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An Electrical Anemograph

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ABSTRACT. The paper describes an anemograph system suitable for installation at airports for distant recording of windspeed and wind direction. Wind direction is recorded on a strip chart recorder, whose recording head is coupled electrically through a selsyn generator and receiver to a windvane. Directions are recorded from North through East to North and North through West to North over a total of 72°. Wind speeds are recorded on a 0-1 MA DC milliammeter recorder by amplifying the AC output from a cup generator anemometer by a transistorised amplifier. Provision is also made in the recorders for changing the chart speeds.

1. Introduction

A gust of importance to aviation has been defined as a positive deviation of the wind from the mean velocity (over a 10-minute period) in excess of 10-knots, during at least 1 second but not more than 20 seconds. A numerical value for the gustiness is given by :

$$G = \frac{V_{max} - V_{min}}{V_{mean}}$$

Fluctuations in wind direction associated with gustiness are regarded as significant for aviation if they involve fluctuations of 45° or more from the mean direction.

The ICAO has recently listed the various gust parameters of operational significance. They are the gust peak speed and gust minimum speed based on values of mean speed and direction, averaged over 10 minutes and the gust formation and gust duration time. Provisional aeronautical requirements for instruments used in observing and reporting wind (including gusts) at airports have also been recommended. The instruments accordingly should be able to detect gusts being formed during a period of a few seconds and the accuracy of the measured peak and minimum speeds should be within $\pm$ 10 per cent of the measured speed. Fluctuations in wind direction associated with significant gustiness should be measured accurately to 20 degrees or less. The time of response of the instrument should, therefore, be such as to give significant gust parameters with sufficient accuracy.

Remote indicating electrical wind instruments now used at airports in India, while capable of indicating wind velocities at a distance and responding to rapid fluctuations in speed and direction are not remote recording. Pressure tube anemographs in use at major observatories for many years do not provide wind information representative of runway conditions and this, coupled with the problems of installation of these instruments at airports, have more or less precluded their use for aviation purposes. Cup contact anemographs either do not give wind speeds directly or are complicated in design and construction.

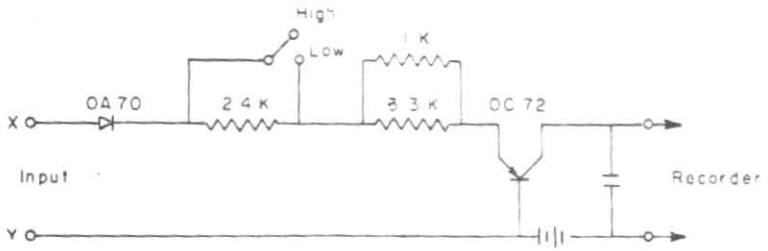

Fig. 1. Circuit diagram of transistor amplifier

The need for an instrument that would record continuously instantaneous values of representative winds from the centre of the runway complex, within the accuracies laid down under the ICAO recommendation had, therefore, been felt for sometime. The paper describes an electrical anemograph designed and constructed at the Instruments Division of the Meteorological Office, Poona to meet these requirements.

2. Description of the equipment

The instrument consists mainly of the two wind speed and direction transmitting units and the wind speed and direction display units. The transmitting units are the conventional cup generator anemometer and magslip type electrical windvane, exposed at heights most likely to give runway takeoff and landing winds within the runway complex. The display units consist of two sets of wind speed and direction indicator panels and two stripchart recorders connected in parallel and located in the meteorological briefing room and the air traffic control tower respectively.

2·1. *Wind speed indicator and recorder*— The wind speed indicator is a moving coil galvanometer with a circular scale, incorporating a metal rectifier. The current flowing in the indicator is directly proportional to the rate of rotation of the cupwheel and the indicator is graduated directly in knots. One, two or three indicators can be connected in parallel to the output of the windspeed transmitter, without affecting the accuracy of the indication, provided the total resistance of the two-core cable between the generator and indicator does not exceed 20 ohms. A transistorised amplifier provides sufficient signal strength to operate the indicators at distance up to 10 km and power to drive the recorder. It is housed in a small thermocole insulated box fitted at the back of the recorder and operates on 18 V.D.C. provided by two 9-volt transistor batteries (Fig. 1).

The recording unit is a moving coil recording D. C. milliammeter of range 0–1 mA, graudated in knots, with its movement spindle vertical (Fig. 2). Alternating current from the generator is taken to a rectifier within the recorder case. A high/low range switch provided in the amplifier triples the range from 0—25 knotes to 0—80 knots for full scale deflection. A lever arrangement enables the chart speed to be increased from 20 mm hr^{-1} to 120 mm hr^{-1} for detailed study of the speed variation with time.

2·2. *Wind direction indicator and recorder* — Muirhead magslip transmitter MKI type E39-A/1 and Receiver MKII type E-10-A/1 operating on 50 V. A. C. are used in the wind direction transmitting indicating and recording units. Unlike wind speed, continuous recording of wind direction is difficult, since the possibility of the vane rotating several times through 360° has to be allowed for. The recorder is, therefore, specially designed to record with a single pen the direction, irrespective of the rotation of the windvane and has a double scale 360°—0°—360°.

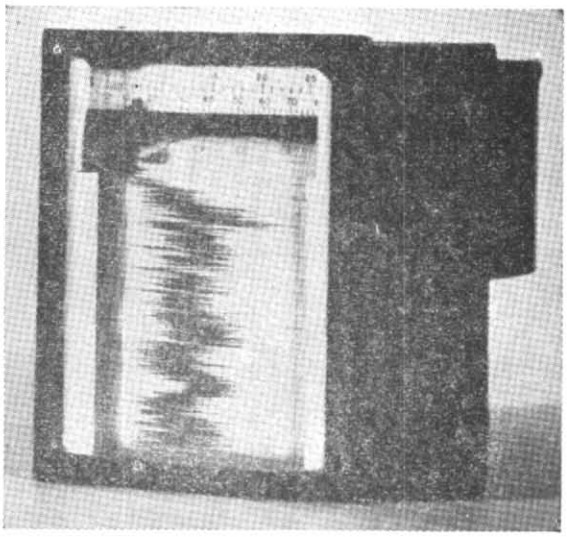

Fig. 2. Wind Speed Recorder

The direction recorder (Fig. 3) consists of a chart drive assembly operated by a self-starting synchronous motor 220V, 50 c/s and the Muirhead magslip with its associated gear and lever arrangements to give a linear movement on the chart to the recording pen arm. The recording pen arm is coupled to the magslip through a system of levers that end in a slotted tongue that engages with one of eight pins on the gear wheel engaging with the magslip pinion. The axes of the gear wheel and the recorder pen arm are so placed that when the gear wheel moves between 42 and 44 degrees from the central position, the slotted tongue disengages from the pin and is returned, by a centering device consisting of two pivoted and weighted levers, to the adjacent pin, which will be near the central position. The North is adjusted to be at the centre of the chart with NESW and NWSE marked on either side. As the vane moves from North through 360° and past the North again, the gear wheel moves through 45° releasing the tongue from the pin. The pen flies back to the 0°(N) position at the centre of the chart with freedom to move either W or E again and record either. The movement of the arm from the central position to the point of disengagement corresponds to a vane rotation of a little less than 360° and also to the movement of the pen from the centre of the chart to one of its edges. The chart, therefore, has a range of 720°.

A 50 volts transformer provides the power supply to the magslips in both the transmitter and recorder and indicator (Fig. 4). The chart drive system is capable of driving the chart at 20, 60 and 120 mm hr^{-1}, a lever arrangement changing the rate of feed as required.

3. Performance and accuracy

Sample records from the electrical anemograph obtained at Poona are shown in Figs. 2 and 3.

Both the speed and direction transmitters have a very small time of response and attain the wind conditions within about 2—3 seconds. Gust maxima and minima, as well as gust formation time and gust duration can be directly measured from the records. The instantaneous and mean wind speeds and directions during any interval can also be read from the chart.

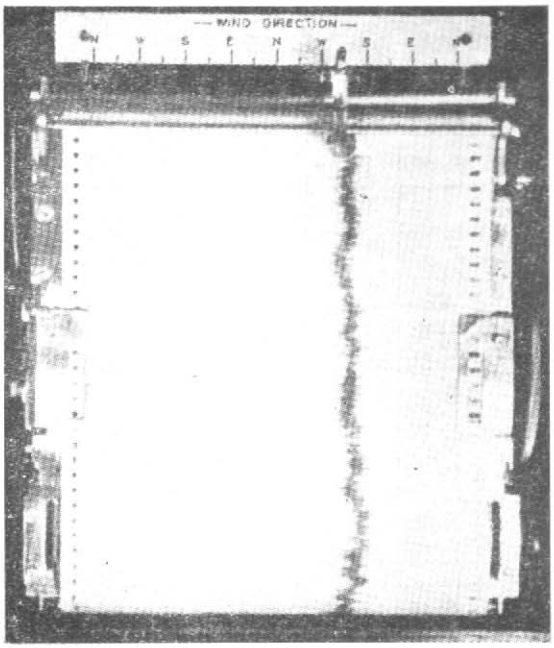

Fig. 3. Wind Direction Recorder

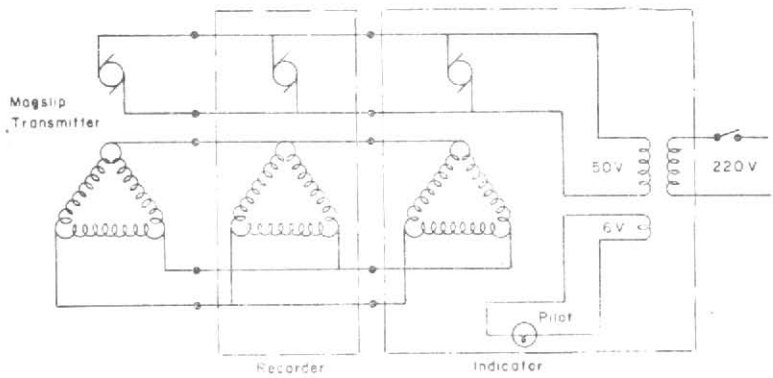

Fig. 4. Circuit diagram of Wind Direction Transmitter Indicator and Recorder

The instrument is simple, compact and easy to install. The recorders can be directly connected in parallel with the wind indicator panels already available at airport meteorological offices. Three units installed at Santacruz, Dum Dum and Poona are working satisfactorily.

4. Acknowledgement

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