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POST OFFICE ENGINEERING DEPARTMENT.

Radio Report No. 276.

The Adjustment of the Leading-in Circuits of the Burnham Radio Station.

OFFICE OF THE ENGINEER-IN-CHIEF,
(RADIO SECTION),
GENERAL POST OFFICE,
LONDON, E.C.1.

hh. 2.VIII.

RADIO REPORT NO. 276.

The Adjustment of the leading-in circuits of the Short Wave Arrays at the Burnham Radio Station.

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at :- The Burnham Radio Station.

date :- December 1933 - January 1934

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29th May, 1934.

Rota 3384 Ra./34.

The Adjustment of the leading-in circuits of the Short Wave Arrays at the Burnham Radio Station.

General.

The Burnham Radio Station, Somerset, is a receiving station for telegraphic signals from ships in all parts of the world and works in conjunction with the transmitting station at Portishead. Ships' short wave transmitters operate within the frequency bands

8.2 - 8.55 megacycles.
11.0 - 11.4 "
12.3 - 12.8 "
16.4 - 17.1 "

Three arrays were erected at Burnham prior to 1933 and seven during the summer of 1933. Each of the ten arrays is directed on one of the four main shipping routes of the world. Arrays have been erected for working each route on the wavelengths commonly used. Details of the arrays are tabulated below.-

Wavelength	No. of arrays provided	Direction of main beam (Degrees E. of N.)				Polarisation	Beam Width in Degrees
35.85 m.	4	0 or 180 ✓	40 or 220 ✓	78 or 256 ✓	109 or 289 ✓*	Horizontal	60°
26.8 m.	2			78 or 258 ✓	109 or 289 ✓*	Vertical	30°
23.9 m.	3	0 or 180 ✓	40 or 220 ✓			Vertical	30°
23.9 m.					108 or 288	Horizontal	40°
17.9 m.	1				289 *	Horizontal	40°

Note (1) *Erected before 1933.

Note (2) The width of the beam may be defined as the angle between the first minima on either side of the main beam.

Drawing WL. 6867 shows the directions of Plett's Zenithal Azimuthal Graticule, which gives the true distance and direction of all parts of the world from London, and to a sufficient degree of accuracy from Burnham.

One array, the 17.9 m., has a reflector, and has therefore only one main beam; the other arrays have no reflectors and have therefore two main beams spaced 180° apart.

The pairs of arrays, marked ✓ in the table, having the same orientation are supported between the same masts with a spatial separation of 12 feet. In each case a 35.85 m. horizontal array

is associated with a 26.8 m. or 23.9 m. vertical array, thus minimising any possibility of interaction. The 23.9 horizontal array is not associated with any other array.

In addition to the above arrays vertical doublets giving omnidirectional facilities are provided for each of the above wavelengths.

Lead-in arrangements.

The arrays are connected to the receivers by two-wire transmission lines having a surge impedance of 600 ohms (200 lb. copper wire at 9-inch spacing): At the receiving building the lines are terminated on insulators on a gantry some 10 feet from the lead-in windows of the receiving building; connection between the gantry and the lead-in windows of the receiving building being made by means of a tapered transmission line, the spacing changing from 9" at the gantry to 4" at the lead-in windows. This was found to result in a terminal impedance of 500 ohms at the window when the remote end of any individual line was terminated in 600 ohms.

Method of matching impedances.

The high frequency impedance measuring set, which will be described in a subsequent Radio Report, was used for the measurement of impedance. The measurements made and the results obtained are described below after a brief description of each type of array. Drawings WL 12183/4/5/6 show the results obtained.

35.85 m. Horizontal Arrays.

Each of these arrays consists of two panels composed of two half-wave doublets connected by a vertical transmission line half a wavelength long, the connections of the upper doublets being transposed to obtain the correct phase relationship. To the base of each of the panels a two wire transmission line, one wavelength long, of 200 lb. copper wire with 9 inch spacing was connected. The impedance frequency characteristic measured at the end of one of these lines showed that the maximum impedance occurred at a wavelength of 37.0 m. The length of the line was reduced until the maximum impedance (/,000 ohms, $\angle 0^\circ$) was measured at 35.85 m.; the length of the line was then 8½ feet less than a wavelength. The line from the other panel was then made the same length and the corresponding wires of each line joined and extended by a 600 ohm line half a wavelength long. The impedance measured at the end of this was 1,500 ohms, $\angle 0^\circ$, at 35.85 M. For convenience in matching to the main transmission line, the length of this subsidiary transmission line was reduced from one half to one quarter of a

wavelength, thus the impedance was 240 ohms $\angle 0^\circ$. A matching line had therefore to be made to transform from 240 ohms to 600 ohms; Its characteristic impedance should be 380 ohms. A two wire line of this impedance cannot conveniently be obtained by reducing the spacing between the two conductors, so a four wire line was constructed consisting of two pairs of wires, each pair being connected in parallel. The spacing between the wires forming the pairs was 9" and the distance between the two pairs 2½". The impedance of the array measured at the end of this matching line was 600 ohms $\angle 0^\circ$ at 35.85 m.

The main transmission line was connected to the end of this matching line, and extended to the receiving room. The impedance measured there was 500 ohms, $\angle 0^\circ$, at the mid-band frequency, and varied between 200 and 1,200 ohms over the working band.

The dimensions obtained in matching the first array were used in lining up the others, check measurements being made at the ends of the feeders and matching lines during construction. The impedance frequency characteristic of each array as measured in the receiving room is shown in drawing W.L. 12183. In this drawing and subsequent drawings showing impedance frequency characteristics, the measured resistance is that resistance, which, in parallel with some undetermined value of capacity or inductance, will give the same impedance as the array or transmission line at the particular frequency under consideration.

Somewhat different feeder lengths were found to be necessary for the 35.85 m. array erected prior to 1933 as this was originally designed for a wavelength of 36.5 m.

26.8 m. and 23.9 m. Vertical Arrays.

Each of these arrays consists of six vertical half wave doublets connected at intervals of a half wavelength to a horizontal transmission line. A two wire line is connected to the centre of this line. The connections between the doublets and this two wire line are made in such a manner that the correct phase relationships are obtained.

Measurements were first made on one of the 26.8 m. arrays. The length of the line from the array, at the end of which a non-reactive impedance (200 ohms) was measured at a wavelength of 26.8 metres, was 98½ feet (1¼ wavelengths = 110 feet). A matching line having a characteristic impedance of 345 ohms was constructed to match the impedance of 200 ohms to that of the main 600 ohm transmission line. The matching line comprised four wires, each a quarter of a wavelength long, supported on insulators, at the corners of a 5-inch square, adjacent pairs being joined

together at the ends. One end of the matching line was connected to the end of the line previously measured, its spacing of 9 inches being maintained up to the junction with the matching line. The impedance measured at the end of the matching line was 600 ohms at a wavelength of 26.8 metres. The impedance frequency characteristic as measured in the receiving room is shown in drawing WL 12185.

Similar measurements were made on the other vertical arrays a similar construction of matching lines being adopted.

23.9 m. and 17.9 m. Horizontal Arrays.

Each of these arrays consists of three panels, those of the 23.9 m. being composed of three horizontal half wave doublets, and those of the 17.9 m of four, spaced at intervals of half a wavelength along a vertical transmission line. The panels are connected together by two wire lines, approximately $1\frac{1}{2}$ wavelengths long from the outer panels and half a wavelength long from the centre panel. The lengths of these lines were made such as to present the maximum impedance at the working wavelength. The lines from the three panels were then connected together and extended by a two wire transmission line half a wavelength long. The impedance of the 23.9 m. array measured at the end of this line was 800 ohms /0° at the mid-band frequency. This was reduced to 600 ohms by reducing the spacing between the wires of the last quarter wavelength to five inches. The impedance of the 17.9 m array was 600 ohms, so that no matching line was required. See drawings WL. 12184 and 12186.

17.9 m. Rotating Array.

In addition to the arrays already described, there exists a small 17.9 m. array mounted on a turntable, the rotation of which is controlled from the receiving room.

The array consists of two panels complete with reflectors, each panel being composed of two horizontal half-wave doublets connected by a vertical transmission line half a wavelength long. The ends of the elements of the doublets farthest from the centre of the array are vertical owing to the restricted length of the turntable. Lines from the panels are supported on insulators close to the steelwork of the turntable and are combined at copper brushes which make contact with two sliprings. Leads from these sliprings are carried close to the ground before entering the receiving room. It is believed that the feeder system could be improved by the insertion of a transformer arranged as shown in drawing WL. 12247, and steps are being taken to put this suggestion into effect.

Results of lining up.

No means were available for measuring the gain of the arrays, but their use during traffic periods showed that they gave considerably better reception than the doublets, which had been found correctly matched. Interference could be much reduced by the use of the array directed towards the transmitter.

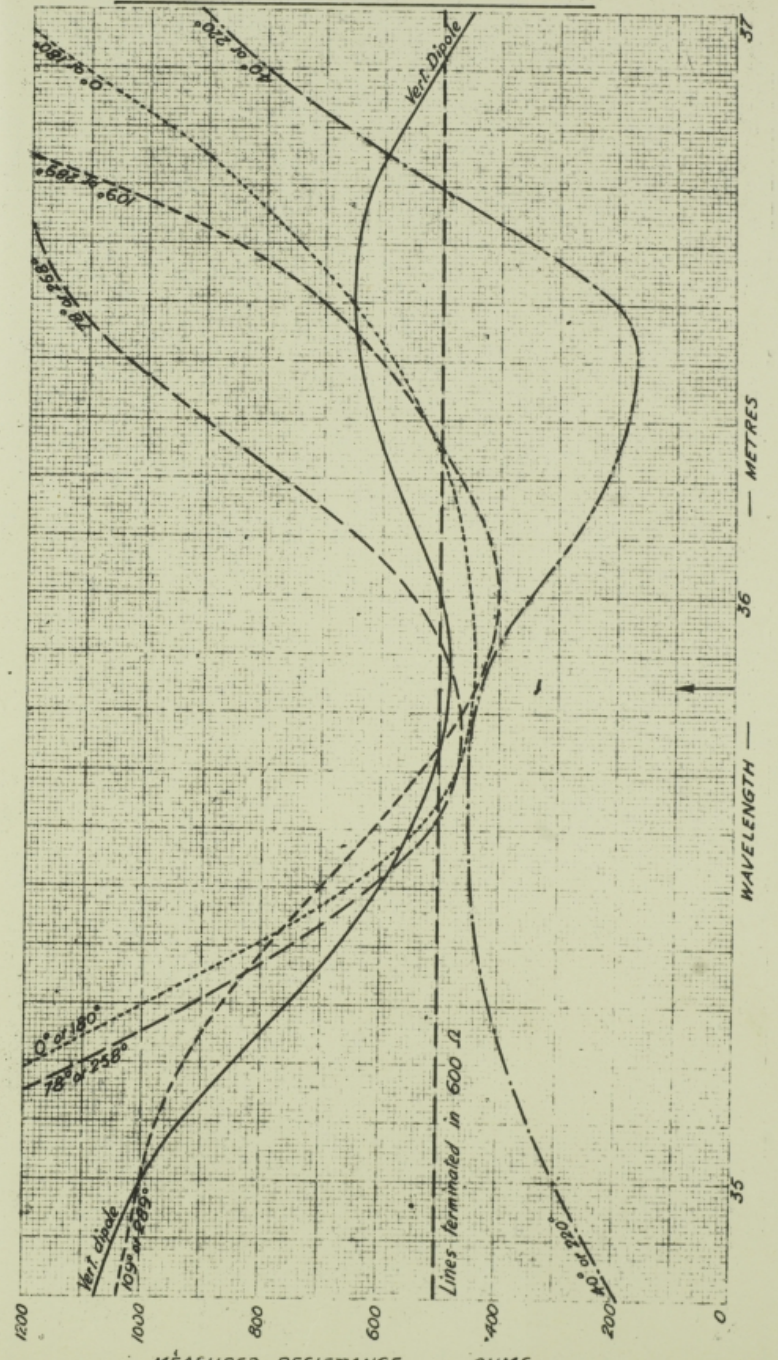
To obtain the best results with these arrays it will be necessary for the input circuits of the receivers to present an impedance of 500 ohms, balanced to earth, and for all the wiring between the lead in windows and the receivers to have a surge impedance of 500 ohms.

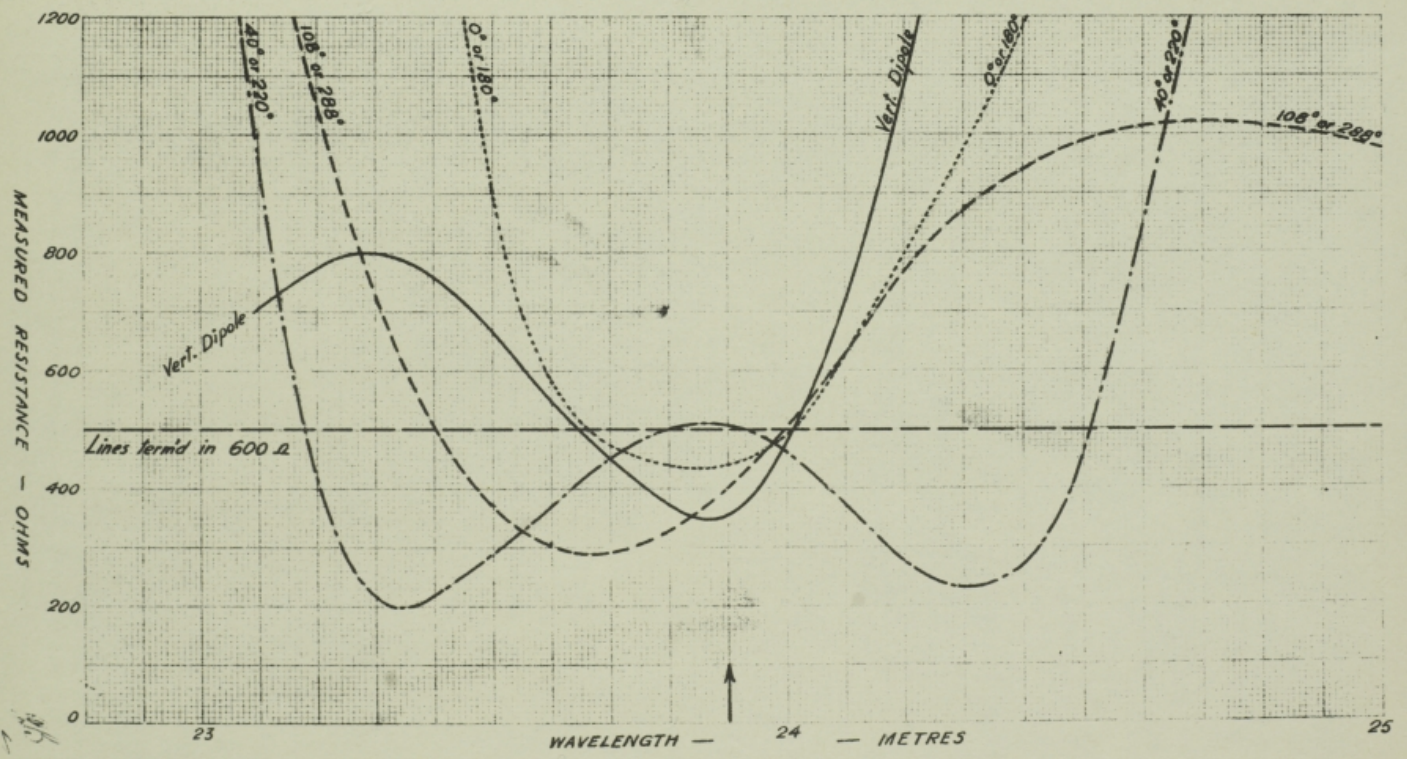
BURNHAM RADIO STATION

35·85 M. ARRAYS

DIRECTIONS SHOWN IN DEGREES E. OF N.

WL. 12183



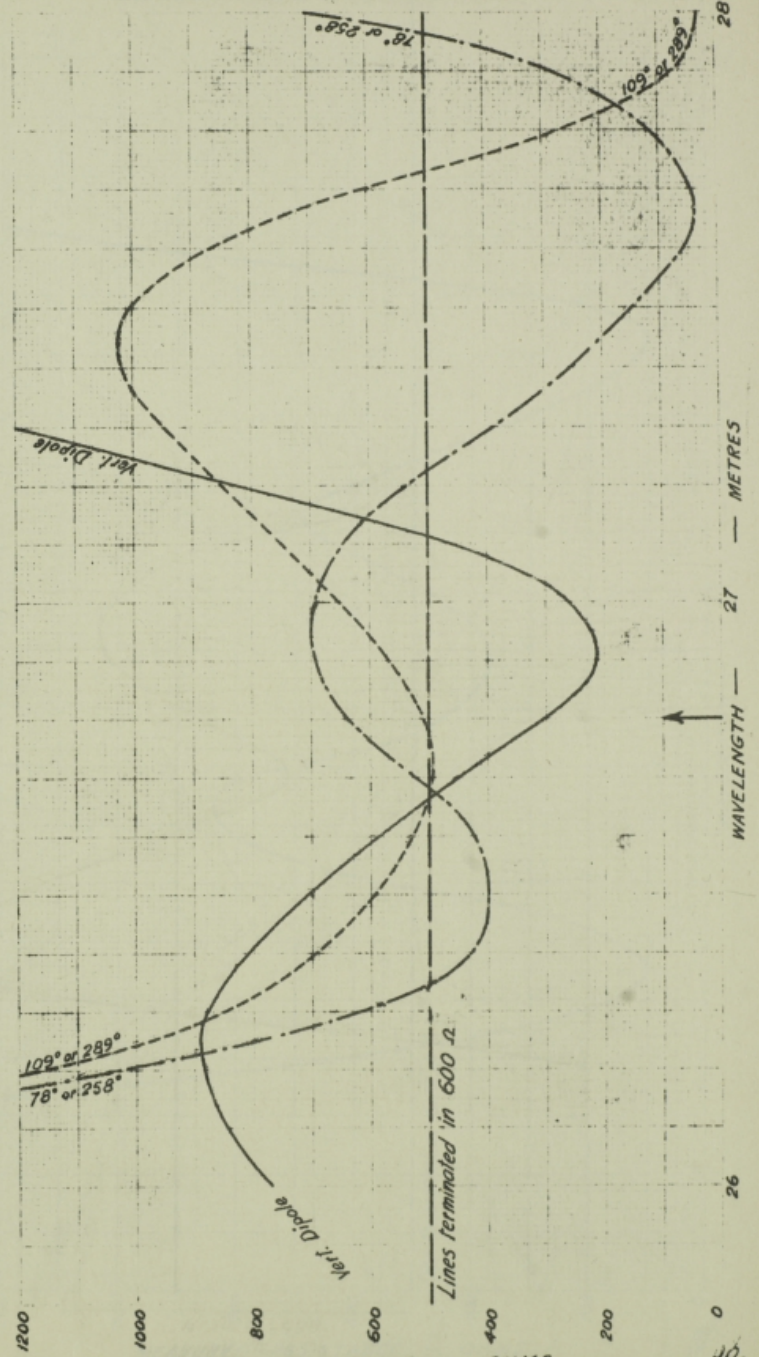


BURNHAM RADIO STATION
23·9 M. ARRAYS.

WL. 12184

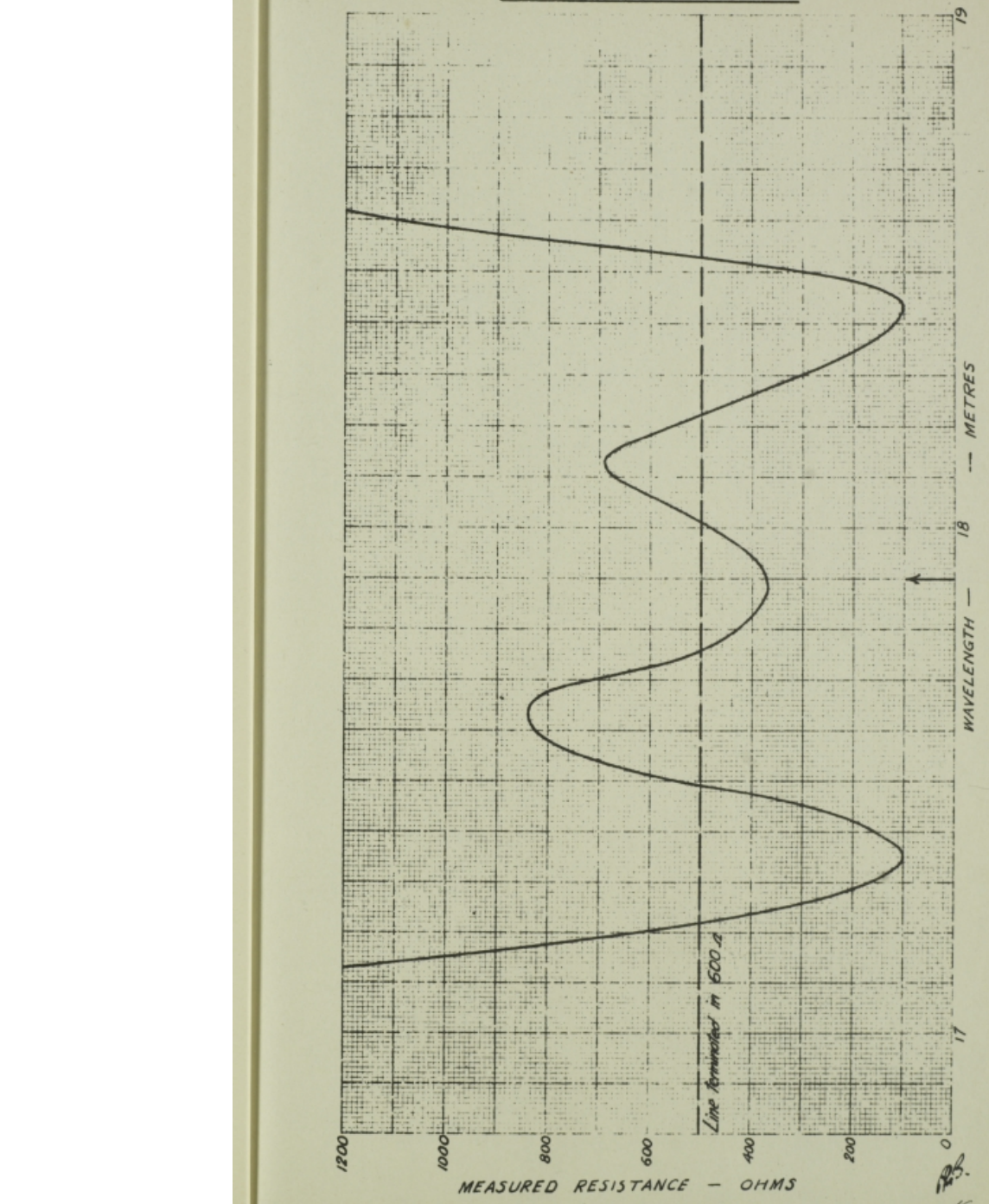
WL. 12185

BURNHAM RADIO STATION
26·8 M. ARRAYS
DIRECTIONS SHOWN IN DEGREES E. OF N.



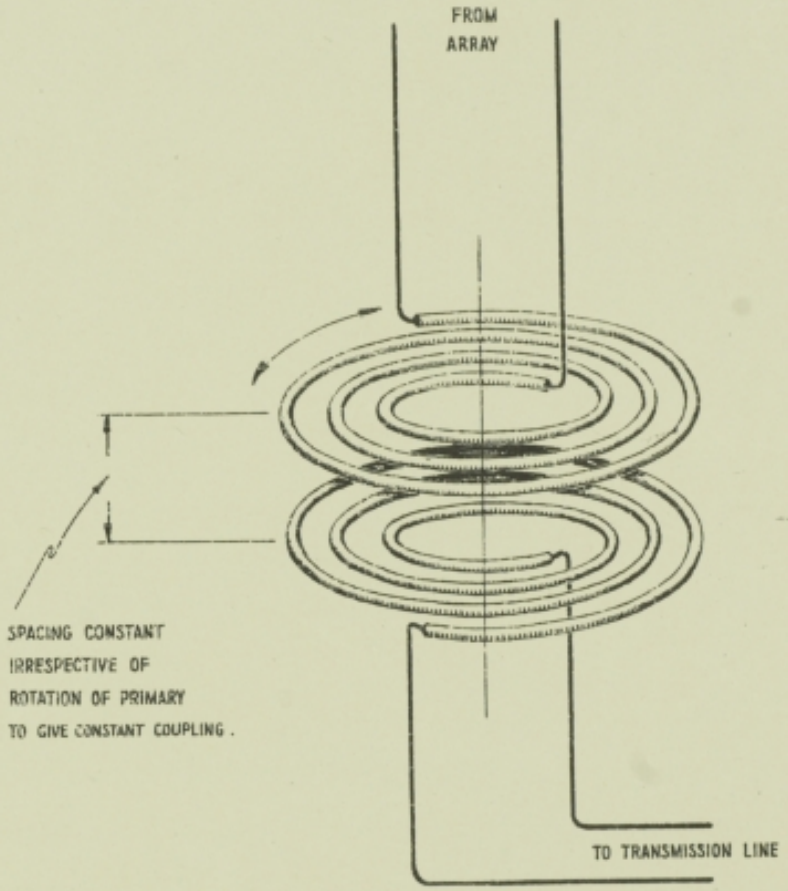
WL. 12186

BURNHAM RADIO STATION
17·9 M. ARRAY
289° E. of N.



SUGGESTED TERMINATION FOR 17·9 M.
ROTATING ARRAY AT BURNHAM.

OFFICE OF THE ENGINEER-IN-CHIEF G.P.O.					
DRAWING WL. 12247					SUFFIX
Specification					
Scale: 1. except where otherwise stated					
Drawn by	Checked by	App'd by WB.	Date 23 5 .34		
Particulars of Amendment	Date	Initials			



OFFICE OF THE ENGINEER-IN-CHIEF G.P.O.

DRAWING WL.6867

Special Notation:-

SCALE [illegible] except where otherwise stated

	Reference	Date
Drawn by		
Traced by		
Checked by		17. 6. 54

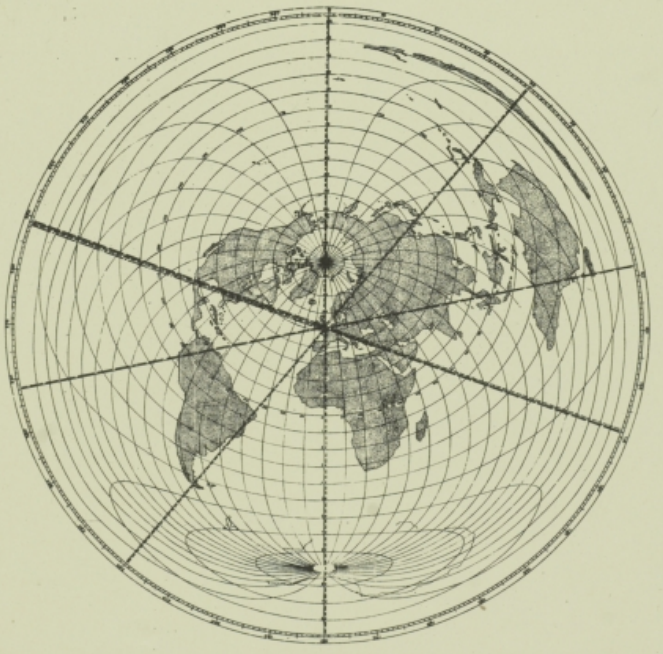
Approved by [illegible] in Radio Section

PHOTO PRINT NOT TO BE SCALED

Particulars of Amendment | By | Date

Drawings & Specifications Quoted.

SUFFIX



35·85 M. 26·8 M.

23·9 M. 17·9 M.

MAP OF THE WORLD ON PLETTS' ZENITHAL AZIMUTHAL GRATICULE GIVING THE TRUE DISTANCE AND DIRECTION OF EVERY POINT FROM LONDON.

PLETTS' ZENITHAL AZIMUTHAL GRATICULE

WL. 6867