A SUGGESTED TOTALISING ANEMOMETER FOR OCEANOGRAPHERS

by

J. N. CARRUTHERS, D. Sc. (Lond.), F. Inst. P., F. G. S.
Fisheries Laboratory, Lowestoft.

The student of wind-driven currents in the sea often requires wind data in a form in which they are not to be found in the usual records. For application to various problems, he would like to know of a given period, what wind, considered to have blown unceasingly throughout it, would have effected the same flow of air past a fixed place of observation as did all the changing winds which actually blew. Although various meteorological records furnish information concerning the total mileage run of wind over stated periods — as obtained from recording anemometers, it is not possible to learn from them what proportion of the total run is referable to the various directions from which the winds may be known to have blown.

The writer of this note has thought that meteorologists, like oceanographers, might find good use for wind data such as could be afforded by an instrument designed to integrate winds in point both of direction and speed. For instance, it is reasonable to suppose that the student of various fundamental problems of climatology and oceanography would benefit greatly from the possession of more extensive data concerning the seasonal variations in strength of the north-east and south-east trade winds. If an instrument designed to supply such data in a simple manner (such as the one to be described below), could be used at a number of suitable island stations in low latitudes, the resulting information upon the rate of ebb or flow of air per month from or to the northern hemisphere, could hardly fail to be of great value in important connections. In mentioning the desirability of maintaining continuous observations upon the variations of such important meteorological elements, we have in mind the consideration paid to them by Sir Napier Shaw in various publications, (1) and certain conclusions reached in a relevant paper by Brooks (2).

Hitherto, in connection with the study of marine currents, it has usually

---

(1) Sir Napier Shaw : *Harmonies and Syncopations in the Seasonal Variation of Atmospheric Elements.*
Gerlands Beitr. z. Geophysik, 33, (Köppen-Band II), 1931, pp. 351-352 ;
The World and Its Weather.
The Listener, August 13, 1930, pp. 239-40 ;
The Drama of Weather.
Cambridge, 1933, pp. 205-207.

(2) C. E. P. Brooks : *The Role of the Oceans in the Weather of Western Europe.*
Q. J. Roy. Met. Soc. LVI, 131-40, April, 1930.

been found necessary to prepare vector-averages of large numbers of individual observations of wind strength and direction.

Several ways of obtaining the desired data by mechanical means have been considered, but, for a variety of reasons, it has been preferred to suggest the use of water as the indicating medium.

It would be a matter for surprise if the idea of using water in some way to integrate winds in respect of direction alone had not previously been conceived. Clearly, it would be simple to let water drip under constant head from a suitably placed hole in a tank orientated by a wind vane, so that the water fell into a fixed circular receptacle provided with radially disposed compartments each labelled for a specific direction of wind. Alternatively, water could be delivered at a constant rate down a tube pointing in a fixed direction so as to fall into one or other of the compartments in a radially-divided tray turning with a wind vane.

The latter alternative might be desirable on practical grounds if it were desired to have the vane mounted on a pole away from buildings; it would, too, remove any need to have water carried high.

The former type would be the more easily constructed and would be more convenient where installation on the roof of a building was contemplated. It is, apparently, to Mr. Richard BENTLEY of Slough that the credit goes for first conceiving the idea of integrating wind direction in this manner. Mr. E. G. BILHAM possesses a description of Mr. BENTLEY's instrument; this "was printed for private circulation but does not appear to have been published" (1). The instrument in question was devised for roof installation and worked on the lines of the first of the two alternatives mentioned above.

An instrument to integrate both direction and strength of wind is naturally a much less simple matter to design. Its indications must be positive — such that the same record is made for a mile of very slow wind as for a mile of fast wind. This rules out any simple device such as allowing rotating cups to drive a suitable system of small dredger-buckets so as to dip water in quantities appropriate to the flow of air past the instrument. With different wind speeds the frictional resistance of the water on the cups moving through it would vary. The writer's colleague, Mr. H. J. BUCHANAN-WOLLASTON has suggested the employment of an Archimedean screw to effect the conveyance of the water with minimal friction.

Various ways of achieving the desired end were considered, but it was finally decided that it would be best to design an instrument comprising two distinct units. It is considered that if the direction-indicating unit and the wind-measuring unit are separated, it will be much easier in practice to arrange for the parts calling for protection against frost and weather, to be enclosed in a small hutment.

On really cold days, obvious steps could then be taken to guard against the freezing of the water, though the addition of some "anti-freezing" liquid to the latter might suffice.

---

(1) This information is from a letter (dated 23rd October 1934) received by the writer from Dr. C. E. P. BROOKS.

At the outset, an all-mechanical instrument was designed, but it was later thought much better to arrange for the employment of electricity in a simple manner. When the question of designing an all-mechanical instrument was under consideration, it was decided to limit the work to be done by the rotating cup system to the operation of an escapement device. The idea was that all work against resistance inherent in the indicating, should be performed by drawing upon the potential energy of a freely hanging weight. The range of wind travel to be allowed for was not the only constructional difficulty envisaged if it were intended to use water as the indicating medium.

Sight was not lost of the possibility of designing an instrument modelled upon the chief feature of certain current-meters in use in marine researches which, employing a very ingenious device due to EKMAN, operate to drop balls in accordance with the flow of water past them (1).

Although the absence of any need for a compass would be a simplification in the case of an anemometer, and although, with a ball-dropping instrument, there would be no necessity to guard against frost and evaporation, nor any difficulty in allowing for a large range of wind travel, it has been considered that the advantages of an instrument employing water as the indicator are great enough to outweigh those which would obtain with a ball-dropping type.

If water be used, it will be possible to take the readings very speedily, and the instrument will lend itself to simple adaptations designed to give it a popular appeal. The latter is most desirable in the hope that more instruments will be set up than would be the case if interest were confined to meteorologists proper.

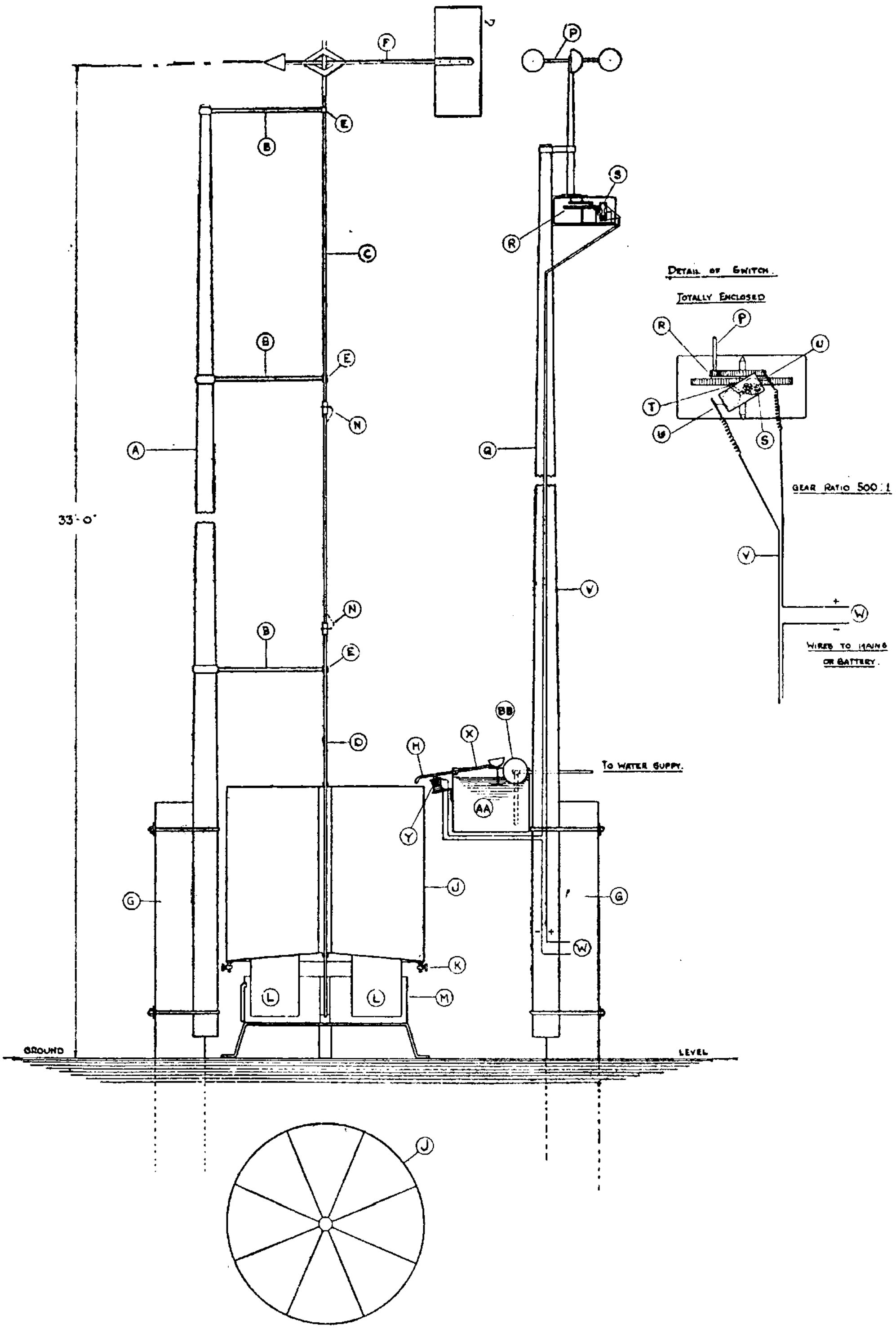
The accompanying diagram, (2) which is self-explanatory to a large degree, depicts an instrument which could supply wind data of the type specified at the beginning of this note. *A* and *Q* are ordinary wireless posts set up on tabernacles so that they can be taken down at will. A vertical rod *C* which is held off from the post *A* as illustrated, turns with the wind vane *F* which is mounted at standard height. In so doing it orientates a circular tank *J*. This latter is divided into sectors as shown, and each sector is provided with a draw-off tap. The two parts marked *L* are damping plates dipping into water contained in a shallow tank *M*. Their function is, of course, to suppress any undue liveliness on the part of the vane. The rod *C* is provided with small jointing sleeves *N* to permit dismantling when necessary. The vane *F* could, if desired, be replaced by a stream-lined metal object.

The measuring unit comprises a set of cups *P* mounted at standard height. It was originally intended to suggest the employment of a 3-cup system with cups mounted on a spider shaped like the Manx Coat-of-Arms.

---

(1) For an account of one such instrument see "Fisheries Notice" No 17 issued by the Ministry of Agriculture and Fisheries.
See also *The Hydrographic Review*, Vol. IV, No 2, Monaco, November 1927, page 207, and
" " Vol. VI, No 1, Monaco, May 1929, page 157.

(2) For which I am indebted to Mr. H. J. GARROOD, A.M.I.M.E., of the firm of ELLIOTT AND GARROOD — makers of oceanographical instruments.



33'-0"
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
S
V
W
X
Y
AA
BB
DETAIL OF SWITCH.
TOTALLY ENCLOSED
T
U
GEAR RATIO 500:1
WIRES TO MAINS OR BATTERY.
TO WATER SUPPY.
GROUND
LEVEL

Such a 3-cup system is used in the writer's current-meter described in the "Fisheries Notice" to which reference has already been made. It was adopted after reading that investigations by FERGUSSON in the United States and PATTERSON in Canada agreed in showing "that the three cup anemometer is decidedly superior to the four cup", and that "the final form of the new (three cup) Canadian standard has been adopted through conversations and correspondence from our (PATTERSON's and FERGUSSON's) combined results" (1). Apparently, however, after using 3-cup anemometers throughout the four years 1928 to 1931 as the Weather Bureau standard in the United States, a return to 4-cup instruments was made. MARVIN writes: "we do not want 3-cup anemometers for accurate measuring instruments any more than we want 3-cylinder engines for our best automobiles, and for much the same reasons — inadequate, erratic, undependable starting and driving torque" (2). It is, therefore, considered that good reason exists for suggesting the employment of a 4-cup system here.

R is the reduction gearing and *V* marks the wires carrying current from the electric mains or some other suitable source of supply.

One possible source of difficulty has called for special attention. As the cups rotate, an electrical circuit has to be periodically made and broken. At times when the cups were rotating fairly quickly, no difficulty would arise in providing for breakage of the circuit. When, however, there was only a very weak wind blowing and the cups were only just rotating, it might easily happen with any ordinary switch gear that the circuit would remain made. To avoid this chance, a special type of switch gear *S* has been devised. It is suggested that contact be made by means of a conductor borne on a pivoted tube containing a sand-glass of the egg-timing variety. It would be arranged that contact would not be made until this component had been rotated far enough out of the vertical for the heavier end (the sand-filled end) to be higher than the empty end. Then, if the cups stopped, the circuit would be broken when sufficient sand had transferred itself to cause the tube to take up a vertical position again. Of course, except at times of very weak winds, the sand-glass would fulfil no function.

When the circuit is made, a solenoid *Y* becomes energised and operates to rock a small pipe which is pivoted on the rim of a tank *AA* which is always full of water. This pipe *X* carries a dipper at one end which dips a constant load of water each time the circuit is broken, and which delivers some or all of its load along the pipe each time the circuit is made. In this way it is proposed to arrange for positive registration so that a given mileage run of wind will yield the same indication for all speeds, except in so far as varying slip on the cups is concerned. *BB* marks a common cistern ball valve controlling constant level when connection is made with the water supply.

It is realised that it might be well to employ a pair of solenoids — one

(1) See J. PATTERSON, *The Cup Anemometer.* Trans. Roy. Canadian Soc. Ser. 3, XX, Section III, 1926.

(2) C. F. MARVIN: *A Rational Theory of the Cup Anemometer.* Monthly Weather Review, Washington, February 1932, p. 52.

*

on the rocking delivery tube and the other fixed on some fitment provided just underneath. If this were done, it would be an easy matter to arrange to give the two appropriate ends opposite polarity.

As water issued from the delivery tube it would, of course, fall into the radially-partitioned tank. After the instrument had been working for one or more days, the water would be drawn off from the various compartments into measuring cylinders.

Having calibrated the instrument against a standard anemometer of known factor, it would be an easy matter to learn how many miles of wind had blown from the various directions represented.

It would, too, be easy to work out the residual wind — as the vector-average wind is often termed in oceanographical circles.

As already stated, provision would be made to guard against mishap through freezing and other effects. This would present little difficulty.

The gearing and the switch component would be cased in.

In designing this instrument regard has been paid to relevant quantities, although the illustration, being diagrammatic, does not indicate this. It is realised that such an instrument would have to give as acceptable indications for days on which little air flow occurred as for days witnessing strong wind conditions. This means chiefly that the compartments of the receiving tank might have to be grotesquely large for the amount of water which would frequently be drawn from them. Guidance as to the upper limit of tank size could be obtained from the consideration that such a daily run of wind as 600 miles (23rd November 1928 is in mind) might be experienced. Clearly, it might be a practical advantage to arrange that modest supplies of water would be accommodated in tubes projecting from the bottoms of the compartments — or at any rate that the tank should be funnel-shaped at the bottom.

The engineer interested in coastal erosion problems would presumably be very interested in such continuous wind data as the suggested instrument would afford, and the writer has reason to know that the geographer whose concern it is to trace coast-line changes would certainly be. When it is mentioned that an attempt would be made to arrange that the instrument could work for days on end — perhaps for a whole week — without needing to have the receiving tanks emptied, another possibility becomes apparent.

We refer to the appeal such an instrument might conceivably make to the authorities of watering-places who are interested in keeping meteorological records.

It would be easy to arrange for the water to be delivered into a receptacle of such a nature as would enable the public to see from day to day in the local meteorological kiosk, what the wind conditions had been. The easiest way of arranging this would be to provide each compartment with an external glass indicator tube clearly labelled for direction and set against a background carrying a scale indicating miles.