CHAPTER VI

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6.1 Introduction

The results discussed so far have all been confined to measurements made on the field strength of the long-wave transmission. At the suggestion of Prof. Ramanathan, a radio-polarimeter was constructed in the laboratory in the early half of 1965 to make a study of the polarization changes in the 164 Kc/s transmissions received at Ahmedabad. The present chapter is devoted to a description of the polarimeter constructed by the author and Dr. S. K. Alurkar at the Physical Research Laboratory.

6.2 Experimental Set-up

The receiving system is shown in block form in Fig. 6.1; single and double arrows indicate unbalanced and balanced signal transfers respectively. The 164 Kc/s signal is picked up by a pair of crossed loop aerials, 6 ft. square, oriented in the N-S and E-W directions. The entire assembly is situated in an open space, away from trees and buildings.

The e.m.f. induced in the loop aerials by the incoming signal is stepped up by two identical pre-amplifiers in the loop antenna assembly. The enhanced signal from the pre-amplifiers is then fed into two separate receiver channels of
Fig. 6.1. Block diagram of L.F. Radio Polcrimeter.
superheterodyne type. Voltage from a common local oscillator is mixed with the signal voltage, which is further stepped up by two stages of R.F. amplification to produce the intermediate frequency signal. It is then amplified by the I.F. amplifiers and passed on to the quadrature plates of a cathode-ray oscilloscope through an R.C. phase adjusting network. For the calibration of the two channels a signal generator output can be switched on or off simultaneously into the two channels by means of a set of relays fixed on the aerial system.

The polarimeter thus comprises the following parts:

i) loop aerials
ii) Tuned pre-amplifiers
iii) Superheterodyne receivers with a common local oscillator
iv) Cathode-ray oscilloscope
v) Calibration unit.

6.3 The tuned pre-amplifiers

The two pre-amplifiers (Fig.6.2) one for the N-S and the other for the E-W channels are identical in design, each has a maximum gain of about 60 db and a half power bandwidth of 2 Kc. Considerable care is devoted to the construction of the circuit in order to ensure perfect balancing of the signal leads with respect to ground. The input stage (6SJ7) utilizes R.C. coupling and the subsequent two stages are transformer-coupled (6J5). For the perfect matching of the output impedance of the pre-amplifier to the input impedance
of the receiver, the amplifier output is fed into a balanced cathode follower (6SN7) and coupled by a 300 ohm transmission line to the first RF stage of the receiver by means of a loose transformer-coupling. The centre of the input coupling coil is grounded. The overall performance of the pre-amplifier has been found to be steady over long periods.

6.4 The Receivers

The receivers are a pair of U.S. Army type BC-314-G superheterodyne communication models, modified to suit the requirements of the present experiment. A common heterodyning oscillator feeds the heterodyning signal to the first detector stage of each receiver. The I.F. output from each receiver is fed by means of a shielded co-axial cable to the final deflection plates of a Du-Mont type 304-A oscilloscope. The oscilloscope trace is photographed with a 35 mm camera using an F2.8 lens. An R.C. phase shift network in the final I.F. stage of each receiver helps to correct any small difference in phase which may be present while calibrating the system.

6.5 The Common Local Oscillator

As each receiver has its own local oscillator, one of them is utilized to operate both receivers, the other being disconnected from the circuit. Fig.6.3 illustrates the method used; which follows that given by Watson-Watt et al (1933). The signal from the R.F. oscillator (6C5) is fed to a phase inverter to introduce the required phase shift of 180°. The
Fig. 6.3. Circuit diagram of Common Local Oscillator.
output of the phase inverter is fed separately to two buffer valves (6J5-2 & 3). The identical output of the buffer valves are then injected into the mixers of the two receivers. The buffer tube does not function as an amplifier but is utilized to prevent inter-mixer coupling between the two channels. A series resistance in the grid circuit of the valve makes a further contribution towards the prevention of this coupling.

6.6 Calibration unit

For calibrating the two channels for equality of phase and gain, a test signal from a standard signal generator is injected into the frames through a buffer unit (Fig. 6.4). Briefly, it consists of two precision resistances of value 2 ohms, with their junction points earthed. Stopper resistances of value 1 K-ohm were inserted at the points shown in the figure to prevent coupling between the frames. The terminals of the loop aerials along with the inputs of the corresponding pre-amplifiers were connected permanently to the fixed points of the two relays R_1 and R_2 of the D.P.D.T. type. The variable contact points of the relays were used to feed the test signal for calibration before every observation. The latter operation did not introduce any undesirable phase changes in the two channels.

If now equal voltages are fed to each frame a straight line inclined at 45° to the axes of deflection will appear on the screen of the CRO-tube, provided both channels are identical in phase and gain. Inequality in gain will tilt the straight line toward that axis whose channel has the
Fig. 6.4. Circuit diagram of Calibration unit.
higher gain, and inequality in phase will result in an ellipse instead of a straight line on the screen.

6.7 Sense of rotation of the polarization pattern

The sense of rotation of the electric vector in the incident field is determined by varying the tuning of the second I.F. stage slightly. A small capacitor is introduced by means of a switch, in parallel with the tuning condenser across the secondary of the second I.F. transformer of the N-S channel, and the change in the pattern observed. Increasing the capacity retards the phase of the N-S e.m.f. The effect of this change, when viewed in the direction of propagation, is to make the ellipse thinner and lean to the left if the spot is rotating in an anti-clockwise direction.

6.8 Experimental results

Measurements have been made with the equipment since April 1965 at a frequency of 164 Kc/s. The next chapter gives an account of the measurements made on the polarization of the down-coming 164 Kc/s radio-waves during the period May 1965 - April 1966.

REFERENCES