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REMOTE CONTROLLED ANTENNA SYSTEM FOR RADIOSONDE DATA RECEPTION

1. Upper air data is generally acquired through wind finding radar and associated radiosonde ground equipment in upper air network in our country. Conventionally the radiosonde aerial is mounted on the radar disc which vitiates the radar characteristics and restricts the free rotation of radar antenna. Also the radiosonde data is lost whenever radar is unlocked or is unserviceable. A need was, therefore, felt to develop an independent antenna system for use with radiosonde ground equipment. This became all the more essential with the increased requirement of observations on board ships and at remote places where installation of wind finding system was not feasible.

2. *System design* — The system basically consists of a helical antenna element mounted on a drive system which is operated with a remote control unit having elevation

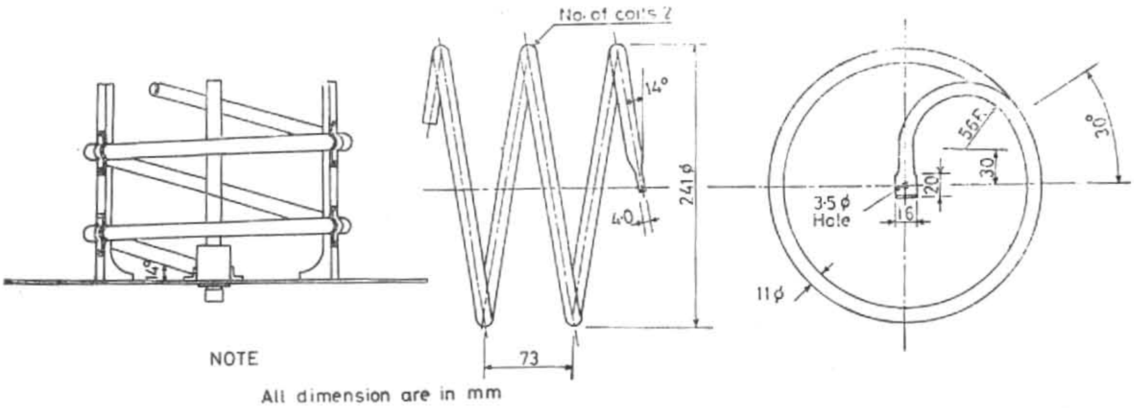

Fig. 1. Design of helical antenna element

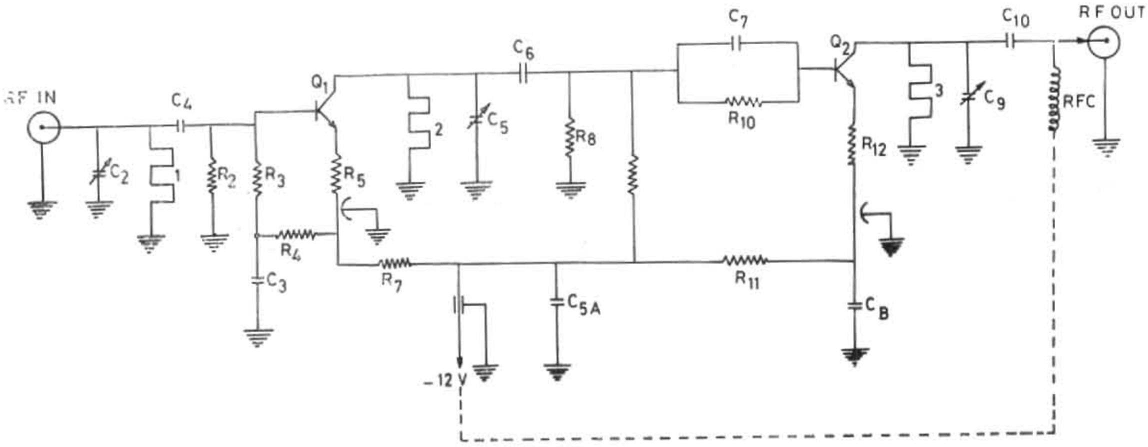

Fig. 2. 400 MHz pre-amplifier

and azimuth angle indicators. The total system may be divided into three main parts :

(*a*) Helical antenna

(*b*) Pre-amplifier

(*c*) Remote-controlled drive system

2.1. *Helical antenna* — Ideal choice for the reception of radiosonde data transmitted by a balloon-borne transmitter is an omnidirectional antenna as the location of transmitter during the flight would depend upon the prevailing wind conditions which sometimes are extremely variable. An omnidirectional antenna with the requisite gain is not a simple matter. Alternatively, one could design a high gain directional system with high resolution drive system which may be able to track the balloon-borne transmitter. Such a system shall be complicated and costly. It was, therefore, considered desirable to adopt a via media and to design a broad lobe antenna with drive facility both in azimuth and elevation so that it could be roughly directed towards the balloon-borne transmitter for clear data reception. An axial mode helical element was selected for this purpose because of its simple construction and easy design.

Basic equations governing the design of helical antenna element are given as :

Beam width (half power) : $B = \dfrac{52}{C_\lambda \sqrt{nS_\lambda}}$ deg

Beam width (First nulls) : $B_N = \dfrac{115}{C_\lambda \sqrt{nS_\lambda}}$ deg

Directivity : $D = 15\, C_\lambda^2\, nS_\lambda$

Terminal impedence : $Z = 140\, C_\lambda$ ohms

where,

n, C_λ and S_λ are number of turns in the helix, Circumference, and spacing in free space wave length, respectively.

A two-turn helix with reflector as shown in Fig. 1 was designed with a beam width of 110°, terminal impedence of 50 ohms and gain of 4.5 db. These characteristics were verified by actually measuring the radiation pattern experimentally. Total weight of antenna with reflector is only 1.2 kg.

2.2. *Pre-amplifier* — A low noise, high gain pre-amplifier as shown in Fig. 2 was designed to achieve better reception and compensate for the loss of signal during transmission through cable of length 30 to 50 metres from antenna to receiver. The specification of the pre-amplifier are as follows :

Frequency range	: 397 to 408 MHz
Gain	: 15 db
Noise figures	: Better than 5 db
Input impedence	: 50 ohms
Output impedence	: 50 ohms

The power to the pre-amplifier is supplied through the RF cable from the receiver by using RF to DC isolation circuit.

2.3. *Remote controlled drive system* — The drive system consists of a head unit for directing the antenna

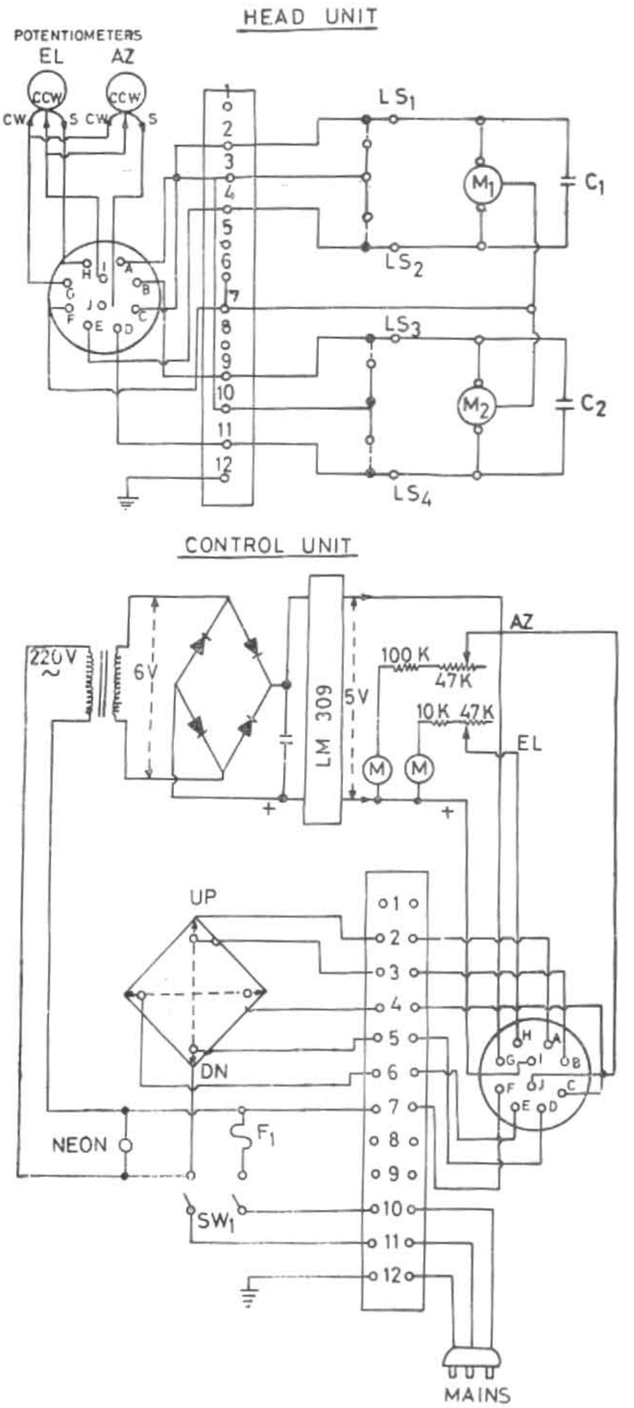

Fig. 3. Drive and control system of radiosonde antenna

and a remote control unit to control the movement of head unit. The system is similar to Pan and Tilt system commercially used for mounting TV cameras. It consists of two fractional horse power motors with suitable reduction gear systems to obtain desired speed of movement. The motors used are of phase-induction type to obtain quick reversibility and good dynamic characteristics. The circuit diagram of the drive system is shown in Fig. 3.

The movement of head unit is controlled by a remotely located unit with a joy-stick which operates four microswitches for left and right azimuth and up and down elevation. For approximate indication of pointing angles of antenna, D.C. selsyn technique has been utilised. Two continuous rotating potentiometers are coupled directly to azimuth and elevation motors and a fixed reference voltage of 3.6 volts is applied to the potentiometer. The output voltages from the rotating terminals of the potentiometor are fed to the two analog voltmeter located on thee remote control unit. The dials of these meters are calibrated in terms of angles as the voltage fed to the meters is a direct function of the position of antenna. Brief specification of the drive system are given below :

Angle of rotation (Azimuth)	: 0 to 350°
Angle of rotation (Elevation)	: 0 to 90°
Operating load	: 15 kg (maximum)
Speed of rotation both in azimuth and elevation	: 6°/sec
Overshoot	: Nominal
Weight	: Less than 10 kg

3. *Installation and operation* — Antenna is fixed with insulators on the head unit arm and the head unit is installed on a terrace free from obstruction in the surrounding area on a 2 metre high boom. Pre-amplifier is fixed at the antenna end and both signal and control cables are taken up to the ground system where the control unit is located. For fixing the north of the antenna the body of azimuth potentiometer is rotated till the needle in azimuth meter of control panel indicates north. Similar adjustment is done for elevation angles.

During initial stage of ascent, antenna is kept vertically up and in course of the ascent the antenna is directed towards the balloon within ±15° by taking the angular directions from the tracking radar or by observing signal strength on the meter provided on the front panel of the radiosonde receiver. This ensures best reception of signals throughout the ascent.

One of the advantages of this system is that during ascent frequent adjustment of direction of antenna is not required due to wide lobe characteristic of antenna which gives lot of ease to the operators. The antenna is light in weight and easy to instal. Therefore, it has proved very useful for radiosonde observations on board ships. About twenty such antenna systems are working in our upper air network and on board ships and their performances were found satisfactory.

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