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RESEARCH REPORT

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Air Ministry,
Great Baddow Research Station,
Nr. Chelmsford,
Essex.

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PRELIMINARY ANALYSIS OF HEIGHT-GAIN TESTS IN THE TROPOSPHERE.

Recently, between January and April of this year, six experimental flights were made under the direction of Mr. Eckersley. Their object was to study the height-gain relations at given distances from a fixed 200 mc/s. transmitter. After the first two flights meteorological instruments were installed in the aircraft, and observations of pressure, temperature and relative humidity were included in the routine. An account of the experimental procedure, with the results obtained, has already been published by Mr. G.A. Isted in report no. TR.488.

The purpose of this present report is to give an account of the preliminary work which Mr. Eckersley has instigated towards analysing and interpreting the data obtained.

Meteorological conditions in the troposphere affect V.H.F. propagation insofar as they control the variation of the refractive index of the atmosphere with height above the ground. Accordingly, the first step of the analysis was to convert the figures of pressure, temperature and relative humidity into a factor directly related to the refractive index of the atmosphere at the location of the readings. Actually, we have calculated $(\mu - 1)10^6$ as our factor since μ differs only by a very small amount from unity. The formula used was:-

$$(\mu - 1) = \frac{80}{T} \times 10^{-6} \left(P + \frac{4800\ P_w}{T}\right)$$

where $$\frac{4800\ P_w}{T} = \frac{4800\ P\ sat}{T} \times \frac{R.H.}{100}$$

and P = total pressure in millibars.
Pw = water vapour pressure, millibars.
Psat = water vapour saturation pressure, millibars.
T = degrees of absolute temperature.

Figs. 1 - 6 inclusive, have been reproduced from report no. TR.488. These graphs show the height-gain measurements made at various fixed distances from the transmitter. The altitude, in metres, and the signal strength, in decibels, are plotted on the horizontal and vertical scales respectively.

Superimposed on these graphs we have drawn curves (dotted) depicting the calculated values of $(\mu - 1)\ 10^6$, from which the change of μ with altitude can be seen.

Examination of figs. 3, 4, 5 and 6 shows a definite relationship between the two curves.

In figs. 3 and 6, the refractive index falls off at a fairly uniform rate with increase in altitude, whilst the measured signal strength is fairly uniform in its increase. Figs. 4 and 5 for 22/4/44 and 23/4/44, show how the rate of change of the refractive index on these days is no longer uniform; the corresponding height-gain curves, especially in fig.5, also show significant changes in their slope.

Figs. 1 and 2 have not yet been referred to because on these flights no meteorological instruments were carried on the aircraft. The values of the refractive index on these days were calculated from the Air Ministry Daily Weather Reports, and since considerable interpolation was necessary to arrive at an estimate of meteorological conditions in the location of the test, it is felt that the results may not show up important local anomalies.

From fig.2, relating to the test made on 29/2/44, it can be seen that there was an extremely sharp cut-off of the signal. Mr. Isted estimated that the signal went through this violent change in about 200 ft - 250 ft change in altitude. It is unfortunate that no meteorological instruments were available on the aircraft during this flight. No significant evidence shows up from our interpolated refractive index curve, possibly due to the limitation already indicated. It is interesting to note, however, that investigation of the Air Ministry Weather Report revealed wide-spread temperature inversions in the region of 7,000 feet, for a period embracing the time taken for the test. The abrupt cut-off seems to point to marked anomalous propagation associated with a well defined discontinuity at these heights.

Further analytical work is in progress upon the data available, and especially upon the attenuation curves supplied in report TR.488, but at this stage we can conclude, bearing in mind the restricted number of tests undertaken, that the results are suggestive of a quite definite correlation between the height-gain relationship and the meteorological conditions represented in terms of the refractive index of the air as a function of height.

The tests were intended to be of a preliminary nature to allow us to judge whether such height-gain measurements are helpful in predicting V.H.F. propagation conditions with a view to laying on a routine service.

The results obtained encourage us in this belief.

DISTANCE 114 KMS FROM TX.

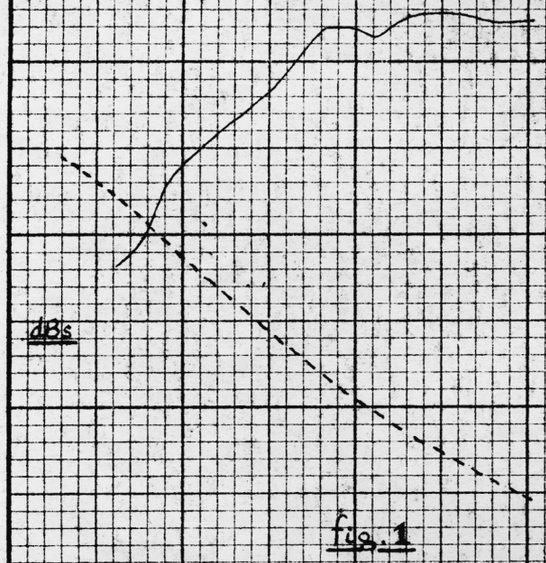

Fig. 1

DISTANCE 148 KMS FROM TX.

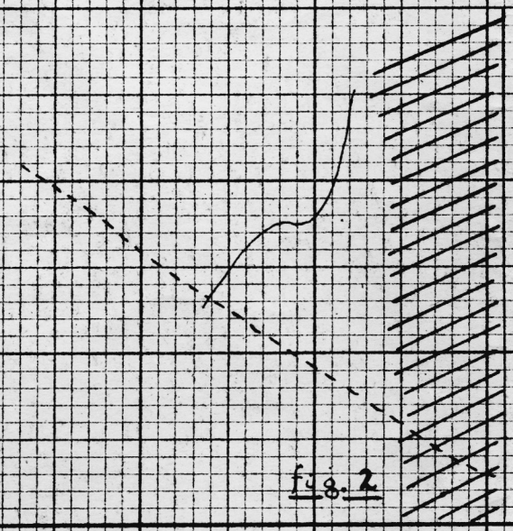

Fig. 2

DISTANCE 177 KMS FROM TX.

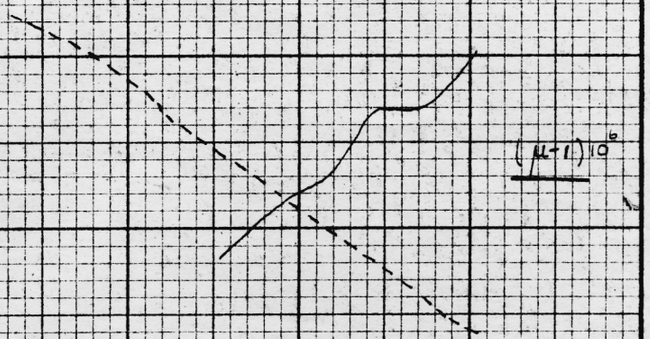

Fig. 3

DISTANCE 154 KMS FROM TX.

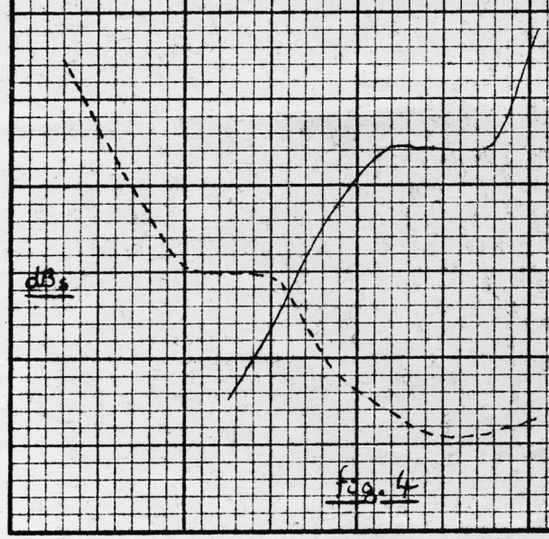

Fig. 4

DISTANCE 147 KMS FROM TX

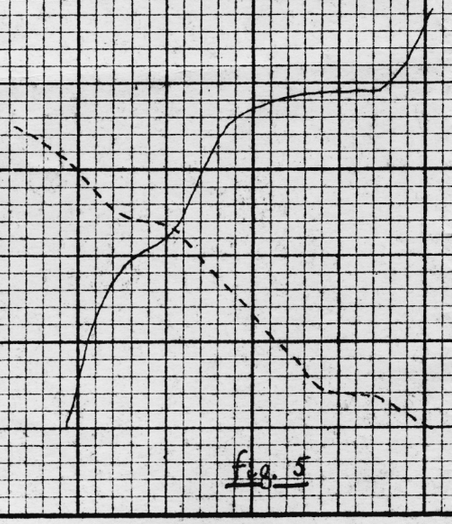

Fig. 5

DISTANCE 140 KMS FROM TX

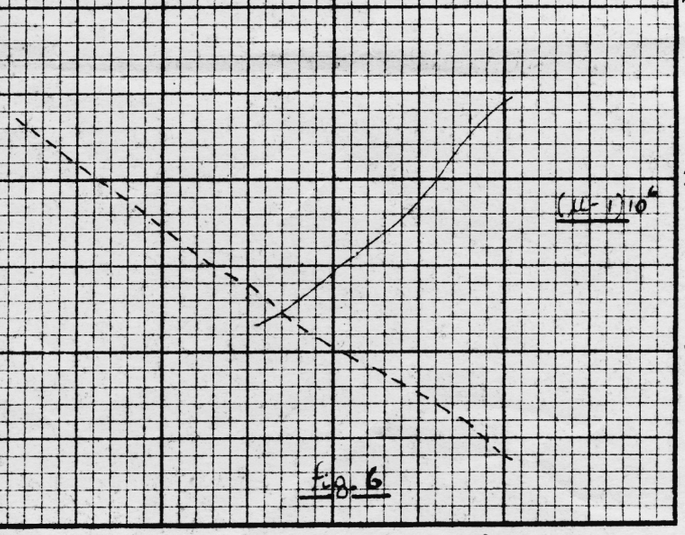

Fig. 6

1000 2000 3000 0 1000 2000 3000 0 1000 2000 3000 4000

HEIGHT IN METRES.

RD/SK 4630