A POTENTIOMETER SYSTEM FOR THE CONTINUOUS INDICATION OR RECORDING OF WIND DIRECTION[1]

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Introduction. The recording of any rapidly fluctuating variable having a 360-deg rotation poses irritating problems, since it is difficult to avoid discontinuity at the limits of the typical strip chart. The problem has been solved by several commercially available electromechanical devices which are fairly complex. In each of these, a specialized recorder is required, so that the instrument tends to be rather expensive. The device described in this paper consists of a relatively simple potentiometer and switch system in the transmitter coupled to a standard recording milliammeter. It is believed that the system provides data of quality comparable to available equipment.

The potentiometer system. One of the more useful sensing elements for wind direction measurements is the potentiometer, which can be obtained in a very wide range of accuracy, torque, size and cost, depending upon the needs of the user. Heretofore, wind vanes utilizing standard potentiometers have been suitable only for short-term recording, owing to the rapid alternation between high and low readings when the brush passes over the break in the resistance circuit. The Beckman and Whitley wind-direction record shown in fig. 1 is an excellent example of the confusion resulting from this alternation.

A twin-brush potentiometer with a winding of 270 deg is the basic sensing element of this instrument. As shown in fig. 2, the potentiometer is connected to the wind vane through a gear train which causes the brushes to rotate at one-half the vane speed. Thus, each brush is in contact with the winding over a full 540-deg rotation of wind direction, and it is necessary to switch to the opposite brush only when the one in use approaches the end of the winding. This is accomplished by the 270-deg and 90-deg switches, S1 and S2, coupled to a double-pole, double-throw relay. In the positions shown in fig. 2, one side of the relay coil is connected to the DC power supply through S1, but the other side is open, so that the relay is not energized and the measuring circuit is operating through the brush designated as B1. If one visualizes a clockwise rotation of the wind vane, it becomes apparent that the closing of switch S2 energizes the relay coil and pulls the two sets of contacts into the left-hand position so that the brush B2 is in the measuring circuit. Further, it will be noted that even if the wind direction changes so that the switch S2 opens, the relay will remain energized through one of its own contacts until a shift sufficient to open switch S1 occurs. Thus either brush, once it enters the measuring

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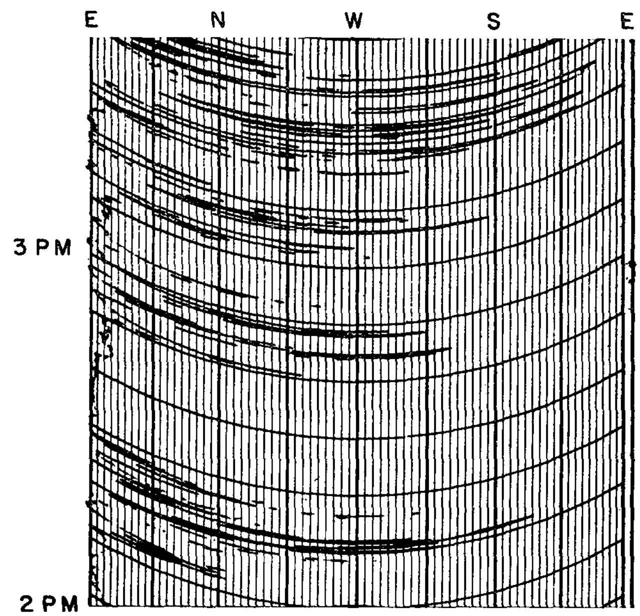

FIG. 1. Section of wind direction record taken from a Beckman and Whitley 170–3. Confusion is created when the potentiometer brush repeatedly crosses the break in the resistance winding.

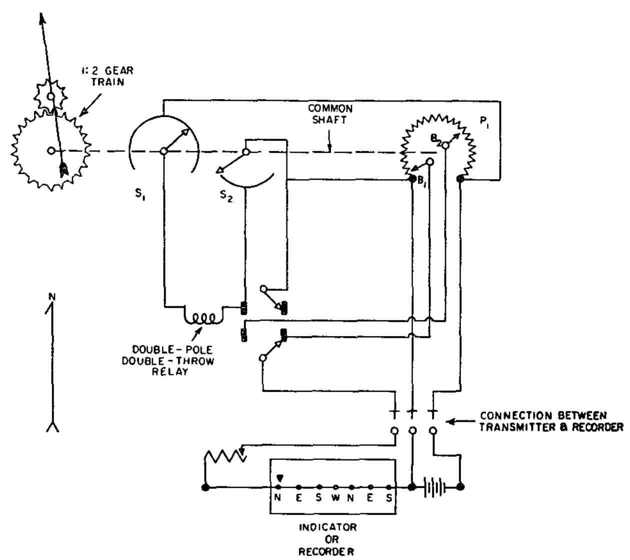

FIG. 2. Schematic diagram of circuit utilizing a twin-brush potentiometer.

circuit, must remain in use until the wind direction changes 180 deg in one direction or 360 deg in the other. The record given by this device is shown in fig. 3.

Fig. 4 is a view of the first working model of the instrument. It will immediately be noted that this is similar in appearance to the Beckman and Whitley model 170-3, and indeed the actual vane and drive assembly of a Beckman and Whitley instrument is normally attached to the device.

The switching devices consist of two Microswitches (1SM1 with JS22 actuator) operated by 90-deg and 270-deg cams. An alternative design utilizes brushes and slip rings for an extremely sensitive response to light winds. This particular instrument was intended for use at 350 ft above ground, and the greater torque associated with the Microswitches is not detrimental owing to the generally strong wind flow prevailing at these altitudes. The relay in this model is a Filtor 6SCG, and it is believed that similar hermetically sealed units are desirable for most vane installations. The potentiometer used is a Giannini model 8511 (Microtorque) altered for two-brush operation.

The torque required to turn the entire assembly is about the same as that needed to turn the potentiometer itself directly, because of the 1 : 2 gear ratio between the vane and the switch-potentiometer system.

The instrument has been used successfully with a 6-v DC power supply, and both 0- to 1-ma and 0- to 5-ma Esterline-Angus recorders. Any similar recording system would certainly be suitable.

Accuracy and applicability. The accuracy of the system is dependent essentially on the linearity of the potentiometer and the deviations of the brush positions from a perfect 180 deg orientation. It would appear that the precision of the two switches, S1 and S2, would also be important to the accuracy of the unit, but this is not actually the case. In practical applications, it is not necessary that the pen shift precisely at the chart margins but only that the pen position accurately reflect the vane orientation. The lengths of the leads in the measuring circuit contribute a systematic error to the indication, but this can be eliminated with the zero adjustment of the meter. The quality of the record produced by this instrument can therefore equal that of any device currently available or, alternatively, it may be made very inexpensively at some sacrifice in accuracy.

As shown in fig. 2, three electrical leads connect the recorder and power supply to the transmitter in the vane. Since the power is used to operate both the switching relay and the measuring potentiometer, it must be adequate to provide a voltage which does not change significantly when the switching relay operates.

It is reasonable to expect the durability of the device to be comparable to that of other quality

FIG. 3. Section of wind-direction record from the twin-brush potentiometer device. The switching of the pen position from the right-hand margin to the duplicate West is easily seen.

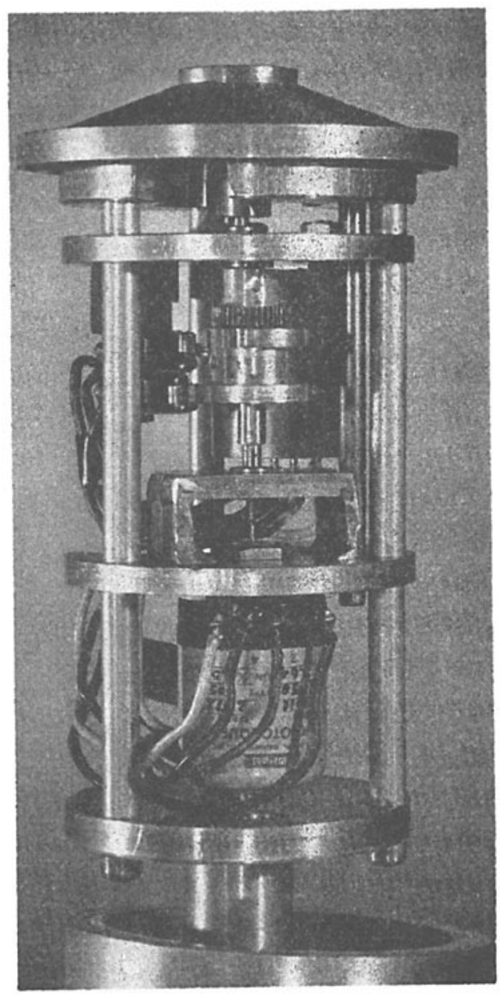

FIG. 4. The direction transmitter assembly. The first working model of the device is shown with the protective housing removed. One of the gears and the 90-deg and 270-deg cams are visible, as is the potentiometer.

instrumentation now in existence. The prototype has operated for six months without apparent difficulty. The limiting factor is likely to be the potentiometer, particularly the mechanical wear of the brushes on the windings. Arcing or similar electrical problems are not serious because of the extremely low wattage required.

Conclusions. The potentiometer wind-direction system described is a method of removing ambiguity and confusion from wind-direction records by utilizing a twin-brush potentiometer turned at one-half the rate of a vane, together with appropriate switching units. This device has advantages over existing systems in that it can be used with standard recorders, and it requires only three wires between the transmitter and the recorder. It seems probable that the device can be made sufficiently durable and accurate for most applications.

COMPARISON OF FLORIDA AND CALIFORNIA FREEZING-NUCLEUS MEASUREMENTS, JANUARY 1957

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1. *Introduction.* Measurements of freezing-nucleus concentration were made at Stanford, California, in January 1956 [1] as part of a widespread chain organized by the Radiophysics Laboratory, Commonwealth Scientific and Industrial Research Organization. These results suggested that there were peaks in freezing-nucleus concentration similar to those reported by Bowen [2] in long term totals of rainfall. In January 1957, stations, using improved equipment, were established in Florida and California with the help of the U. S. Weather Bureau and Stanford University, respectively.

2. *Apparatus.* The equipment was similar to that described by Warner [3] and consisted of a 10-liter refrigerated tank held at −10C. The air sample was cooled to any required temperature below this by a controlled adiabatic expansion. The ice crystals which formed were detected when they fell into a dish of supercooled sugar solution at the bottom of the tank.

3. *Procedure.* At West Palm Beach, Florida, the apparatus was installed at the Lake Worth Coast Guard Station on Peanut Island, and observations were made where possible in on-shore winds in order to be free from contamination by terrestrial dust or smoke from industrial sources. Three or more observations were made at each of a series of fixed temperatures and a graph of ice-crystal concentration against temperature was obtained. In general, only one series of observations was made each day. Where two series of observations were made, no significant difference was observed between the mean results. The number of ice crystals usually increased logarithmically with decreasing temperature (fig. 1).

At Stanford, California, following the experience of the previous year, it was considered preferable to take a series of observations of ice-crystal concentra-

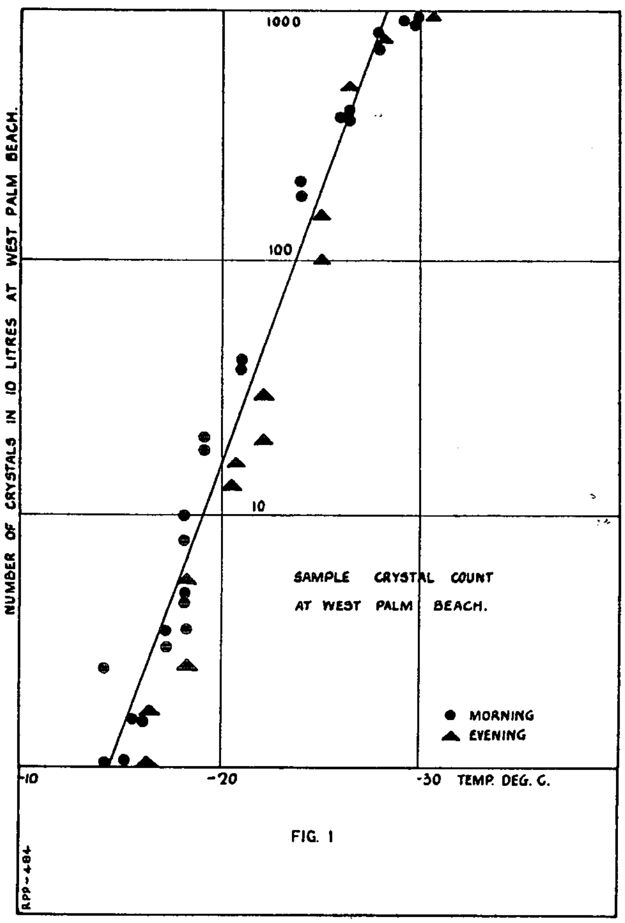

FIG. 1. Sample freezing-nucleus count from West Palm Beach, Florida. Number of ice crystals at indicated temperature.

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