.-Feb., 1933.*

Editor: H. M. Dowsett, M.I.E.E., F.Inst.P., M.Inst.R.E.

RADIO COMMUNICATIONS BY MEANS OF VERY SHORT ELECTRIC WAVES.

By H. E. MARCHESE MARCONI, G.C.V.O., LL.D.

The following is the second and concluding part of the reprint of a Paper delivered before the Royal Institution of Great Britain, on Friday, December 2nd 1932. The first part of this paper was published in THE MARCONI REVIEW, No. 39.

During these investigations the problem of wavemeter and frequency measurements had, of course, to be taken into careful consideration.

At an early stage in our work, when the plate-grid Lecher wire circuit was used, the coupling of a Lecher wire wavemeter to the transmitter was found fairly satisfactory, and measurements made by observing the pulling effect exercised by its coupling on the electrical supplies ; but this proved quite useless as soon as more power was available.

Sensitive, but necessarily also high resistance thermo-junctions were used at the centre of a dipole constituted by two straight rods fixed into the terminals of the thermo-couple, but the tuning was very flat and indefinite.

With the comparatively large amount of energy radiated from the new transmitter, it was then found possible to use the thermo-couple of a standard 0 to 125 milliamperes Weston Ammeter, the low internal resistance of which had already enabled us to secure a much sharper tuning.

Our present standard wavemeter and radiation indicator was then developed by placing the thermo-couple of that instrument in the centre of a dipole aerial provided with large end capacities taking the form of large discs. Naturally, the total length of the arrangement securing tuning is substantially shorter than with the usual straight rod dipole arrangement. It is only 8 cms. instead of 28 cms. in the case of 60 cms. wavelength, and the arrangement secures a marked improvement in sensitiveness and selectivity.

With this type of wavemeter it is possible to measure wavelengths to a millimetre, by coupling to the wavemeter a Lecher wire which, when in tune, pulls the oscillation induced in the wavemeter down to practically zero. Such an arrangement permits the calibration of the standard instrument which, in the system developed, is used as a radiation indicator to adjust both the transmission and the modulation.

Having ascertained the mechanism of working the new circuit, it was then possible to investigate if it could readily be used for the production of shorter wavelengths, say of the order of 40, 30 or 20 centimetres.

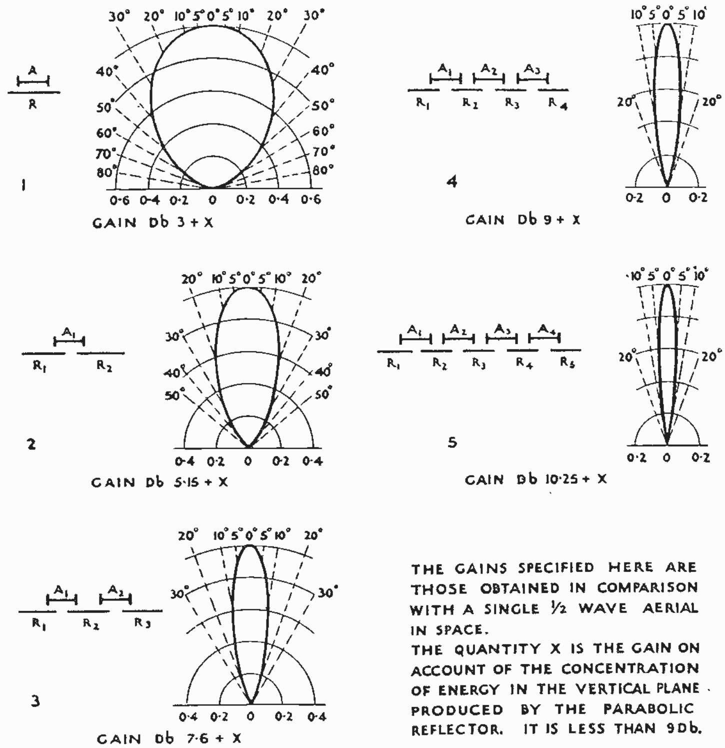


FIG. 4. *Energy Polar Diagrams of Aerial Systems.*

The first thing observed was that by varying proportionally all the dimensions of the external circuits and readjusting the electrical supplies, the standard valves were capable of generating at practically constant efficiency all wavelengths with a perfect continuous range from 80 cms. to 50 cms.

Below 50 cms. the tuning of the plate circuit became very indefinite and the efficiency fell off rapidly.

It looked, therefore, as if with the normal type of valves the plate circuit at this shorter wavelength was behaving as one of our standard disc wavemetres would if the end capacities were disproportionate to the length of the connecting rod.

With a view to checking this conclusion, a set of valves was constructed having smaller and shorter electrodes, and with them a continuous range from 55 to 35 centimetre wavelength was obtained with an efficiency as satisfactory as with the other type.

It is interesting to point out here that while with each type of valve the grid high potential and plate negative potential had to be increased as the wavelength was decreased, the same wavelength of say 55 cms. could be produced at its maximum power with either of the valves, but with a grid potential in the case of the smaller valves, smaller than in that of the standard 60 cms. type.

The idea of utilising a system of unit reflectors followed logically on that of the system of unit transmitters just described.

The advantages inherent in the possibility of placing side by side several transmitter units working in phase with each other for the purpose of increasing the power of a transmitting station would, in fact, have been partly lost if the same method could not have been extended to the reflector.

Considering the type of multi-unit transmitter developed we decided to adopt, at least for the time being, the ordinary well-known cylindrical parabolic reflector.

Of this type of reflector we already possessed a considerable amount of experience and data, and its design was a fairly straight-forward proposition.

However, the high efficiency observed by experimenting with these very short waves with free end reflector rods in place of wires or rods supported at each end by insulators, leads to a peculiar type of construction where each reflector rod is supported at its middle point by a copper tube bent into a true parabolic curve.

Fig. 6 will convey a good idea of this kind of herring-bone reflector construction and the manner in which these units can be mounted side by side to build up a multiple unit reflector.

This reflector system is economical in construction and offers the important advantage of a small wind resistance.

The aperture of the reflector was fixed to three wavelengths, because we knew from experience that with this type of reflector very little was to be gained by exceeding this figure.

The focal length of the reflector has been made equal to a quarter of the wavelength used.

The distance between the reflector rods has been determined by the desirability of placing the unit transmitter and the unit reflector at a distance securing the maximum directive effect without producing unduly large and detrimental side beams. This critical distance is $\frac{3}{4}$ of a wavelength.

The fixing of this distance by the above considerations, and the necessity of preventing the reflector and rods from touching one another, determined the maximum length of the reflector rods and consequently their spacing distance, since these two factors are interdependent.

While the addition of two unit reflectors on each side of the directly excited reflector unit by one transmitting unit secured no appreciable advantage, a very marked improvement in the radiation power was observed by placing the transmitting dipole no longer at the centre of one of the reflector units, but on the focal line between two adjacent reflector units.

In the case of several unit transmitters, this method of exciting say 3 unit reflectors by two unit transmitters—thus securing the simultaneous excitation of the centre unit reflector by two unit transmitters—offers a new method of keeping the oscillation of several transmitters in phase.

With this mode of keeping several transmitters in phase, the tuning of the outside filament plays an important role, and their adjustment is critical.

With this system of unit transmitters and unit reflectors, many different arrangements are possible, each corresponding to a different power of radiation which can be made variable over wide limits.

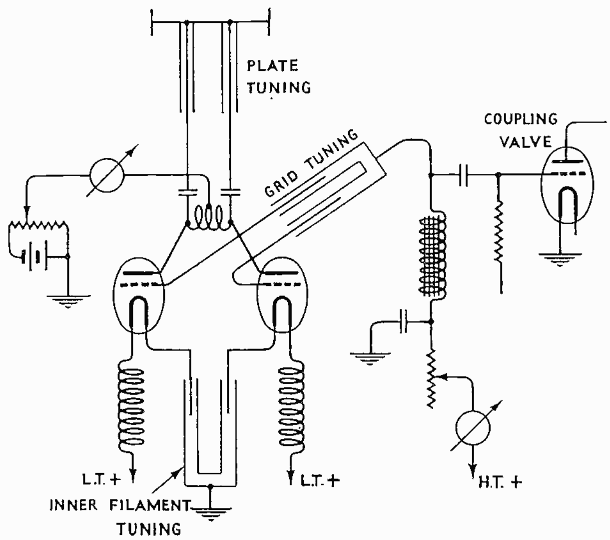


FIG. 5.

Fig. 4 shows some of these alternative arrangements.

In Fig. 4 (1) shows the simplest and most economical case of one unit transmitter working in the centre of one unit reflector ; (2) the next more powerful arrangement —one unit transmitter exciting two reflector units ; (3) which is our present normal arrangement, consists of two transmitting units exciting three reflector units, and so on.

Fig. 10 shows the arrangement of the four transmitter units, five reflector unit transmitter, described hereafter.

On the right side of each of these alternatives has been drawn the horizontal polar diagram obtainable by each, and the values indicated in Decibels are the gain due to the directive properties secured by the adequate spacing of the unit transmitters. To this gain must be added the gain secured by the parabolic reflector itself, which is of the order of 8 Decibels.

The first short distance receiving tests carried out indicated that—as in the case of the transmitter—electron oscillator receiving circuits based on a plate grid Lecher wire principle were inadequate. The time spent in investigating the possibilities of this type of circuit was by no means wasted, however, for, in addition to the experience gained in the novel practice of tuning a receiver by means of resistance adjustment and by milliammeter and voltmeter readings, the preliminary experiments brought to our knowledge the following valuable information.

It was clearly indicated that the successful newly developed transmitting valves were very inefficient when used in the receiver, thus rather upsetting the more or less generally accepted idea that with the Barkhausen oscillating circuits the same valves were suitable for both purposes. In contrast with what was observed in the case of the transmitter, it was found that the plates of the valves were the active electrodes, and should therefore be connected to the aerial instead of to the grids. Further, it was made clear that tuning was best secured by varying grid, filament, and plate potentials more or less simultaneously; and that no design would be useful commercially unless all circuits were provided with current-measuring instruments.

In view of the results obtained, the plate-grid Lecher wire circuit was therefore definitely discarded, and a receiver was constructed on the same lines as the new transmitting circuit comprising a plate, grid, and inside and outside filament-tuning.

The results obtained with this new receiver were most satisfactory. It was not at first appreciated, however, that too tight a coupling existed between the plate and the grid circuit and that, therefore, the big advantage of plate and inner filament-tuning was not being realised. Consequently, all the first types of receiver used in earlier demonstrations were not provided with either grid or inner filament tuning.

The electrical adjustments of the receiver are critical, but this disadvantage has been largely overcome by designing special resistances giving only small resistance variation for relatively large movements of their controlling handles.

Fig. 5 gives the schematic diagram of our latest receiving circuit which is in present use.

Numerous distance tests, and a few official demonstrations have been given from time to time, and each has gone to prove the availability and practicability of these very short waves for the purposes of radio communication.

The first demonstration was given to representatives of the Italian Ministry of Communications early in October, 1931, between Santa Margherita and Sestri Levante, near Genoa, a distance of 11 miles over sea.

The transmitter, consisting of two radiating units working into four reflector units, was installed at Santa Margherita on the balcony of a private Villa at a height of 50 metres above sea level.

The receiver which was of our first type, without plate or inner filament-tuning and without supersonic variable plate bias, was installed on the top of a small signal station tower at Sestri Levante at a height of 70 metres above sea level.

The elevation of the two instruments was capable of giving a direct line of vision over a distance of 24 miles, that is to say, slightly more than twice the actual distance at which the test was carried out.

On the 29th of October, 1931, a second demonstration was given to the same experts and between the same places, with an improved receiver, fitted with variable supersonic plate bias ; moreover, at that demonstration the commercial possibility of a carrier suppressor-voice-operated device, developed for the transmitter, was also shown.

The third demonstration took place on the 19th of November, 1931, between the same transmitting experimental station at Santa Margherita and Levanto, a distance this time of 22 miles, mostly over sea.

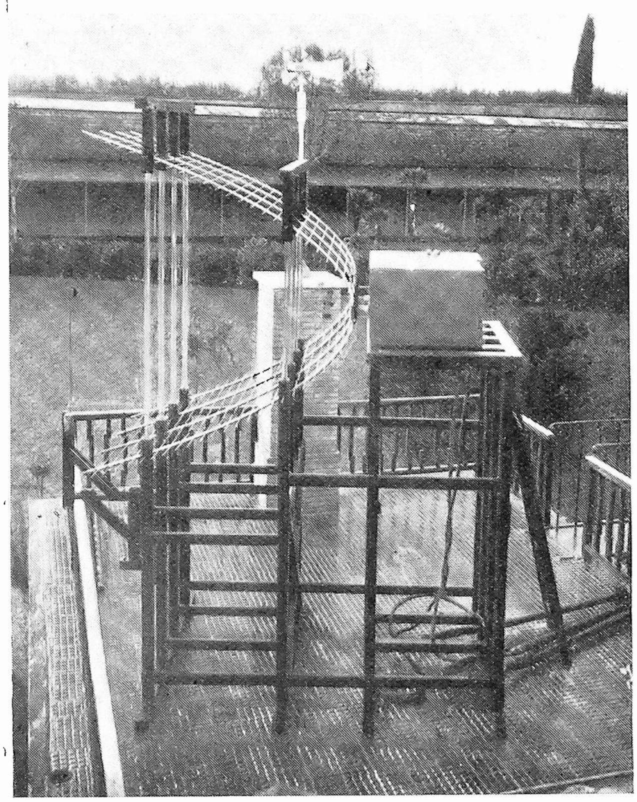


FIG. 6. *Transmitter and Receiver installed in the Vatican.*

The receiver at Levanto was installed on the balcony of a private Villa, at a height above sea level of 110 metres.

The sum of the heights of the two stations was 160 metres, which is sufficient for a direct vision over 27·5 statute miles, or 20 per cent. in excess of the distance covered. This demonstration was given to representatives of the Government and the Press.

It is very interesting, I think, to mention that, although the apparatus used were the same as those for the previous demonstration between Santa Margherita and Sestri Levante, the increase of the distance from 11 to 23 miles, made very little difference to the strength of the signals received.

The next was a duplex demonstration, which took place on the 6th of April, 1932, again between Santa Margherita and Sestri Levante. Its purpose was to show the advanced model incorporating two wire telephone terminal apparatus, and to demonstrate the practicability and the resulting advantages of working both transmitter and receiver in the same reflector.

That demonstration was given to experts of the Italian Government and representatives from the Universities and Technical Colleges.

All the new apparatus was explained and demonstrated, and excellent two-way communication was maintained on two wires for several hours.

Soon after the Duplex demonstration of Santa Margherita—Sestri Levantel, the Vatican Authorities decided to adopt the new system for telephonic communication between the Vatican City and the Palace of His Holiness the Pope at Castel Gandolfo, near Rome.

This application is of great interest as the distance between the two points, a matter of 20 kilometres is entirely over land, and also because there is no actual clear vision between the two places, on account of the intervening trees in the Vatican Garden, and those of the Avenue built over the Gianiculum Hill, situated at about four miles from the Vatican.

Having at the time no experience of such working conditions it was decided to check beforehand the possibility of successfully operating such a circuit.

For that purpose, a small experimental single transmitter single reflector unit was placed at the Vatican City and standard receiver with a single unit reflector was installed first at the College of Mondragone, east of Castel Gandolfo, from which a direct vision of the transmitter was possible, and afterwards at Castel Gandolfo.

These interesting tests took place towards the end of April, 1932, and were entirely successful, the signals being received with great strength at Mondragone and afterwards only slightly weaker at Castel Gandolfo, leaving no doubt as to the possibility of successfully linking together the two places, notwithstanding what would generally have been considered unfavourable conditions.

It is also interesting to mention that to reach Mondragone, the waves had to pass through the masts and aerials of the high power Radio Station of the Italo Radio Company at Terranuova.

On the 26th of April, 1932, a demonstration of the apparatus was given to His Holiness the Pope.

At the end of last month, the apparatus for that first commercial link on a wavelength below one metre, was installed and tested, and although the official inauguration will not take place until next month, the circuit is already in operation and working satisfactorily.

Fig. 6 shows the transmitter and receiver which are working in the same reflector, recently installed on the roof of the Annexe of the main Vatican Wireless Station.

Fig. 7 shows the remote control of this transmitter and receiver as well as the telephone terminal equipment which permits the extension of the radio circuit to any ordinary Vatican or outside telephone line.

Fig. 8 gives the back view of the same apparatus.

Figs. 6, 7 and 8 illustrate the new very short wave system as the practical outcome of our recent tests and researches.

With the object of carrying out long distance tests, a five unit reflector, four unit transmitter was constructed, which constitutes what I believe to be the most powerful short wave transmitter yet produced.

This transmitter induced 30 milliamperes in the standard wavemeter at a distance of 12 metres, representing 21 wavelengths from the aperture of the reflector.

Fig. 9 is a photograph of this experimental transmitter, while Fig. 10 illustrates the four unit transmitters, working in phase side by side, mounted inside the screened box, behind the reflectors.

In July this year, one of our standard receivers with single reflector unit was installed astern of the main deck of the yacht "Elettra," and preliminary tests were carried out with the new powerful transmitting station installed at Santa Margherita.

These tests demonstrated that although the optical distance corresponding to the small height of the Santa Margherita Station and the yacht "Elettra" was only 14·6 nautical miles, the signals were still perceivable at a distance of 28 miles, consequently well beyond the optical range and notwithstanding the intervening curvature of the earth. These signals began to lose strength noticeably at about 11 miles from Santa Margherita, that is, before reaching the optical limit, but after passing that position they were observed to decrease in strength only gradually, until no longer perceptible. Above a distance of 22 miles the signals were suffering from a kind of deep fading causing them to disappear completely from time to time.

At a distance of 18 miles the speech was still 90 per cent. intelligible, but from 20 miles until the signals could no longer be heard, tone Morse signals only could be clearly identified.

At the end of July, 1932, the equipment of the Santa Margherita Station was transported to the obsolete Seismographic Observatory of Rocca di Papa which is situated about 12 miles south of Rome at a height of 750 metres above sea level and about 15 miles inland.

On the 2nd of August, good duplex communication was established between that new experimental station and the yacht anchored in front of Ostia, a distance of about 18 miles, 57 centimetre waves being used from Rocca di Papa to the yacht "Elettra," and 26 metre waves in the reverse direction.

On the 3rd, the yacht was forced to leave for Civitavecchia harbour on account of bad weather, but the journey was utilised for a propagation test.

During this test, and with the view of keeping the beam directed on the yacht, the reflector at Rocca di Papa was tuned east of Ostia, 5 degrees every half-hour.

Very good signals were received in the yacht up to a distance of 85 kms. At that distance the signal strength decreased considerably, but remained perfectly audible in spite of the intervening hills masking completely the position of the transmitting station.

The signals were only lost at a distance of 90 kms. when, having to enter Civitavecchia Harbour, the receiving reflector could no longer be kept directed on Rocca di Papa.

On the 6th of August, the yacht, with representatives of the Italian Government on board, moved on to the line Rocca di Papa—Golfo Aranci, Sardinia, for the purpose of carrying out a long distance investigation on the propagation of these waves.

The tests started when the yacht was 34 miles from Rocca di Papa with excellent duplex telephonic communication, very strong signals being heard at both ends of the circuit.

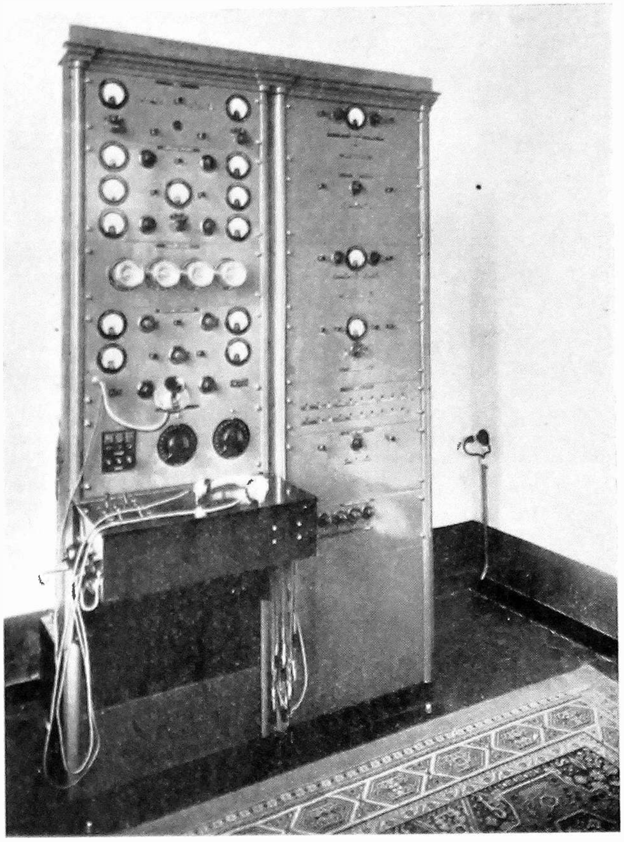


FIG. 7. *Remote Control and Terminal Equipment of the Vatican Transmitter and Receiver.*

At 58 miles good duplex communication was still possible; that is to say, already 6 miles in excess of the optical range; but shortly afterwards the signals lost their strength rapidly, became erratic and suffered from slow and very deep fading until, at a distance of 80 miles, they could only be perceived at times.

Listening, of course, continued, in spite of these poor conditions, when on reaching 87 miles, the average strength of the signals suddenly increased and soon reached practically the same strength as was observed at 46 miles.

This return to good signal strength conditions lasted until the distance of 100 miles was reached, when the signals faded away again very rapidly, assuming a slow

Figs. 6, 7 and 8 illustrate the new very short wave system as the practical outcome of our recent tests and researches.

With the object of carrying out long distance tests, a five unit reflector, four unit transmitter was constructed, which constitutes what I believe to be the most powerful short wave transmitter yet produced.

This transmitter induced 30 milliamperes in the standard wavemeter at a distance of 12 metres, representing 21 wavelengths from the aperture of the reflector.

Fig. 9 is a photograph of this experimental transmitter, while Fig. 10 illustrates the four unit transmitters, working in phase side by side, mounted inside the screened box, behind the reflectors.

In July this year, one of our standard receivers with single reflector unit was installed astern of the main deck of the yacht "Elettra," and preliminary tests were carried out with the new powerful transmitting station installed at Santa Margherita.

These tests demonstrated that although the optical distance corresponding to the small height of the Santa Margherita Station and the yacht "Elettra" was only 14·6 nautical miles, the signals were still perceivable at a distance of 28 miles, consequently well beyond the optical range and notwithstanding the intervening curvature of the earth. These signals began to lose strength noticeably at about 11 miles from Santa Margherita, that is, before reaching the optical limit, but after passing that position they were observed to decrease in strength only gradually, until no longer perceptible. Above a distance of 22 miles the signals were suffering from a kind of deep fading causing them to disappear completely from time to time.

At a distance of 18 miles the speech was still 90 per cent. intelligible, but from 20 miles until the signals could no longer be heard, tone Morse signals only could be clearly identified.

At the end of July, 1932, the equipment of the Santa Margherita Station was transported to the obsolete Seismographic Observatory of Rocca di Papa which is situated about 12 miles south of Rome at a height of 750 metres above sea level and about 15 miles inland.

On the 2nd of August, good duplex communication was established between that new experimental station and the yacht anchored in front of Ostia, a distance of about 18 miles, 57 centimetre waves being used from Rocca di Papa to the yacht "Elettra," and 26 metre waves in the reverse direction.

On the 3rd, the yacht was forced to leave for Civitavecchia harbour on account of bad weather, but the journey was utilised for a propagation test.

During this test, and with the view of keeping the beam directed on the yacht, the reflector at Rocca di Papa was tuned east of Ostia, 5 degrees every half-hour.

Very good signals were received in the yacht up to a distance of 85 kms. At that distance the signal strength decreased considerably, but remained perfectly audible in spite of the intervening hills masking completely the position of the transmitting station.

The signals were only lost at a distance of 90 kms. when, having to enter Civitavecchia Harbour, the receiving reflector could no longer be kept directed on Rocca di Papa.

On the 6th of August, the yacht, with representatives of the Italian Government on board, moved on to the line Rocca di Papa—Golfo Aranci, Sardinia, for the purpose of carrying out a long distance investigation on the propagation of these waves.

The tests started when the yacht was 34 miles from Rocca di Papa with excellent duplex telephonic communication, very strong signals being heard at both ends of the circuit.

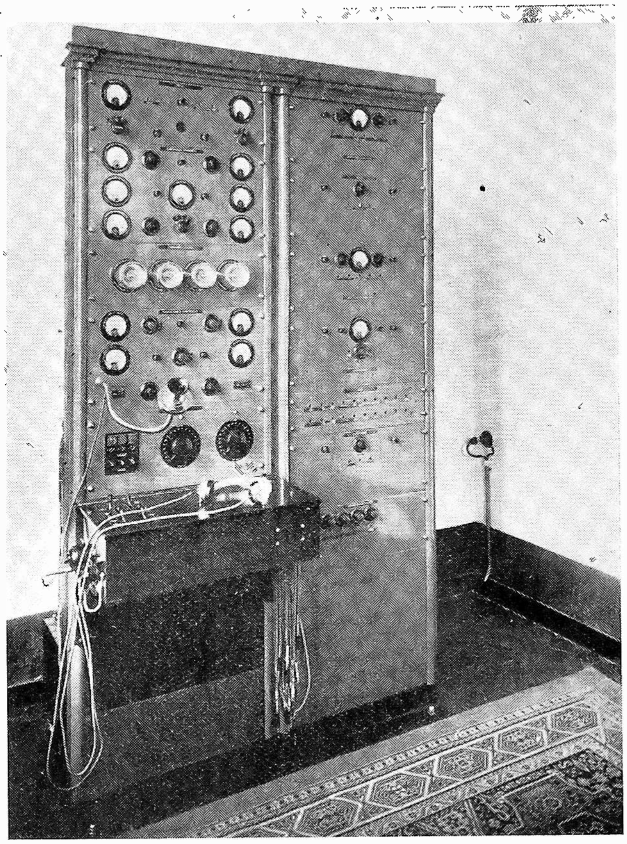


FIG. 7. *Remote Control and Terminal Equipment of the Vatican Transmitter and Receiver.*

At 58 miles good duplex communication was still possible; that is to say, already 6 miles in excess of the optical range; but shortly afterwards the signals lost their strength rapidly, became erratic and suffered from slow and very deep fading until, at a distance of 80 miles, they could only be perceived at times.

Listening, of course, continued, in spite of these poor conditions, when on reaching 87 miles, the average strength of the signals suddenly increased and soon reached practically the same strength as was observed at 46 miles.

This return to good signal strength conditions lasted until the distance of 100 miles was reached, when the signals faded away again very rapidly, assuming a slow and deep fading characteristic. They were finally perceived for the last time at a distance of 110 miles.

On the 10th August this important long distance test was repeated.

Over the first 70 miles the results repeated themselves very well, but from that distance onwards they varied in regard to the following points.

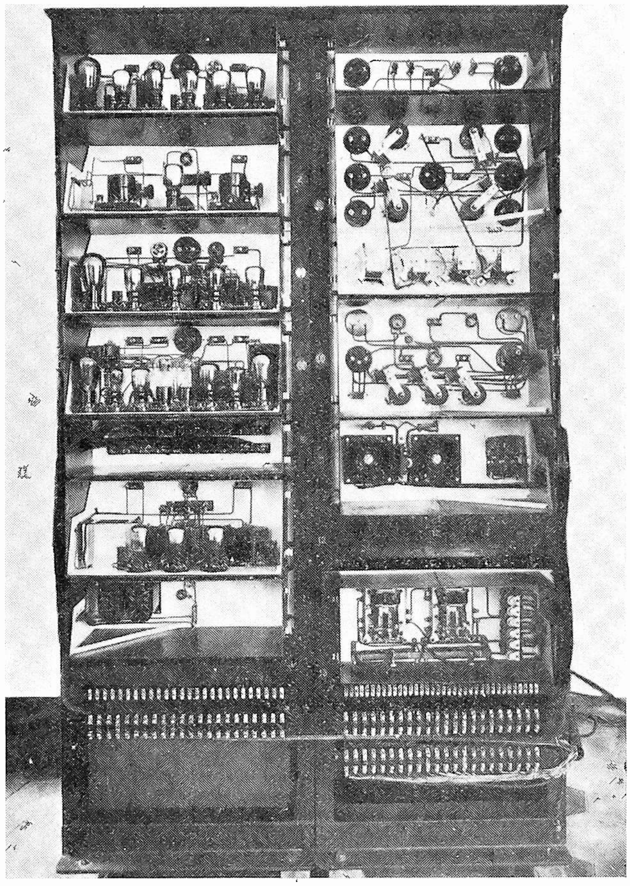


FIG. 8. *Back view of Remote Control and Terminal Equipment of the Vatican installation.*

First, the signals instead of fading away rapidly to nearly complete inaudibility, at the distance of 72 miles assumed a character of very slow and deep fading but maintained an average intensity of signals nearly constant up to 110 miles from Rocca di Papa.

Secondly, at that distance, instead of losing the signals altogether, they kept that slow deep fading characteristic with a progressive decrease of average strength until they became inaudible from time to time and were heard for the last time on the yacht at a distance of 125 nautical miles from Rocca di Papa.

The yacht arrived the same night at Golfo Aranci, Sardinia, and next morning the receiving apparatus was disembarked and installed on the tower of the signal station of Cape Figari, 340 metres above sea level.

Rocca di Papa station had been requested to start transmission again at 4 p.m. and we had the great satisfaction of being able to pick up its signals almost immediately.

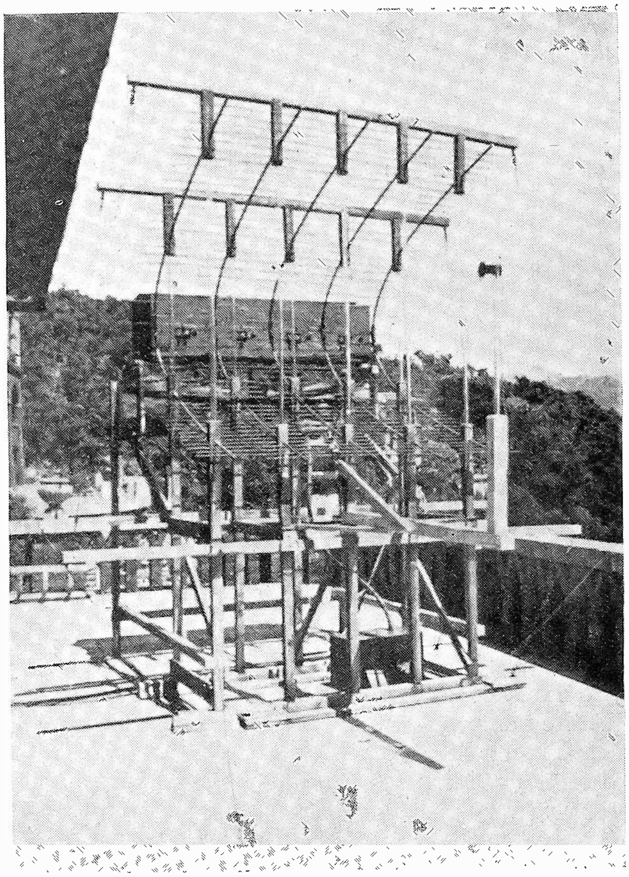


FIG. 9. *Four Unit Experimental Transmitter with Five Unit Reflector.*

The tests lasted until midnight, the signals, however, assuming the same slow deep fading already observed on the yacht, excellent 100 per cent. intelligible speech being received during the strong periods of the signals, but reaching practically inaudibility during the weak periods.

The average signal strength appeared also better before sunset than after.

The distance between Rocca di Papa and Cape Figari is 168 statute miles whilst the optical distance taking account of the height of the two places is only 72 statute miles.

It is interesting to add that at Cape Figari the angle of reception was investigated several times by tilting the reflector and it was found that the waves from the distant station reached the receiving experimental station from a horizontal direction.

In conclusion, I feel that I may say that some of the practical possibilities of a hitherto unexplored range of electrical waves have been investigated, and a new technique—which is bound to extend very considerably the already vast field of the applications of electric waves to radio-communications—developed.

The permanent and practical use of micro-waves—on the Vatican Castel Gandolfo link—provides the first example of what will be, in my opinion, a new and economical means of reliable radio-communication, free from electrical disturbances, eminently suitable for use between islands, and to and from islands and the mainland, and also between other places separated by moderate distances.

The new system is unaffected by fog, and offers a high degree of secrecy, by virtue, principally, of its sharp directive qualities.

Its strategic uses in war-time are obvious, no less than its practical value to navies and aircraft, in so far as the communications can be confined to any dsireed direction.

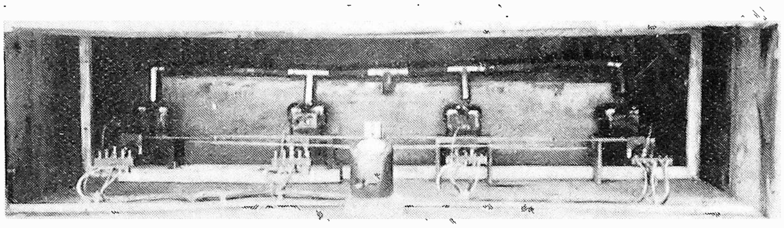


FIG. 10. *Four Unit Transmitter.*

The fact, however, that the distance of propagation of these waves appears to be limited, suggests other advantages in war-time, besides greatly reducing the possibility of mutual interference between distant stations.

In regard to their limited range of propagation of these micro-waves, the last word has not yet been said. It has already been shown that they can travel round a portion of the earth's curvature, to distances greater than had been expected, and I cannot help reminding you that at the very time when I first succeeded in proving that electric waves could be sent and received across the Atlantic Ocean in 1901, distinguished mathematicians were of the opinion that the distance of communications, by means of electric waves, would be limited to a distance of only about 165 miles.*

In any case, the new system is now available for advantageously replacing optical or light signalling in all its long distance applications, as for example, between signalling stations along coasts, or between forts constructed along a frontier, and in general will be found advantageous in many cases where the erection and maintenance of an ordinary short distance telephone or cable circuit is difficult, or too expensive.

Other applications such as broadcasting and television are already under consideration, and the study of the new fields of application for these so far unutilised electric waves will, I feel sure, soon bring about the design of greatly improved methods, and apparatus.

* H. M. Poincare—Notice sur la telegraphie sans fil. Annuaire pour l'an 1902 des bureaux des longitudes—Paris.

THE MARCONI SHORT WAVE TELEPHONE-TELEGRAPH INSTALLATION OF THE LEAGUE OF NATIONS

It is the purpose of this article to describe the radio installation supplied by the Marconi Company to the League of Nations, at Prangins, Vaud, Switzerland. This consists of a Type S.W.B.7 Short Wave Transmitter, together with control tables, protective circuits, valve cooling plant, feeders and aerials.

The aim of the designers in producing this type of transmitter has been to provide a high power short wave set for telegraphy and telephony, of extreme flexibility as regards choice of wavelength, without in any degree sacrificing constancy of frequency. This aim has been realised by employing a valve oscillator of new design, whilst automatic wave change gear permits a change from one to any other of four pre-set spot wavelengths in less than two minutes.

Other features include a half-minute change from telegraphy to telephony, high speed keying, totally enclosed panels, accessibility of all controls, swivelling main instruments with large scales, and full automatic protection of operating staff and apparatus.

THE power rating of the S.W.B.7 supplied to the League of Nations is 30 to 40 kw. power input to the last stage, giving up to 29 kw. output on telegraphy and 15·8 kw. carrier wave output on telephony.

Another edition of this transmitter, employing higher power valves, is also available, for which the rating is 50 to 60 kw. power input to the last stage, giving up to 42 kw. output on telegraphy, and 22 kw. carrier wave output on telephony.

Four spot wavelengths are provided, one pair of which will be normally anywhere in the 21,420 k.c. to 10,710 k.c. band (14 to 28 metres approximately), and the other pair anywhere in the 12,000 k.c. to 3,000 k.c. band (25 to 100 metres approximately).

Wave change between pre-selected spot waves can be effected in from 2 to 3 minutes. The operation is extremely simple as all adjustments are pre-set.

Any spot wave may be shifted to any other spot wave within the limits specified above, by changing or adjusting the inductances, and re-tuning and re-balancing the various circuits. The time required for this change is from 2 to 3 hours for each spot wave varied.

The constancy of frequency which can be maintained exceeds 1 in 20,000 under conditions of wide variation of temperature and normal changes of high and low tension voltage.

The power supplied to the aerial feeder varies with the wavelength, and also depends on whether the transmitter is used for telegraphy or telephony.

The following table gives an idea of the figures obtainable :—

TELEGRAPHY.						TELEPHONY.			
Wave-length.	H.T.V.	Feed in Amps.	kw. input.	kw. output.	Effi-ciency %	H.T.V.	Feed in Amps.	kw. input.	kw. output.
16 m.	7,600	5.22	40	23	57.5	6,700	3.4	22.8	12.0
40 m.	8,260	4.75	40	29	72.5	6,700	3.4	22.8	15.8

A transmitter of a similar type but of higher power has recently been installed at the Ongar Wireless Station of Imperial & International Communications, Ltd., for telegraphy and facsimile services. The figures for this transmitter are :—

TELEGRAPHY.						TELEPHONY.			
Wave-length.	H.T.V.	Feed in Amps.	kw. input.	kw. output.	Effi-ciency %	H.T.V.	Feed in Amps.	kw. input.	kw. output.
14 m.	8,000	6.5	52	29	55	7,000	4.5	32	18.0
16 m.	8,400	6.5	54	32	60	7,000	4.5	32	19.0
25 m.	9,000	6.7	60	41	69	7,000	4.5	32	22.0
32 m.	9,000	6.7	60	42	70	7,000	4.5	32	22.4

The total time required for changing over from telegraph to telephone working is only half a minute. This is due to the novel design of the combined modulator and absorber panel, and the provision of coupled switches for the change over, which features will be described later.

For keying, full power absorption is employed, as this system maintains a steady load on the power supply, thus avoiding fluctuations of H.T. voltage, with consequent keying transients. Keying speeds are governed by capacity of line and relay and may exceed 200 w.p.m.

All panels are built in the form of a rigid framework of delta metal angle, with brass screening between high frequency stages. The panels are totally enclosed by easily removable perforated brass screens or gates. The latter provide access to the circuits for adjustments or replacements. These features prevent inter-stage reaction, provide adequate ventilation and permit observation of the valves and circuits through the perforations under working conditions.

Gate switches are provided on all panels operating at a high potential. On opening any of the gates, all dangerous supplies are immediately cut off.

One of the novel features of this transmitter is the design of the main high tension instrument mountings. These consist of swinging brackets carrying a swivelling case in which the instrument is mounted on substantial insulators, the case and bracket being earthed. The instruments have large scales, and can be rotated to any convenient angle, thus facilitating the observation of several transmitters from a central control point.

Transmitter Units.

Fig. 1 is a view of the transmitting room showing the panels on their supporting plinth, with the control tables in the foreground. The block diagram (Fig. 2) gives a key to the arrangement of the units, which are as follows :

Master Oscillator Panel.—This panel is divided into four screened compartments, or ranges, one for each spot wave (see Fig. 3). Each compartment accommodates a Franklin temperature compensated valve oscillator with a five-stage amplifier consisting of amplifying or frequency multiplying stages. The required range is selected by switching from the control tables.

Intermediate Amplifier Panel.—This panel is divided into five main screened compartments. Each of the four lower compartments contains an independent

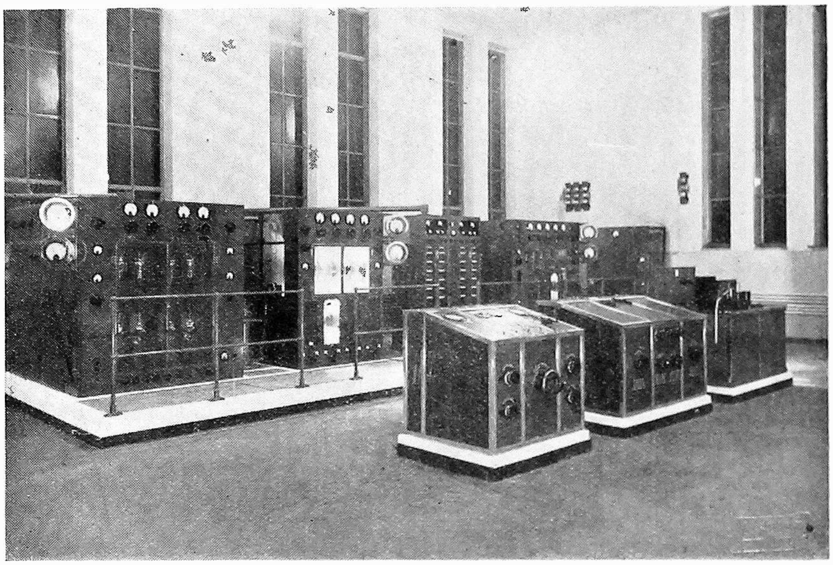


FIG. 1.

first stage amplifier one for each spot wavelength labelled Range 1, 2, 3 and 4 respectively (Fig. 2), while the top compartment contains a second stage amplifier.

The Master Oscillator outputs are fed by means of four Franklin tubular concentric feeders to the primaries of four grid input transformers, mounted one under each first stage amplifier compartment. These are of the interchangeable plug-in type, and each secondary winding is tuned by its own variable condenser, which, when once set for any spot wave needs no further adjustment. The output from any one of these first stage amplifiers may be switched on to the grid circuit of the second intermediate amplifier. The switching operation which selects the required first stage output also connects the H.T. supply on to the selected first stage anode circuit. The corresponding first stage filament is switched on in two steps by one of four selector switches on the filament control table.

The second stage of the intermediate amplifier comprises an anode tuning condenser and four independent anode inductances with their associated coupling coils, one for each spot wave. The inductances are arranged round a circular table mounted on ball bearings, and by rotating the table, the appropriate inductances for the required spot wave are rapidly selected. The four coupling coils are tuned by four variable condensers. On each side of the anode tuning condenser are two balancing condensers, of which one pair is hand controlled, and the other automatically controlled by the wave change mechanism.

Main Amplifier.—With the exception that everything is on a larger scale, the design of the main amplifier circuit is similar to that of the intermediate amplifier. Only two balancing condensers are employed, one on each side of the anode tuning condenser, and by an ingenious link mechanism, each of these is controlled by either the automatic wave change gear or a hand control.

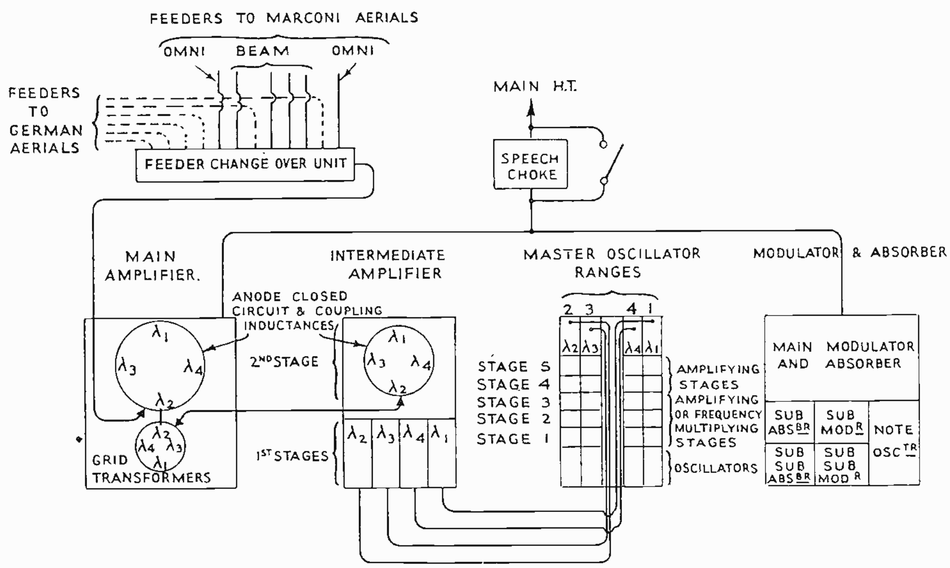


FIG. 2.

Wave Change Mechanism.—Between the intermediate and main amplifier panels are situated a brass lever and a large handwheel. The former controls the lateral movement of both the inductance turntables, while the handwheel enables both turntables to be rotated simultaneously. This mechanism, and the various operations which are automatically performed when changing wavelength are described in detail in a later section of this article.

Modulator and Absorber.—This panel comprises the following stages:—

Note Oscillator for I.C.W. Telegraphy.
Sub Sub Modulator.
Sub Modulator.
Sub Sub Absorber.
Sub Absorber.
Main Modulator and Absorber.

In the last named stage, by means of mechanically coupled change over switches, the valves can be utilised as either main modulators or main absorbers. This feature and the inclusion of all the other telephone and telegraph stages in the same panel results in a considerable saving in capital outlay on valves, generating plant, and panels, as well as economising in floor space.

Detailed Description of Panels.

General.—Throughout the transmitter the minimum number of leads are employed, especially in the high frequency circuits, resulting in high efficiency, and increased stability on low wavelengths.

The master oscillator stages and the first stage of the intermediate amplifier consist of composite units which are assembled on the bench and then fixed in the panels. The only wiring throughout the transmitter consists of the various supply leads, and the high frequency input and output connections.

In each panel fixed capacity coupling is employed between stages. From each panel, a variable and tuned inductive coupling transfers the energy via a concentric tubular feeder to the succeeding panel, or in the case of the main amplifier, to the aerial.

All resistances are of the clip-in type, and with the exception of certain wave change controls, all controls and instruments are mounted in front of the panels. All tuning condensers are provided with numbered scales and pointers and all hand controlled balancing condenser knobs are fitted with clamps to prevent accidental disturbance of balance once the initial adjustments have been made.

The filament rheostats on the panels are designed to control the filament voltage in steps not exceeding 0·1 volt.

Master Oscillator Panel.—Access to each of the four ranges for tuning or coil changing is by means of a glass door. Each range consists of an oscillator unit and its associated amplifier.

All valves are mounted horizontally at the back of the panel, and are easily accessible for replacement.

Any two master oscillator ranges may be in operation simultaneously to save time in wave changing or for other purposes, due to the fact that the combined H.T. and output selector switch controlling the four first stages of the intermediate amplifier only permits of one of these stages being in operation at a time. The drive of the spare master oscillator range is therefore only effective as far as the grid circuit of the first stage intermediate amplifier.

Oscillator Unit.—This consists of a valve oscillator of special design. A compensating condenser is so adjusted that any increase of inductance due to increase of temperature and consequent expansion, is counteracted by a corresponding decrease of capacity of this condenser. The inductance inside the unit is provided with six tappings, which in conjunction with a six-way switch of special design, permits variation of the total amount of inductance in parallel with the tuning condenser. The range of frequencies covered by the tuning condenser for any position of this switch is sufficient to provide an overlap with the frequency bands covered by the condenser for either of the adjacent switch positions. The tuning condenser is provided with a vernier enabling accurate frequency settings to be obtained in conjunction with the calibration charts provided. One vernier division represents a change in wavelength of about 1 part in 20,000, equivalent to 1 k.c. at 15 metres. The unit is lagged with felt to prevent rapid temperature change, and complete screening of the high frequency circuit is provided by the cylindrical brass case. A Sorbo rubber mounting insulates the unit from vibration. The oscillator employs two triode valves. The self-compensating action of the oscillator renders unnecessary the use of an oven with thermostatically controlled heater.

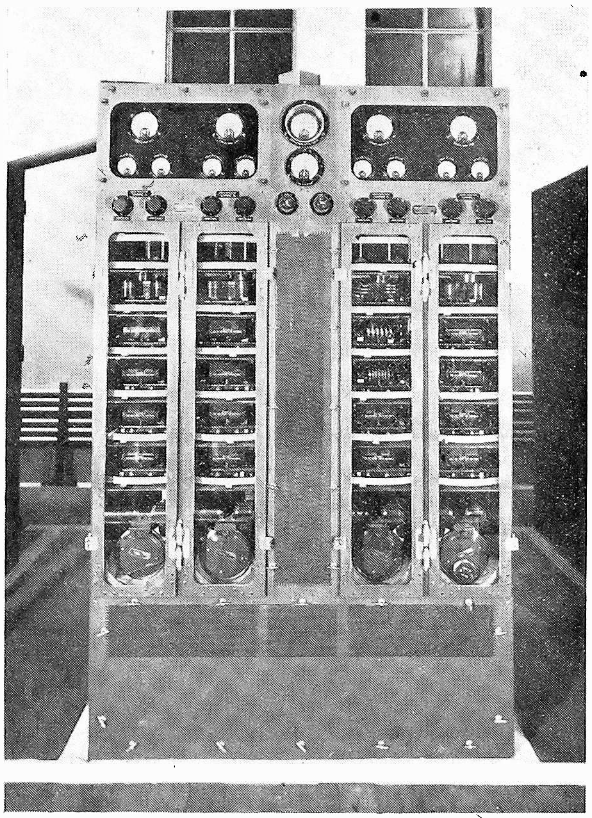


FIG. 3.

Amplifying or Frequency Multiplying Stages.—Each of these stages is easily removable. Stages 1, 2 and 3 each employ screened grid valves and may be used as either amplifiers or frequency changers. The oscillatory circuits of these stages are made electrically symmetrical with respect to earth by means of a small adjustable condenser which forms part of the tuning condenser unit.

Stages 4 and 5 are amplifying stages, in each of which two valves are arranged as the opposite sides of a capacity Wheatstone bridge circuit. The other two sides consists of adjustable balancing condensers which, with the tuning condenser, form a compact composite unit. Two triode valves are used in both stages 4 and 5.

In each of the four ranges, the output from Stage 5 to its concentric feeder is via a tuned circuit with variable inductive coupling.

All the above stages are provided with plug-in coils, each coil being marked with the stage number, and the wave range obtainable with its condenser.

The wave range of the master oscillator supplied with this transmitter is given below :—

Range.	Oscillator Wave Band.	5th Stage Amplifier Output Wave Band.	Spot Wavelengths.
1	404 —319 metres	40 —100 metres	40.30 metres
2	182 —144 ,,	24 — 45 ,,	31.30 ,,
3	225 —178.2 ,,	14.9— 28 ,,	20.64 ,,
4	152.5—120.6 ,,	13.5— 19 ,,	16.25 ,,

A 5 to 1 wave range is obtainable from any one of the four ranges by changing plug-in coils, and by a suitable choice of harmonics for the frequency changing stages, e.g., 20 to 100 metres, or 14 to 70 metres.

Intermediate Amplifier Panel.

First Stage.—The design of the high frequency circuit of this stage is of particular interest by reason of the entire elimination of connecting leads between the anode inductance and the various capacities. The circuit consists of a composite unit comprising an anode tuning condenser, with interchangeable plug-in inductance, one semi-adjustable balancing condenser, two adjustable balancing condensers, of which the ratio is adjustable by hand control from the front of the panel, two fixed coupling condensers, and an adjustable condenser for producing electrical symmetry with respect to earth. The whole unit is easily accessible for adjustments and can be removed from the panel without dismantling by unscrewing a few bolts. The three balancing condensers are arranged as three arms of a capacity Wheatstone bridge, the fourth arm consisting of the anode to grid capacity of a triode valve.

Second Stage.—As in the first stage, the circuit consists of a capacity bridge in which two opposite arms each carry the anode to grid capacities of two triodes in parallel. Each of the other two arms of the bridge contain two adjustable balancing capacities. Of these, two in opposite arms are relatively small and are automatically controlled by the wave change mechanism ; the other pair are controlled by hand from the front of the panel, and are only used for initial adjustments or when changing valves.

Both the rotating table carrying the four closed circuit inductances, and its support, consist of large gunmetal castings. The inductances are mounted on conical porcelain insulators. Below each inductance, and connected to its ends are two large contacts which engage with large switch type contacts on each side of the closed circuit condenser, when the table is pushed forward. The support for the table is mounted on rollers, and is moved forwards or backwards simultaneously with a similar assembly in the main amplifier panel, by a brass lever situated between these two panels. The intermediate and main amplifier turntables are shown in Fig. 4.

On moving the turntable forward, another pair of switch contacts reconnects the H.T. supply to the centre point of the required closed circuit inductance.

Four coupling coils are provided, one for each spot wave. Coupling is controlled from the front of the panel and is varied by swinging the coils radially behind the closed circuit inductances. Each coupling coil carries two contacts which, on pushing the table forward, engage with two other contacts, connected to the outgoing feeder, and to one of four pre-set tuning condensers.

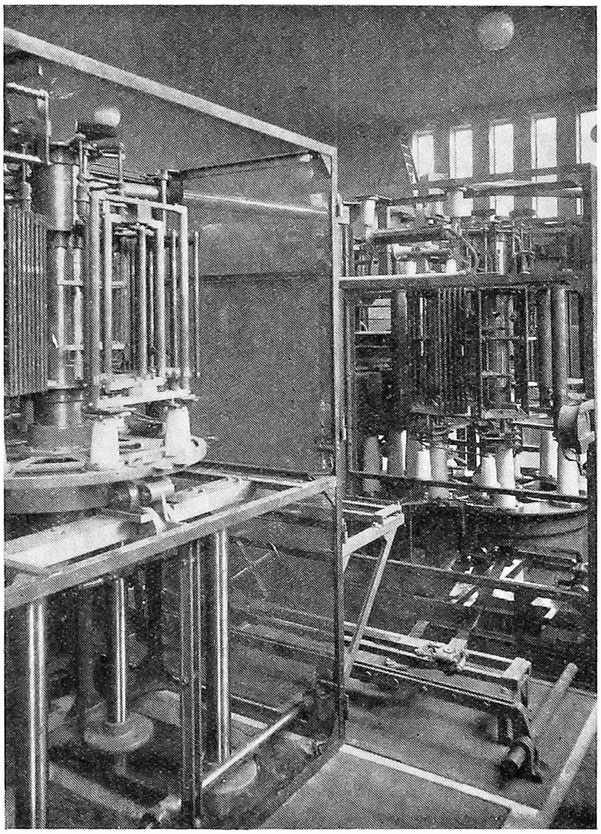


FIG. 4.

On the periphery of the turntable are mounted four pairs of adjustable cams, one pair for each spot wave. On each side of the panel, near the turntable, is mounted a lever and link mechanism, each of which controls one of the smaller pair of balancing condensers. On rotating the turntable in order to change wave-length, the cams operate these two condensers via their link mechanisms. The circuit is initially balanced by means of the pair of hand controlled balancing condensers. The cams are so adjusted that on changing wave, the change in capacity due to the cam controlled condensers provides the necessary correction in the total balancing capacity to maintain stability on the new wave.

Main Amplifier Panel.

The general arrangement and working principles of the main amplifier circuits are similar to those on the intermediate panel. Two cooled anode valves in parallel are arranged as the opposite arms of a capacity bridge. As before, a turntable is operated by the large handwheel and lever common to both turntables. On the table are mounted the four closed circuit inductances. Adjacent to these are the four coupling coils, each tuned by a pre-set variable condenser. The inductances, feeder coupling coils, and H.T. supply are automatically connected to the rest of the circuit by switch contacts on moving the table forward, as in the intermediate panel. On each side of the closed circuit condenser are mounted the two balancing condensers. These and their operating mechanism differ slightly from those in the intermediate panel. Only one moving plate is used on each side instead of two, and this is controlled by both the cam control and the hand control independently. For wavelengths below 22 metres the inductive reactances of the grid leads, and of the leads to the moving plates of the balancing condensers, are neutralised by automatically switching in fixed condensers when changing grid transformers. Each grid circuit has its own milliammeter.

The high frequency output from the intermediate amplifier is brought via a concentric tubular feeder, and fed to the grids of the valves through one of the four high frequency transformers, there being one for each spot wave. These are mounted round a cylindrical structure which is rotated by a large handwheel. The ends of each transformer primary and secondary winding are brought out to a pair of knife contact sectors mounted on the cylinder. By rotating the cylinder, these sectors may be made to engage with two pairs of switch contacts, so enabling any one of the four transformers to be switched into circuit. The pair of contacts which connect with the primary winding sectors are connected to the input feeder terminals, while those which connect with the secondary winding sectors are connected to a variable condenser, controlled from the front of the panel. A cam mechanism at one end of the cylindrical structure, operates the switches for the fixed reactance condensers in the grid and balancing condenser leads, while at the other end of the cylinder a four-way rotary selector switch connects the positive terminals of the four grid milliammeters to any one of four grid bias supply terminals. This enables the correct grid bias voltage to be applied for any wavelength without further adjustment, and speeds up the wave changing operation.

Output Circuit.

The four coupling coils on the turntable, previously described, swing radially for variation of coupling, as in the intermediate panel. On moving the table forward, the toothed sector which operates the selected coupling coil, engages with, a rack controlled from the front of the panel, and the automatic switching connects one end of the coupling coil to its pre-set variable condenser, and the other end to the inner of the aerial feeder.

Check Receiver Supply.

One end of a carbon resistance is connected to the terminal of the aerial feeder, the other end being earthed. Tappings on this resistance are provided from which a lead is taken to the check receiver.

Modulator and Absorber Panel.

Single triodes are used for the note oscillator, sub sub modulator, sub modulator sub sub absorber and sub absorber stages.

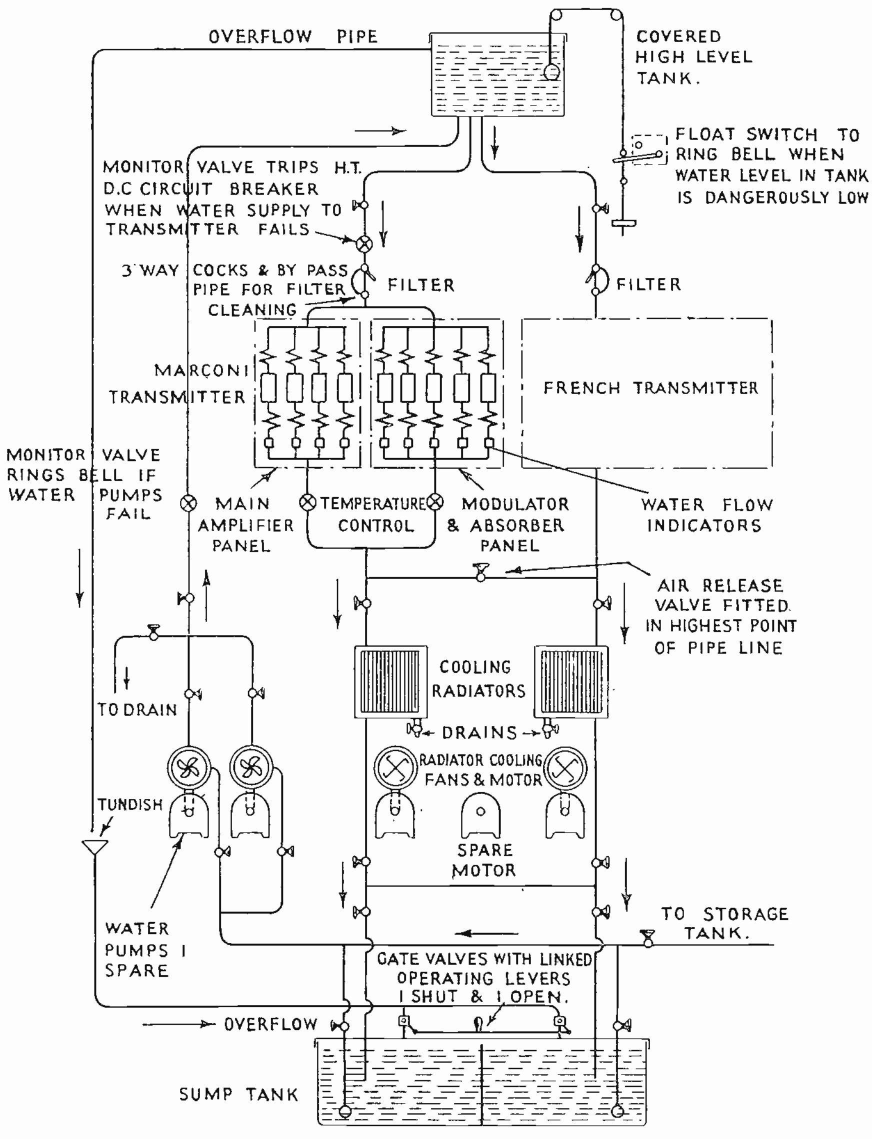


FIG. 5.

In the main modulator and absorber stage five valves of the water cooled anode type are employed and by means of change-over switches can be utilised as either main modulators or main absorbers.

Modulator and Absorber Panel.

Single triodes are used for the note oscillator, sub sub modulator, sub modulator sub sub absorber and sub absorber stages.

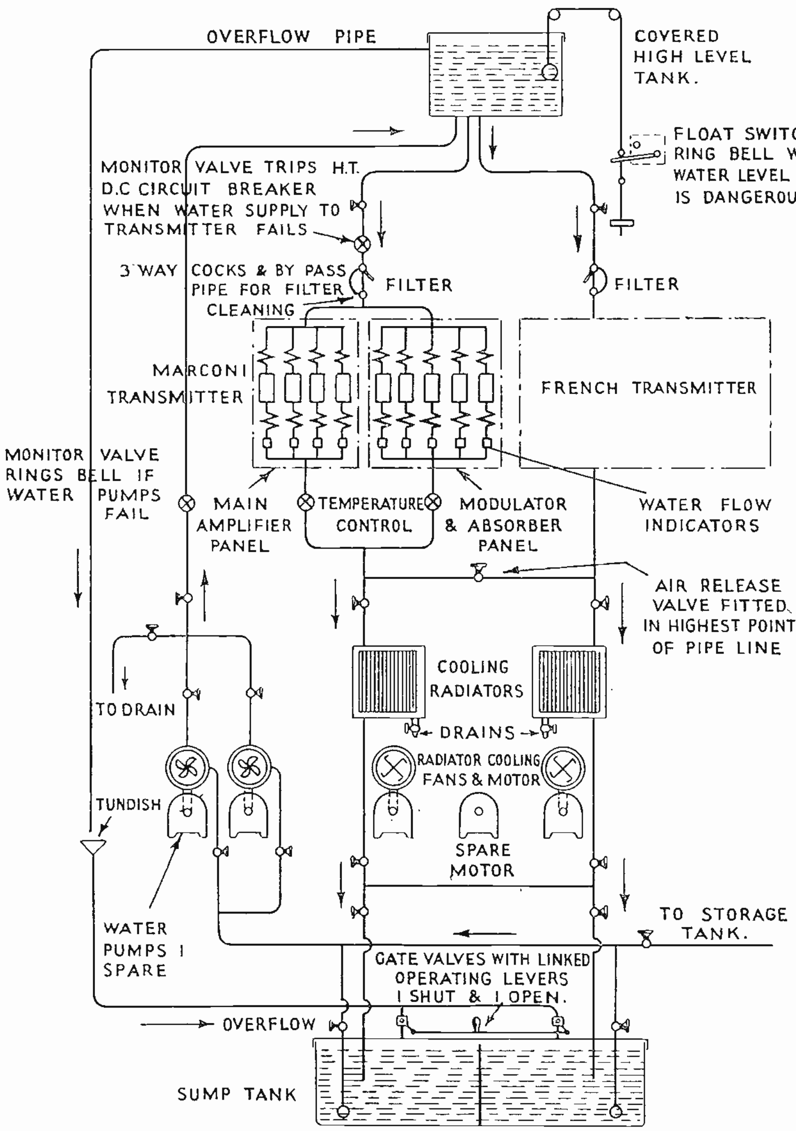


FIG. 5.

In the main modulator and absorber stage five valves of the water cooled anode type are employed and by means of change-over switches can be utilised as either main modulators or main absorbers.

Carbon lamps are provided in series with the anodes and grids of the main modulator and absorber valves. Those in the anode act as limiting resistances in the event of the grid negative supply failing and they also give a rough visual indication of any unevenness of anode feed between the valves. Those in the grid-prevent self-oscillation.

For telephony, grid current galvanometers are provided.

For I.C.W. telegraphy, the note oscillator anode and filament supply are switched on by means of two switches coupled together and operated by one handle. These are arranged so that the filament circuit is made first and broken last when operating the switch. Another switch connects the note oscillator output to the grid of the sub sub absorber via the keying relay for I.C.W. telegraphy, and also changes over the sub sub absorber grid positive supply lead from one positive supply to another when changing from C.W. telegraphy to I.C.W. telegraphy.

Telephone-Telegraph Change-over Switches.

For changing from telephony to telegraphy, five switches are provided to change over the grids of the five main modulator or absorber valves from a grid negative supply for telephony to another supply for telegraphy, derived from a potentiometer which is automatically made negative during "key down" periods and positive during "key up" periods.

In the anode circuit of the main modulator or absorber are two more switches. When changing over from telephone to telegraph, one of these short circuits the speech choke, and the other short circuits a resistance which is placed in series with the main amplifier anodes for telephony. Another change over switch connects the H.T. supply on to the sub sub absorber for telegraphy, and to the sub modulator and sub sub modulator for telephony. Adjacent to this is a similar switch which connects or disconnects the H.T. supply to the sub absorber.

Three more switches control the filament supplies of the auxiliary stages. The foregoing twelve switches are mechanically coupled, and operated by one handle on the front of the panel.

The grid of each main modulator or absorber valve is connected to a switch. On telephony the grids of the valves are switched over to a negative supply, individual control of the grid voltages being obtained by tappings on a potentiometer. On telegraphy the grids are switched over to tappings on another potentiometer incorporated in the panel. This potentiometer forms part of a grid control circuit containing three other resistances, the upper end of the circuit being connected to the main H.T. supply and the lower end to the main absorber negative supply via the main absorber grid negative switch.

Keying.

The potential applied to the grids of the main absorbers from the tappings on the potentiometer depends on three variables :—

(1) The positive potential from the main H.T. supply applied to the top of the grid control circuit ;
(2) The value of grid negative applied at the bottom of the control circuit ; and
(3) The position of the sliders on the potentiometer.

Now the top of the control circuit is tapped on to the main H.T. supply at the bottom of the second stage intermediate amplifier anode resistance, so that the effective potential depends on the drop in this anode resistance, i.e., whether the second stage intermediate amplifier is taking feed or not. With this stage taking feed the positive potential applied to the top of the control circuit is so reduced that the predominant potential is the main absorber negative, and the main absorber is therefore cut off (key down). The action of the remaining absorber stages is as follows :—

When the keying relay is at " mark," the sub sub absorber grid is made positive ; this stage therefore takes an anode feed, and the drop in its anode resistance reduces the positive potential applied to the sub absorber grid. The sub absorber grid negative takes charge, cutting off the sub absorber anode feed, and the consequent rise of potential at the bottom of its anode resistance is sufficient to operate the first stage intermediate amplifier. The latter drives the second stage intermediate amplifier, which in turn drives the main amplifier. When the first stage is cut off by the sub absorber, the second stage intermediate amplifier loses its drive ; the standing negative on the second stage and main amplifier grids is then sufficient to cut these stages off. With the keying relay at " space," the converse action takes place in each stage.

With the exception of the main modulator and absorber grid switching, the modulator portion of the circuit conforms to standard practice for choke control.

Switchboard and Control Units.

The switchboard, which is placed opposite the transmitter, controls an A.C. power supply for motor-generators and auxiliaries, and the outputs from D.C. generators for transmitter units, control units, and generator excitation. In front of the transmitter are mounted three control tables (Fig. 1). On the power and filament control tables are mounted rheostats for adjusting the various supplies, while push button switches are provided for starting and stopping all motor-generators, and for controlling the main H.T. circuit breaker and all auxiliary supplies. Indicating lamps and alarm gongs give warning of failure or excessive temperature of the valve cooling water, and indicate whether supplies are on. On the signalling control table are mounted the check receiver, bridge amplifier, undulator, relays and local microphone amplifier.

Protective Circuits.

Automatic relays which protect operating staff and apparatus, provide that the H.T. supply is immediately cut off by an overload, by excessive heating or failure of valve cooling water, or by failure of grid bias, master oscillator output, or filament supply. Opening any panel gate cuts off the H.T. and grid bias supplies, and failure of cooling water shuts down the filament generator. Indicating lamps and alarm gongs give a clear indication of the source of any fault.

Valve Cooling.

Rain water in a closed system with gravity feed is used for cooling the valves, and water is pumped from the sump back to the high level supply tank. Radiators in conjunction with fans are used to cool the water and the rate of cooling is controlled by means of adjustable shutters. The circuit is shown in Fig. 5. Warning and automatic trip devices are incorporated in the system which operate if water temperature rises above normal or if the cooling system is not functioning in a correct manner.

Earth System.

The main earth plate is fitted just outside the transmitter room and is of steel, 36 feet long and 2 feet 6 inches deep, buried vertically in the ground.

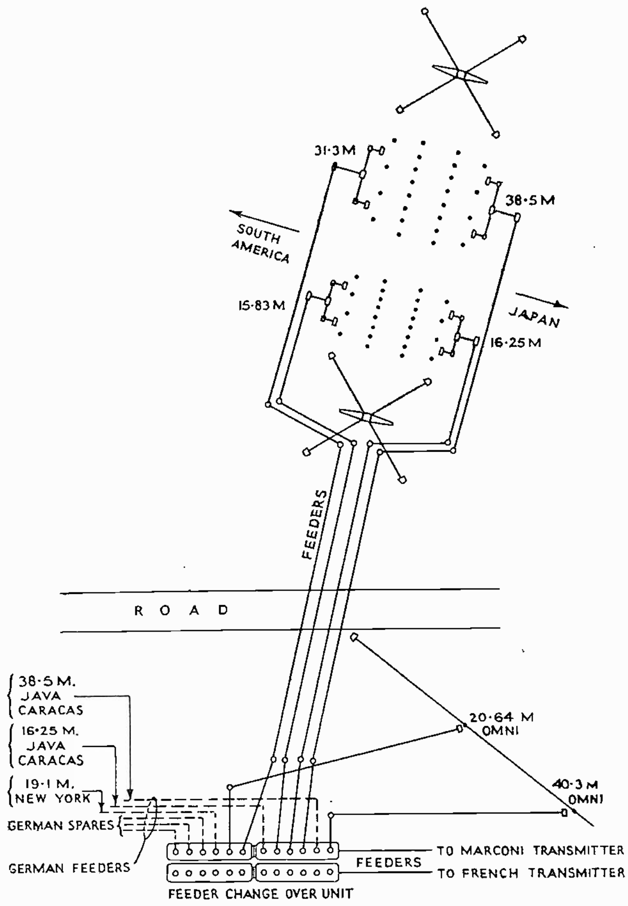


FIG. 6.

Feeders and Aerials.

The output feeder from the main amplifier first passes to the load link and ammeter box in which provision is made for connecting the output, via the feeder change over unit, to any one of twelve outgoing feeders, or alternatively, to the lamp load. The latter consists of six racks each of twenty 230 volt 250 watt radiator lamps connected twenty parallel, six series.

From the feeder change over unit, twelve feeders leave the building, of which six are for the Marconi aerials, and six are German. Of the latter, three go to German aerials, and three are spares.

Four of the Marconi aerials are Franklin beam arrays with reflectors and are designed to give a broad polar diagram of field intensity. Two of these give a concentration in the direction of the Far East, one array on a wavelength of 16·25 metres for day working, and the other on 38·5 metres for night working. The other two beams radiate in the direction of South America, one on a wavelength of 15·83 metres for daylight use, and the other on 31·3 metres for the night period.

The two remaining aerials are of the omni type, and are used mainly for European communications. One is of the Franklin uniform type designed for 20·64 metres, and the other is a simple vertical dipole for a wavelength of 40·3 metres. The layout of the aerials and feeders is shown in Fig. 6.

Power Supply.

The incoming power supply to the station is at 13,000 volts, 3 phase, 50 cycles, and this is transformed down to 500 volts and brought to the A.C. panel of the main switchboard in the transmitter room.

An emergency power supply is also available from a Diesel driven 3 phase, 500 volt, 50 cycle alternator, of a capacity sufficient to operate the station at full load.

Power Plant.

The motor-generators, auxiliary rectifier, and air and water supply motors, are fed from the 500 volt, 3 phase supply, and are housed in the basement immediately under the transmitter room. Duplicate sets are provided.

The master oscillator anode and filament machines consist of direct coupled motor-generators separately excited from an independent 110 volt D.C. motor-generator. The anode generators are rated at 2 kw., 400/1,000 volts D.C., and the filament generators at 6/12 volts, 100 amps D.C.

The main filament generators have direct coupled 110 volt exciters, and are of 20/30 volts, 1,000 amps. capacity.

The main H.T. D.C. generators also carry their own 110 volt exciters, and are rated at 60 kw., 6,000/10,000 volts.

The speech choke and H.T. D.C. cubicle are also housed in the basement.

Landline Interconnections.

The transmitting station at Prangins is 24 kilometres from Geneva, and about 18 kilometres from the receiving station at Colovrex. The landlines from the Central Office at Geneva to Prangins and Colovrex pass through the League Palace, and are so arranged that in time of emergency, the service could be carried on from the Palace of the League of Nations direct.

MARCONI REVIEW, NO. 39. ERRATA.

On page 19, line 30, substitute the expression

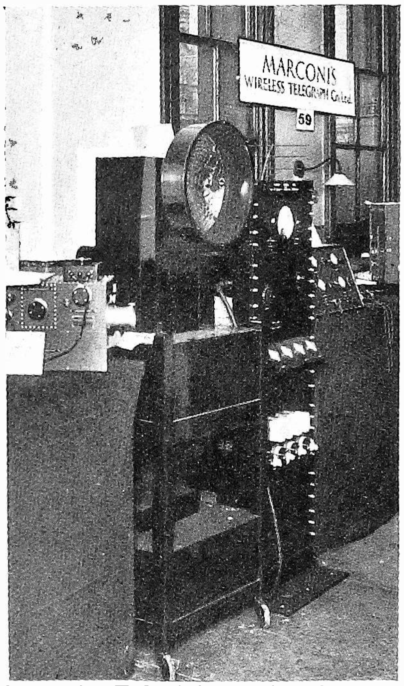
$$\hat{E} = \sqrt{\{\hat{E}_3 \sin(\omega_3-\omega_1)t+\hat{E}_2 \sin(\omega_2-\omega_1)t\}^2+\{\hat{E}_1+\hat{E}_2 \cos(\omega_1-\omega_2)t+\hat{E}_3 \cos(\omega_3-\omega_1)t\}^2}$$

for the expression

$$\hat{E} = \sqrt{\{\hat{E}_3 \sin(\omega_3-\omega_1)t+\hat{E}_2 \sin(\omega_2-\omega_1)t\}^2+\{\hat{E}_1 \cos(\omega_1-\omega_2)t+\hat{E}_3 \cos(\omega_3-\omega_1)t\}^2}$$

MARCONI TELEVISION AMPLIFIER

WITH FLAT REPONSE CHARACTERISTICS FROM 10 CYCLES TO 150 KILOCYCLES.



Marconi Television Amplifier at Physical Society Exhibition, South Kensington.

At the Physical Society Exhibition held at the Imperial College of Science and Technology in the first week of January, 1933, the Marconi Company exhibited an amplifier capable of faithful reproduction of frequencies from 10 *cycles to* 150 *kilocycles. A description of this amplifier is given below.*

FOR purposes of television and other work with photo-electric cells and interrupted light, as well as for many other experimental purposes, amplifying equipment is required possessing uniform sensitivity over a very wide band of frequencies, and this equipment has been specially developed to meet this need.

The equipment is divided into two units :—

(A) A portable unit which contains the photo-electric pick-up device, together with an amplifier designed to deliver to the line connecting the two units, a signal power level which is well above that of induction disturbances, cross talk, etc., which might arise under practical working conditions.

The second unit (B) is a fixed unit, and is mounted on a small rack. It includes a control unit, an amplifier unit designed to raise the signal energy to a level sufficient to modulate a transmitter, or to actuate a monitoring unit, and also a power level indicator.

In order to obtain the widest possible frequency spectrum, new methods have been used for amplification, and response correction. Throughout the equipment no transformers or other iron core components have been utilised, and a method of resistance amplification, using screen grid valves, has been developed to avoid the losses associated with ordinary triode circuits. Special methods of compensation have allowed the flat frequency response region at both low and high frequency ends to be very much extended, and care has been exercised in keeping to a minimum both phase shift and harmonic production. Under practical working conditions, the frequency characteristic may be regarded as flat from 10 cycles to 150,000 cycles.

Provision is made in the photo-electric pick-up unit for a limited correction for droop in photo-electric cell response, and units are provided to meet the requirements of different types of cells, etc.

The overall magnification of the first amplifying unit is of the order of 100 decibels. The voltage amplification of the second amplifier is relatively low, as it is designed more as a power converter. For many experimental purposes, the first unit may be used by itself and apart from the second unit, and provision has been made for inputs other than photo-electric cells. A special bench mounting for this unit can be provided where required, and it should thus prove, on account of its sensitivity and flat response, of great use for laboratory measurements.

OBITUARY.

It is with great regret that we have to record the death at Southampton on the 2nd January, 1933, of George Stephen Kemp who had the honour of being Marchese Marconi's first assistant, as he was appointed when the latter came to England in 1896, and for the whole subsequent period of 37 years he was in constant touch with Marconi and his work.

Mr. Kemp's early days were spent in the Navy, and for a number of years he was a Chief Instructor in Electrical and Torpedo work at Portsmouth. He left the Navy to become Laboratory Assistant to the late Sir William Preece, then Chief Engineer of the General Post Office. It was in this capacity that he was detailed by Sir William to assist Marconi when in 1896, the first demonstration of wireless telegraphy was given in this country to Officers of the Post Office and other Government Departments, on the roof of the General Post Office. In November, 1897, Mr. Kemp joined the Wireless Telegraph & Signal Company, the forerunner of the Marconi Company, and from that time onwards, he was employed on experimental and other work at the various historic Marconi Research Stations and Laboratories, such as Bournemouth, The Haven, The Needles and Poldhu. He accompanied Marconi to Newfoundland in December, 1901, and took part in the first demonstration of Transatlantic wireless telegraphy, when the famous " S " signals from the high power station at Poldhu were received by Marconi using a kite and a special form of coherer detector, the signals being also heard by Mr. Kemp.

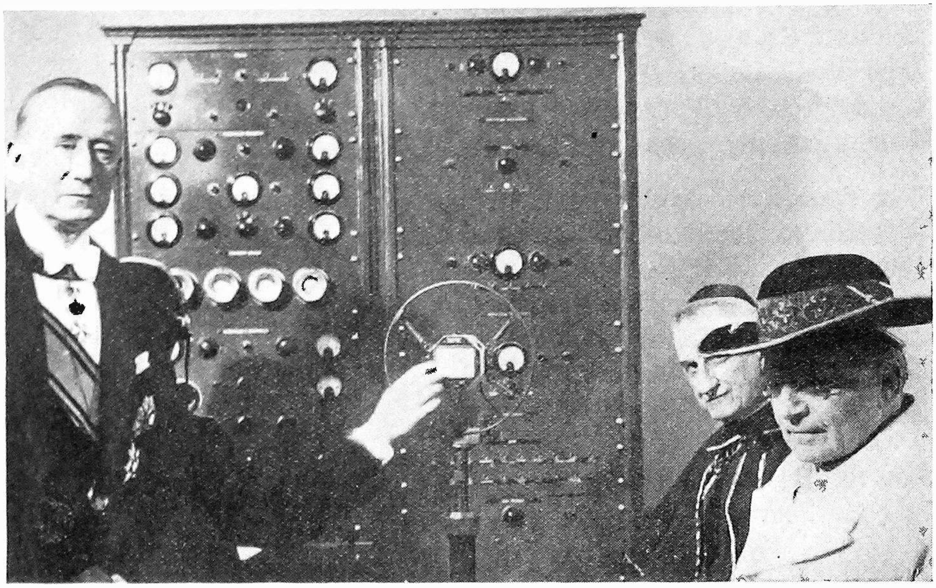
His knowledge and carefully preserved records of Marconi's early work often proved to be of considerable use to the Marconi Company, notably in its action at New York against the De Forest Wireless Telegraph Co., in 1905, which established the priority of Marconi's work to that of his competitors.

Mr. Kemp was in his 76th year. He leaves a wife, two sons and one daughter.

Among those who attended the funeral at Southampton on January 6th, were, Mr. H. W. Allen, representing Marchese Marconi, Mr. B. O. Collis, representing the Marconi Company, and Mr. Andrew Gray, representing Marconi Veterans.

MARCONI NEWS AND NOTES

FIRST MICRO-WAVE RADIO TELEPHONE SERVICE



His Holiness the Pope (right) *and His Excellency Marchese Marconi* (left) *at the ceremony which inaugurated the micro-wave radio telephone service between the Vatican City and Castel Gandolfo.*

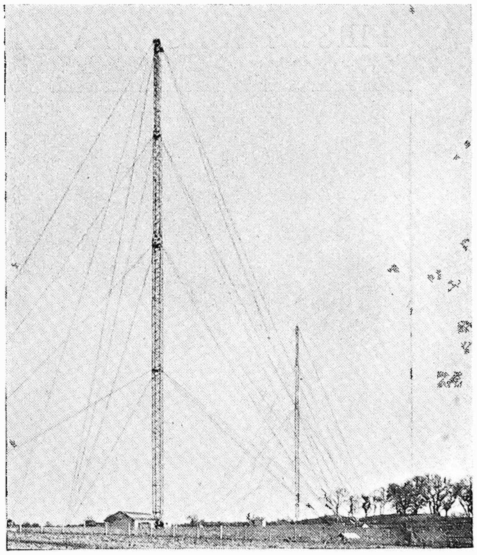
THE first regular micro-wave radio telephone service in the world, between the Vatican City and the Palace of His Holiness the Pope at Castel Gandolfo, near Rome, was inaugurated by the Pope on Saturday, February 11th.

The installation of the micro-wave stations in the Vatican City and at Castel Gandolfo, which operate on the wavelength of 60 centimetres, was personally supervised by Marchese Marconi, the Vatican authorities having been the first to decide upon the adoption of the micro-wave system for telephonic communication following a demonstration of two-way communication given by Marchese Marconi in Italy early last year.

During his recent visit to London, Marchese Marconi described his new micro-wave apparatus to the members of the Royal Institution of Great Britain, and in regard to the micro-wave telephone service between the Vatican City and Castel Gandolfo he said : " This application is of great interest, as the distance between the two points, a matter of 20 kilometres, is entirely over land, and also because there is no actual clear vision between the two places on account of the intervening trees in the Vatican Garden and those of the Avenue built over the Gianiculum Hill, situated at about four miles from the Vatican."

Irish Free State Broadcasting Station.

THE Irish Free State Broadcasting Station at Athlone, erected by the Marconi Company to the order of the Irish Posts and Telegraphs Department, was opened by President de Valera on Monday evening, February 6th.

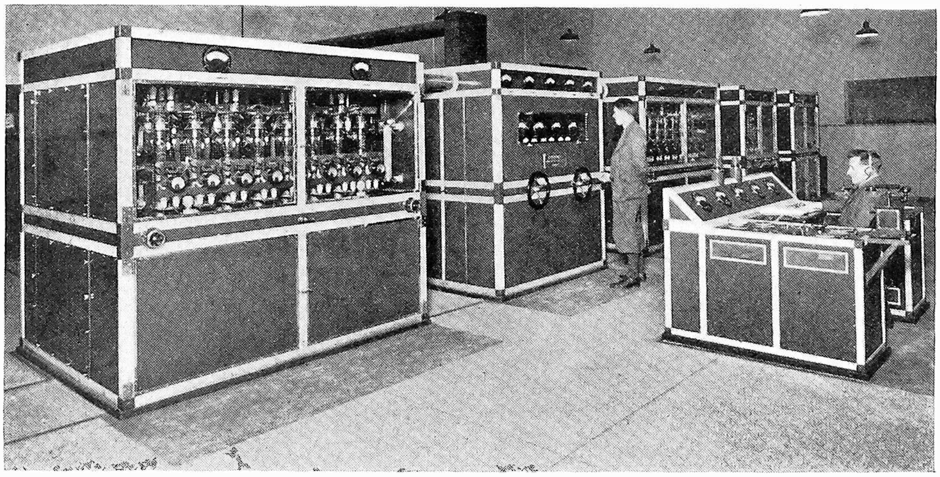


Masts and buildings of the Irish Free State Broadcasting Station, Athlone.

The President delivered his address at the Dublin studio, which was connected by land line to the transmitting station at Athlone, at the geographical centre of Ireland. With him in the studio were Senator Connolly, Minister for Posts and Telegraphs; Mr. O'Kelly, Minister for Local Government; Mr. Geoghegan, Minister for Justice; and Mr. McEntee, Minister for Finance.

In introducing the President, Senator Connolly, Minister for Posts and Telegraphs, referred in appreciative terms to the efficiency of the new station.

"The station at Athlone," he said, "is one of the most up-to-date and powerful in Europe, and it is planned to give a high-class service to as large a part of Ireland



Marconi 60-kilowatt transmitter installed at the Irish Free State Broadcasting Station, Athlone.

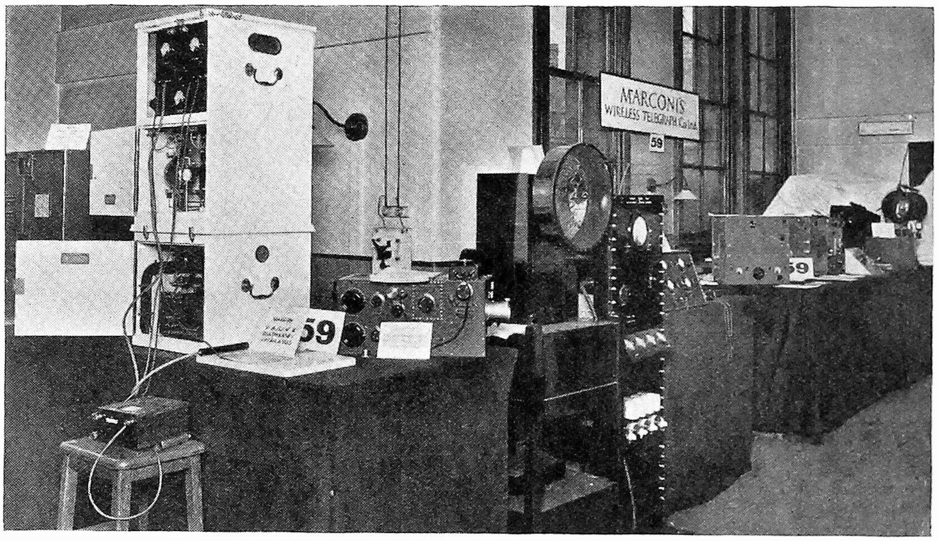
as is possible under present technical limitations; to carry Irish programmes to exiles from the Mother Country, and to peoples of other nations, over as wide an area as possible.

"The reports received on our test transmissions indicate that the station will more than meet our expectations.

"We have had many enthusiastic reports from listeners in Newfoundland, in India, and Greenland, and from practically every country on the Continent of Europe.

"It is my hope, and the hope of all connected with this station, that the programmes will carry pleasure and interest into the homes of both the Irish people and the friends of the Irish people abroad."

The station is equipped with the latest type of Marconi broadcasting transmitter with an unmodulated aerial energy of 60 kilowatts and modulation up to 80 per cent., and arrangements have been made whereby the power of the transmitter can be doubled at any time if required. The wavelength of 413 metres, previously used by the Dublin broadcasting station, has been adopted for Athlone, but the new transmitter can be adjusted to any wavelength between 300 and 550 metres.



Marconi exhibits which attracted widespread scientific interest at the recent Physical Society Exhibition in London. The exhibits are, from left to right: Marconi 300-watt marine telephone-telegraph transmitter; Marconi valve diathermy equipment; Marconi portable unmodulated radio frequency generator and attenuator; Marconi television amplifier; Marconi micro-wave equipment; Marconi portable picture transmitter and receiver; Marconi equi-signal beacon receiver; Marconi light-beam telephone equipment.

"Regional" Broadcasting in Japan.

JAPANESE listeners are to have the advantage of an organised service of alternative programmes in the near future, the Broadcasting Corporation of Japan having adopted a "regional" broadcasting plan on similar lines to that of the British Broadcasting Corporation.

In accordance with this plan, the broadcasting station at Osaka is to be fitted with an additional Marconi transmitter which will broadcast simultaneously with the present installation to provide alternative programmes throughout the service area of the station.

The new equipment of the Osaka station consists of a Marconi Type P.A. broadcasting transmitter, of 10 kilowatts power and incorporating the most modern features of design, including the principle of low power modulation. The quality and reliability of this type of equipment, one of which is installed and working at the Nagoya Station, has already proved highly popular with Japanese listeners, as is indicated by the Japanese Broadcasting Corporation's order for the additional transmitter at Osaka. The present single transmitter at Osaka is, incidentally, a Marconi Type Q.D. installation of 10 kilowatts power.

Other broadcasting stations at which the Marconi Type P.A. broadcasting transmitters are installed, or on order, include Bratislava, Bucarest, Lwow, Reykjavik, Trieste, Florence, Bari, Viborg, Wilno, Monte Ceneri (Switzerland), Buenos Aires and Cape Town. All these transmitters were designed and built at the Marconi Company's works at Chelmsford, Essex.